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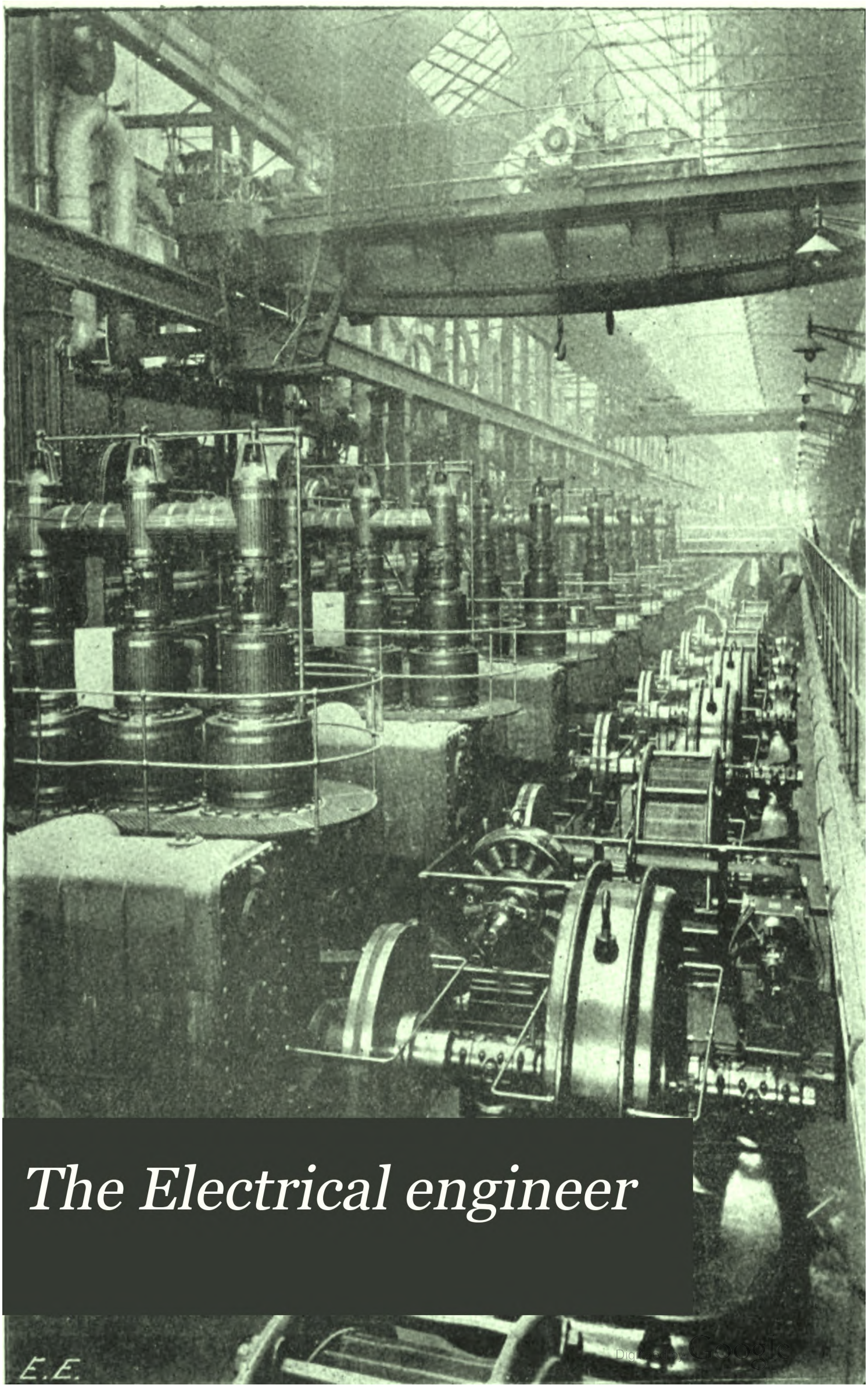

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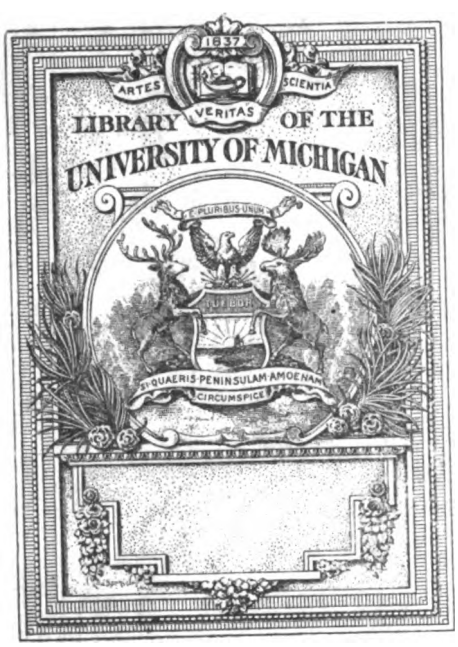

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THE

ELECTRICAL ENGINEER.

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NOTES.

Books Received.—We have received from Messrs. Swan Sonnenschein and Co., Limited, a copy of "Electricity Made Easy," by Messrs. E. J. Houston and A. E. Kennelly.

New Year's Greeting.—The Scottish firm of Messrs. D. Bruce Peebles and Co., which has recently taken up the manufacture of electric motors, has sent out to its friends a neat New Year's card. A view of the works where the P P P protected and enclosed steel-clad dynamos and motors are manufactured and a photo of a motor illustrate the good wishes.

Electric Boats.—It is perhaps not generally known that the idea of propelling boats by electricity is a comparatively old one. According to *Electra*, a successful attempt was made by Prof. Jacobi in 1838, who used at first Daniell and later on Grove elements. His boat seated 12 persons, and a speed ranging from 2·3 km. to 4·17 km. per hour was attained.

London Tramways.—We are glad to note that the Tramways Committee of the Nottingham Corporation have so modified their position that Mr. Baker will be released at the end of this month, and will be free to take up his duties as manager of the London County Council tramways. By so doing they have not only obliged the London County Council, but also have shown a kind consideration to Mr. Baker, who has our best wishes for success in his new work. The Nottingham Committee have now appointed Mr. John Aldworth to succeed Mr. Baker.

Ghent Exhibition, 1899.—A competition of motor-cars for the use of fire brigades will take place at the forthcoming international provincial exhibition in Ghent. The conditions are that upkeep, consumption of coal, and production of machine must not be too costly, and that the machines must be always ready to start. They are to be used for fire-engines, escape ladders, water-carts, etc. Exhibits will be classed in two sections, one for vehicles of 2½ tons and the other of vehicles capable of transporting five tons when fully loaded; they must be capable of a speed of 12 miles per hour on the level. A detailed report of the trials will be issued.

Industrial Congress at Buenos Ayres.—We have received a communication from a committee which is organising an industrial congress at Buenos Ayres, Argentine. It sets forth that every respectable person, no matter wherever his or her abode, will upon application be enrolled as a member of that congress, and will be entitled to receive diplomas, publications, etc. The various branches of industry and agriculture will form part of the discussions. Those who wish to enjoy all these privileges may obtain them by addressing El presidente del Comitè de Organizacion del Congress industrial Argentino, Don Eduardo Castro, Lorea 86, Buenos Aires. After dwelling upon this honour to be conferred upon mere foreigners in the grandiloquent language which comes so natural to the noble don, it is incidentally mentioned that no communications will be noticed unless accompanied by £1. 12s. per applicant.

The Franklin Institute.—This institution, which has its home in Philadelphia, has decided to extend its membership on the lines of the following resolution: "That the Board of Managers hereby authorises the creation of a class of junior associates, to be composed of persons 'friendly to the mechanic arts' between the ages of 18 and 25 years, who, in consideration of the payment of an annual fee of 3dol., payable in advance on Oct. 1 in each year (or a *pro rata* amount after Jan. 1), shall have the following rights and privileges—viz., the use of the library and reading-room, and attendance at all meetings of the institute and of the several sections and the lectures."

The London Chamber of Commerce.—A meeting of the Electrical Trades Section of the above Chamber of Commerce will be held to-day (Friday, 6th) to discuss the following questions: firstly, the threatened municipalisation of electrical undertakings, and to consider what action should be taken in reference thereto; secondly, to consider the applications now being made by corporations for power to deal in electrical fittings and apparatus, and what action should be taken in reference thereto; thirdly, to consider the present position of electrical supply companies in London; and, lastly, to consider a proposal for a separate trade section of this Chamber in the exclusive interests of electrical traction.

Klondyke Telegraphs.—Those who invested their money in response to the recent advertisement of the Canadian, British Columbian, and Dawson City Telegraph Company will find little consolation in the following statement, which appeared in the London *Daily Mail* of Tuesday last. This was to the effect that "the Canadian Government is contemplating the construction of a telegraph line and wagon road from Ashcroft, a point on the Canadian Pacific in British Columbia, to Dawson City, a distance of 1,400 miles. It is estimated that the enterprise will cost £1,100,000." If this figure is at all correct, it is another instance of how much the above-mentioned company has over-stated the cost of construction of the telegraph line, as the wagon road will cost a very large proportion of the above amount.

The Electric Arc as a Cutting Tool.—There have been frequent references made in our columns, and in those of the daily Press, to the advantage which the electric arc would give to the burglar should he wish to gain access to a locked safe. We expressed the opinion that although with such an arc steel plates can be more or less readily melted, the burglar has not much chance of using this new accessory to his present number of tools. We see in the *Electrical Review* of New York, that the case is reversed at Cincinatti, Ohio, where the bank authorities are using the electric arc for such a purpose themselves. An old strong-room, built up of steel plates 2½in. in thickness, was found to be greatly in the way of some improvements required by the bank, and ordinary means, short of blasting, proved

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ineffective in breaking up the structure, and in consequence a firm has undertaken to cut the plates up into removable sections, by using the arc supplied from the town mains. We fancy the bill for electric energy will come out rather high.

Electric Automobiles.—The recent severe snowstorm in New York City gave the first opportunity for observing the behaviour under trying climatic conditions of the cabs and broughams operated by the Electric Vehicle Company. To the surprise of even some of their most staunch upholders, the electric automobiles, says the *Electrical World*, gave better service through the trying night of Nov. 26 than did the horse-drawn vehicles. The cabs ran through the whole night, the last coming in about six o'clock in the morning, by which time the snow had reached an average depth of about 8in., and much more where drifted. Other cab companies turned over orders to the electric service rather than fill them themselves. No very marked change in their running was noticed, although the mileage per charge of battery was, as a precautionary measure, greatly reduced, the vehicles being ordered in for fresh charges after covering 10 or 12 miles. The ease with which they ran is probably due to the large pneumatic tyres, 5in. in diameter, with which they are fitted, which give a large bearing surface and reduce the tendency to cut deeply into the snow.

Enemies of the Telegraph.—The *Daily News* has collected a few instances of the destruction of telegraph poles by animals which have been met by the telegraph engineers. Thus, before the bisons were killed off the American prairies they used the telegraph as rubbing posts, and sometimes threw down miles of the lines. Norway has a large woodpecker which pecks great holes in the posts, presumably under the illusion that nests of insects are inside, and that the humming of the posts, due to the vibrations of the wire, is caused by them. California, too, has a woodpecker which pecks little holes in the posts, and fills them with acorns for its winter store. Now we learn from the *New York Sun* that the bears of Aristook, in Maine, U.S., have taken to climbing the posts and breaking off the porcelain insulators which carry the wire, probably because they have some resemblance to their favourite crab apples. Our contemporary forgets two modern instances of such destruction The first we have in mind is the Arab of the Soudan, who for many years used telegraph poles for fuel whenever possible. The second and more grievous animal is the ordinary small boy with a stone in his hand.

Electricity in the French Navy.—Following up the circular letter of Sept. 12 last regarding the acquisition by the navy of electrical workmen under a three years' volunteer enlistment provision, the Minister of the Navy has sent to the vice-admirals, the army corps commandants, and the naval prefects a set of examination papers on theoretical and practical points, which all candidates will be required to pass. The manual tests will, says the *Electrical World*, consist of three pieces of work, to be selected from each of the three groups denoted by the letters A, B, and C. A—(1) To make up a joint in a stranded conductor; (2) splice two conductors together; (3) prepare a wire brush; (4) bevel a brush; (5) restore a brush, the wires of which have been bent. B—(1) Put together a switch; (2) put together a push button; (3) make a fuse; (4) make a terminal; (5) make a socket to fit a given incandescent lamp. C—(1) Take a Leclanché cell to pieces and set it up again; (2) take a vibrating bell mechanism to pieces and set it up again; (3) to cut a bell or a galvanometer into a given circuit; (4) being provided with a battery, a bell, and a push button, to arrange them properly in circuit. We cannot congratulate the Minister of the Navy on the above list, as it is far from up-to-date. Thus wire brushes for dynamos are things of the past.

Rotary Converters.—Mr. C. P. Steinmetz contributes to the *Electrical World* the first of a series of useful articles on this subject, which was brought so largely before the English Institute of Electrical Engineers by Prof. Thompson's paper. The first article, which we have before us, is largely of an introductory character, but Mr. Steinmetz goes thoroughly into the question of the effect of increasing the number of phases on the alternate-current side. His results in this respect are summarised up in two tables, which give the relative heating of a machine when used as a continuous-current generator and as a converter with a supply of one, two, three, four, six, twelve, or as many phases as there are commutator segments. From these it is seen that, assuming an internal energy loss of 4 per cent., and assuming unity as the power factor of the incoming current, a 100-kw. machine must be limited, for the same copper heating, to a rating of 82 kw. if used as a single-phase converter, but may be run at 131 kw. with three-phase supply, 161 with four-phase supply, 194 kw. with six-phase supply, and 231 with as many phases as commutator segments. These figures are, of course, based on the use of commutators properly proportioned for the increased load.

The Motorcar Show.—It has been announced that it is the intention of the Automobile Club to hold an international show of motor vehicles and accessories on the Richmond Athletic Ground from June 24 to July 1. An exhibition building of 12,000 square feet (which can be considerably increased if desired) is proposed to be erected for the display of motor vehicles and their accessories. Another building will accommodate the vehicles to be shown in motion on the track and on the hills in the neighbourhood of the show. Steps are being taken to obtain the patronage and attendance of members of the Royal Family and others in high positions. The objects of the show are stated to be: (*a*) an exhibition of motor vehicles and accessories; (*b*) time tests of motor vehicles on the track (three laps to the mile); (*c*) motor cycle races; (*d*) hill-climbing tests in the neighbourhood of Richmond; (*e*) awards for the best design and general appearance of motor carriages; (*f*) competition for commercial motor-vans, omnibuses, etc.; and (*g*) conveyance of public in motor vehicles on the track. A charge of 1s. per foot is to be made for space for exhibition of motor vehicles in the exhibition building. It is proposed to make arrangements with the railway companies by which persons from all parts of England may visit the show at reduced fares.

The L.C.C. Architect.—Mr. Horace T. Bonner, A.R.I.B.A., sends an indignant letter to the *Daily Mail* on the above subject. He is particularly incensed that out of the nine selected candidates for the post of architect to the London County Council, not one was considered capable. Should not Mr. Bonner look back on the past history of the Council for the reason for this? What we do object to in his letter is that he goes out of his way to disparage the work of the tramway manager, who he calls a horsekeeper. He says: "The salary offered for the appointment of superintending architect, whose jurisdiction over all lines of frontage, new streets, and important public works (including fire brigade stations) embraces the whole of the county of London—something like 200 square miles in extent—is to be exactly the same amount—viz., £1,500 per annum—as that of the tramway superintendent, a gentleman who has to look after horses and cars, and buy oats, hay, and forage, and that for tramway lines and services not yet being entirely worked by the London County Council. Surely this is hardly a com-

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pliment to the profession of architecture—'the mother of all the arts'; but I am afraid that until a Bill is passed by Parliament for the registration of architects, the members of the profession will be treated as upon the equality of a horsekeeper."

Bucharest Tramways.—The Bucharest correspondent of the *Financial News* says that there is a rumour afloat that the tramways of the city have been purchased by a foreign syndicate. In some quarters it is asserted that the syndicate is Belgian, but others state that it is British, the exact truth not being yet known. There are at present two tramway companies in Bucharest—one English and the other Belgian. These two companies have been making large profits every year, and their position and prosperity are said to be assured. It is announced, however, that they have sold their concessions to a syndicate. The general opinion is that the tempting price which has been offered has brought about the decision to take this step. The Belgian tramways are said to have been sold for 11,000,000fr. and the English for 6,500,000fr., making 17,500,000fr. altogether. The two concessions expire in 18 years, when they become the property of the city. A sinking fund of 1,000,000fr. must therefore be annually set aside, not to speak of working expenses and a dividend sufficient to give a fair return on the capital employed. It is said that the syndicate is to replace the present traction power by electricity on the principal lines, and at the same time to supply the electric light to the streets through which the cars run, if the city agrees to prolong the concession for another 20 years.

Electric Ship's Cranes.—Electric cranes have, says *Kuhlow's Review*, now been used for some time on the Norddeutscher-Lloyd's steamers. They are all built of the same type, with a lift of about 17ft. Two sizes are used for loads of 3 and 1½ tons respectively. As many as 16 have been erected on one vessel. The power in this case is supplied by four steam dynamos, which, working continuously, give 75 kw. for lighting and 90 kw. for power purposes. These give 105 volts at 210 revolutions per minute. Only two of these dynamos are required for 16 cranes, one being reserved for the supply of current for lighting purposes and the other for a stand-by. The lift-gear consists of a simple worm-and-wheel gearing fixed to a 25-h.p. motor running at 900 revolutions. The swivelling motor has a double worm and wheel, and a cogwheel transmission without a self-acting stop. For the latter purpose a hand-brake is fixed upon an elongation of the motor axle, a slight pressure upon the footplate of the brake being sufficient to stop at once a load descending at the maximum speed. Two marine controllers, behind which are fixed two resistances, serve to start, regulate, and turn the motors. Both are directed by a single lever, which is turned in the direction in which it is desired to move the crane. The arrangements of both sizes of cranes are identically the same, therefore the smaller ones work with about the same speed.

Untechnical Roporting.—A correspondent in Belfast has forwarded to us a cutting from the daily papers there, which he considers brings up most strongly the need of a little technical editing in our daily papers. He was afraid that from our note in our issue of Dec. 2, entitled "Free Shocks," our readers might consider that the English reporters had a monopoly of such errors. The cutting forwarded describes an occurrence witnessed at the junction of Donegall-street and Rosemary-street in Belfast. At this point "a leakage occurred from the electric mains, and the effects could be felt for a considerable area in the roadway. As horses approached the place the poor animals themselves apparently became suspicious of the spot, and their shivering and shuddering in the majority of cases led their drivers to hasten their onward progress. When the horses were attached to unloaded vehicles nothing more serious took place, but two animals which were drawing coals, and whose speed was consequently slower, were stricken down with great rapidity." Worse than this was to follow, and "although warned not to do so, the driver of a very light machine persisted in proceeding over the place in question, the result being that his animal was also brought low and its knees injured; *while a little terrier*, whose curiosity apparently led it to take the same track, *was actually blown several feet up into the air.*" This dog should certainly be preserved by the reporter in order to authenticate his story. The conclusion of the report tamely states that Mr. Victor M'Cowen put the matter right quickly on his arrival at the spot.

A New High-Speed Engine.—A Newcastle firm of consulting engineers, Messrs. Sheffield and Twinberrow, have recently designed and patented a new type o enclosed automatic self-lubricating engine which is specially suitable for electric traction or lighting work. In this design the high and low pressure cylinders are placed close together in order to nearly eliminate the vibrating couple, and to reduce the pressures on the main bearings, of which two only are provided. Initial condensation, the great foe to economy, is reduced by the small dimensions of clearance surfaces, resulting from the position of the valves within the cylinder heads; these valves are operated from a crown cam fixed on the end of the crankshaft, which determines the period of exhaust and compression, but the extent and duration of the opening to steam are controlled by a shifting cam surrounding a fixed one and rotated thereon in a helical direction under the action of the governor. The lubricating oil is forced through tubular plungers attached to the backs of the cross-heads, which are drilled to admit it to the gudgeons, where it is piped to the big ends. The main bearings, etc., are supplied from pipes connected to the barrels in which the plungers work. The quantity of oil drawn into the system at each revolution is regulated by a valve connecting the barrels, and the necessity of pumping oil to waste through a by-pass is obviated. Engines of 50 h.p. are now under construction, and the designs for higher powers, up to 800 h.p. and 1,000 h.p. each, such as are suitable for traction purposes, are now being matured. In the larger engines a special disposition of the parts is adopted which still further eliminates the causes of vibration, including that due to the angularity of the connecting rods.

Street Railway Franchises.—There is now pending in the Chicago City Council, says the *Street Railway Review*, an ordinance providing for the extension of the street railway franchises for 50 years, in accordance with the Allen law passed last session, in Illinois. This law the Chicago papers, with one exception, all attack. Here are a few choice extracts from the opposing papers: "Democrats of the eighth ward were also in favour of violence if necessary. One clause of the resolutions passed was as follows: 'Resolved that this club assist in any summary proceedings to be dealt out to any alderman voting for franchises without just compensation to the city.'" "Noose badges became numerous yesterday. They are made of black satin and contain a picture of a gallows with a noose depending from its projecting arm. Each badge is accompanied by a black pin, which is employed to attach it to the coat." "Wanted, 10,000 strong-limbed and fearless men. Apply at the Council Chamber, with ropes, the night the aldermen attempt to pass the 50-year

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franchise robbery. Come prepared to do business." Practically the whole trouble grows out of personal and political motives. The Allen Bill is not the vicious measure which the Chicago Press would make it. Not one person out of 500 who thinks the Bill a bad measure has ever read it, or could tell anything about it except that it permits the granting of a 50-year franchise. What they do know is that it actually places no limit on the percentage which the granting bodies may exact. The political feature of the whole thing centres in the mayor of the city, who has other ambitions, and political organisations, ward clubs, and the entire local party machinery have been enlisted in the work of opposing the companies and advancing the political interests of the mayor.

Overhead Wires.—The *Street Railway Review*, of America, in its last issue falls into a serious error in its commendable attempt to prove that the overhead trolley lines of electric tramways are not dangerous. The following extract shows the line which our contemporary takes in this respect: "The untimely death of a line inspector in Toledo emphasises the fact that the voltage of the trolley lines is low and safe compared with lighting circuits. The electrical inspector accidentally came in contact with a circuit at a voltage between 4,500 and 5,000, and even that did not cause instant death, for he was able to rise from the ground after he had fallen from the shock. A circuit at 5,000 volts is not merely 10 times more dangerous than one at 500 volts, but it is infinitely more so. Perhaps one reason for less public opposition to the high-potential lighting circuits is that the city government either owns the system or rents the power for lighting the streets. In England, where the fallacy that the trolley wires are very dangerous has not spent its fury, high-potential alternating-current circuits are in general use. If the citizens can tolerate a voltage of 1,000, 2,000, or even higher for lighting purposes, certainly the trolley wires at 500 volts will bring no added peril." We quite agree with the statement that a 5,000-volt circuit is more dangerous than a 500, and we cannot understand how the municipal authorities in the States can allow overhead circuits at this potential to be erected in their towns. In England, voltages of 1,000, 2,000, and in some cases higher are certainly used for electric light mains, but our contemporary has forgotten the fact that such conductors are always underground. It speaks well for the regulations issued by the Board of Trade that, although we have had to chronicle some fatal accidents to the workmen employed by central stations using these voltages, in no instance has a consumer or one of the public received a fatal shock.

Flywheel Accidents.—Mr. C. J. Benjamin recently read an interesting paper on "The Bursting of Small Cast-Iron Flywheels" before the American Society of Mechanical Engineers. The paper was founded on a series of experiments in which a number of flywheels were run up in speed until they flew to pieces. These experiments were carried out in the laboratory of the Case School of Applied Science at Cleveland. To obtain the speed necessary to burst the small flywheels, a Dow steam-turbine capable of being run up to 10,000 revolutions per minute was used. In several trials a shield of 12in. oak was found to be necessary to stop the flying fragments. The wheels were usually demolished by an explosion resulting in a large number of fragments. The conclusions arrived at by the author are summarised as follows: (1) Flywheels with solid rims, of the proportions usual among engine builders, and having the usual number of arms, have a sufficient factor of safety at a rim speed of 100ft. per second if the iron is of good quality, and there are no serious cooling strains. In such wheels the bending due to centrifugal force is slight, and may safely be disregarded. (2) Rim joints midway between the arms are a serious defect, and reduce the factor of safety very materially. Such joints are as serious as mistakes in design as would be a joint in the middle of a girder under a heavy load. (3) Joints made in the ordinary manner, with internal flanges and bolts, are probably the worst that could be devised for this purpose. Under the most favourable circumstances they have only about one-fourth the strength of the solid rim, and are particularly weak against bending. In several joints of this character on large flywheels, calculation has shown a strength less than one-fifth that of the rim. (4) The type of joint made up of links shrunk over cast-iron projections on the rim was considered by the author to be the best that could be devised for narrow-rimmed wheels not intended to carry belts, and possess, when properly designed, a strength of about two-thirds that of the solid rim.

Weathered Coal.—Messrs. R. S. Hale and H. J. Williams recently presented the records of a series of tests they have made on the effects of weathering on the calorific properties of coal to the American Society of Mechanical Engineers. The samples tested were exposed for 11 months under ordinary conditions as to rain, etc. They were then analysed and compared with the same coal which had not been so exposed. The authors conclude from the figures so obtained that (1) weathering decreases by about 2 per cent. the theoretical calorific power as calculated by Dulong's formula; (2) that weathering decreases by about one-half of 1 per cent. the actual or true calorific power as shown by the three results obtained with the bomb; (3) that if the results calculated from the analyses are interpolated from Kent's curve, which is based on the per cent. of fixed carbon as determined by proximate analysis (the latter being a more or less variable quantity according to the age and degree of exposure of the coal) the remarkable result is obtained that the weathering of a sample of coal increases the percentage of fixed carbon in the combustible, and also increases by about 1 per cent. the calorific power of the coal. It may be noted that the English form of Dulong's formula, which neglects the term $0 \div 8$, but uses slightly lower values for the heat of combustion of C and H, would cause the calorific power as computed to agree more closely with the results obtained with the bomb than the formula $146\ C + 620\ (H - O \div 8) + 40\ S$. This is especially noticeable when the weathered and unweathered samples are compared. In a general way, the results show a slight diminution of calorific power in the grades of coal examined, directly traceable to weathering. They also show that where coal has not been exposed to oxidation by weathering or otherwise, there is a reasonable close agreement between the results calculated by Dulong's formula and those obtained with the bomb calorimeter. Last of all, they show that when it is desired to compare the respective calorific power of coal that has been altered, to a greater or less extent, by oxidation with those of coal that has not been exposed to the weather, the use of Dulong's formula, or any of its modified forms at present in use, as well as the use of Kent's curve, would lead to erroneous conclusions.

A New York Power Station.—We have received some further details of the large contract which has been given to the Westinghouse Electric Company for the conversion of the Third Avenue Railway of New York from the cable system to the electric conduit system. This work necessitates the construction of a power-house, in which engines and generators will be placed capable of producing 64,000 h.p. This will be by far the largest power-house, electric or otherwise, in the world, and apart from its con-

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struction, and the conduit system, and from the line, the cost of the engines, boilers, electric generators, transformers, switchboards, car motors, and other electrical equipments, will, according to official statements, come to something more than one million pounds sterling. The President of the Third Avenue Railway, in speaking of this new undertaking recently, said that the officers and consulting engineers of the company had devoted several months to the investigation of the various systems of current transmission and of electrical apparatus for generating and utilising the power. They had in view the most effective equipment for economising in fuel and labour, coupled with the highest electrical efficiency. He also stated that, as this new generating station would be the largest and most complete power plant in existence, his Board had decided, in view of the complex features of mechanical and electrical engineering involved, that the work could be best carried out under one responsibility, and for that reason they had awarded the entire undertaking to the Westinghouse Electric Company, the builders of the great electric generators at Niagara Falls. It is interesting to note that the Niagara plant—up to now the most important power plant that has been constructed—develops 40,000 h.p., while the Third Avenue plant will be more than half as large again. The same builders are now constructing an electric plant which will have an ultimate capacity of 75,000 h.p., driven by the waters of the St. Lawrence River. However, neither the Niagara nor the St. Lawrence plant is intended merely for railway, but chiefly for manufacturing and lighting purposes. The former has been for several years successfully conducting electric current over 20 miles to the city of Buffalo, and it is now reaching out to Hamilton, Ontario, and to more distant cities than Buffalo on the American side.

A French Electric Locomotive.—The *Revue Générale des Chemins de Fer* has, in a recent number, a description of a new electric locomotive which the Paris, Lyons, and Mediterranean Railroad has been trying on its main line between Paris and Melum. This engine has about one-half the power of the ordinary express locomotive of the company, but its power is exerted through two axles only, and by increasing the number of axles without changing the type of the machine its power can be added to as may be desired. The engine is supplied with electric current from a storage battery, which is hauled behind in a special vehicle. In consequence, a great part of the power developed is absorbed in hauling this heavy tender; but the storage battery could be done away with, of course, by taking current from a conductor, and, therefore, the observations made are of the same value for experimental purposes as if the current had been so supplied—that is, the use of the storage battery has been merely an expedient to simplify the investigation. This locomotive is mounted on three axles, two of which are driving axles, and all the wheels are of the same diameter—namely, 1·1m. The forward axle is simply a carrier; the second and third, or driving axles, are not coupled, each carrying its own motor. The locomotive proper carries, besides the motive machinery, an electric air-compressor, to supply the Westinghouse brake, and also a number of smaller storage batteries. The current supplied by these cells serves an exciter and compressor, to supply the Westinghouse brake and power for lighting, and is sufficient to move the locomotive at a speed of from one to three miles per hour. The total weight of the locomotive itself is 44 tons. The tender, carrying the storage battery, weighs 45 tons, most of this being, of course, the weight of the accumulator cells. Many journeys have been made with this locomotive, first between Paris and Brunoy, then between Paris and Melum. The maximum load hauled going and coming so far has, says the *Railway News*, been 147 tons, including the tender, but not the locomotive itself, and with this load the engine has made a mean speed of 28 miles per hour. Extreme speeds on a moderate down grade have reached 63 miles per hour with a load of 100 tons hauled. Experiments made so far have been intended only to watch the working of the various mechanical and electrical parts of the locomotive, and to ascertain the limit of the power of the battery. They will soon be followed by other experiments to show the efficiency, economy, etc., of the apparatus.

Electrical Work in the U.S.A. Navy.—Mr. W. D. Weaver, late chief engineer of the U.S.S. "Glacier," read a paper on Dec. 14 before the New York Electrical Society on "The Electrical and Engineering Work in the Navy during the War." The author in this paper stated that the lessons taught by the late war with respect to the employment of electricity aboard men-of-war are few in number, though important in their bearing. The most decisive result was the demonstration of the immense superiority of electricity over steam for the operation of turret-training apparatus. The advantages of the electrically-driven turrets were so decisive that the author considers the question of the employment of electric power for this purpose is no longer an open one. Another question which the test of battle has settled definitely is the superiority of electric ammunition hoists, not only in efficiency in working, but in their convenience with respect to location and space occupied. This convenience generally will tend to greatly extend the application of electric power on shipboard. Against the great success in the particulars just mentioned the author sets the failure of electrical range-finding apparatus, and of electrical indicating apparatus in general. As to the first mentioned, the enemy gave so few opportunities for its use, and even then so little necessity existed for its employment in view of the leisurely manner in which U.S.A. vessels could pick up their range, that possibly neglect had something to do in the case. Mr. Weaver considers, however, that electrical range-finding should not be condemned in general because of the failure of a single system. In fact, the weak points in the one in question would seem to be easily overcome by the employment of alternating currents of high frequency and considerable voltage, thereby enabling a drop between indicating points to be obtained by means of inductance which would be in the order of volts instead of possibly milli-volts, as where the direct current is used. Speaking of future developments in electrical driving on board ship, the author places first that of electric ventilation. For warship ventilation, both with respect to coal economy and deriving the most efficient results in ventilation itself, the electric fan offers an ideal solution. The modern warship being divided into numerous compartments, each of these can be supplied with its own electric fan or fans, either for isolated ventilation or to supply a system of only such extent as will involve no sacrifice in efficient ventilation. The type of engine now employed with steam ventilators undoubtedly requires anywhere from 75lb. to 200lb., and even more, steam per horse-power hour. In the case of a large electric plant and with fan motors of the most ordinary efficiency, this would be reduced to considerably below 50lb., while at the same time the ventilation for a given expenditure of power would be greatly increased in efficiency. The other points dwelt on are the use of electric motors to drive the workshops, the ice-making plants, feed pumps, and deck winches on board ship. The paper concluded by pointing out the need of a good staff of electrical engineers for the U.S.A navy.

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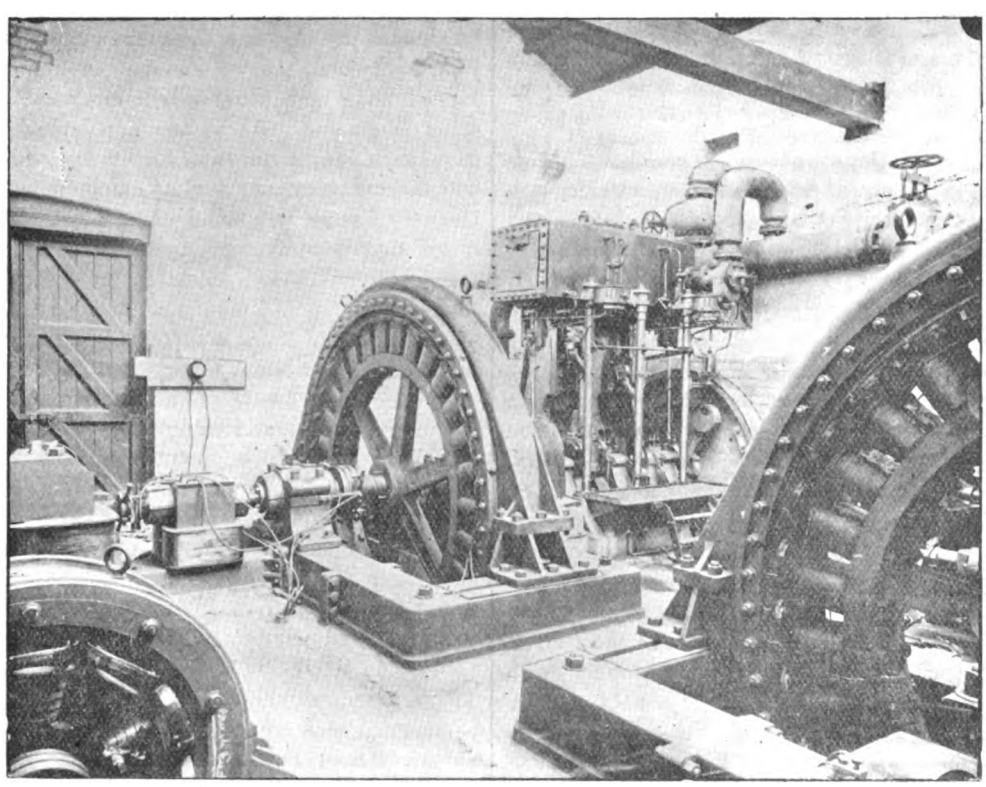
ECCLES ELECTRICITY WORKS.

We have in a previous issue referred to the official opening of the municipal electricity works at Eccles, which took place on Dec. 14 last year.

ALDERMAN W. DODSON KENDALL, J.P., CHAIRMAN OF ECCLES ELECTRIC LIGHTING COMMITTEE.

The history of electric lighting in the borough of Eccles is one which a few years ago was only too common, and was caused by indecision on one side of the Council and active hostility on the other. The Eccles provisional order is an old one (granted in 1893), and ever since it received the confirmation of Parliament until 1897 electric lighting has been the question of the hour, and the general fighting topic on the Council. In 1894 the Corporation obtained the advice of the late Dr. John Hopkinson as to the desirability of establishing electricity works. He reported in favour of it, and in 1895 Mr. Clirehurgh (of the firm of Lacey, Clirehugh, and Sillar) was instructed to prepare a scheme. After much opposition in the Council and in the Press, it was resolved in 1896, by a narrow majority, to apply to the Local Government Board for powers to borrow £20,000. When, however, the enquiry was held, owing to a change in the constitution of the Council caused by new elections, the curious spectacle was presented of a large majority of the Council appearing in opposition. Under these circumstances the application for borrowing powers was refused, and the electric lighting question again shelved. Shortly afterwards, however, owing to several applications by companies for powers in the borough, Mr. Clirehugh was instructed to prepare a scheme which would not embrace the street-lighting, and would be simply sufficient to fulfil the conditions of the provisional order. This was accordingly done, and borrowing powers were applied for and granted by the Local Government Board. Although the capital expenditure was so restricted, the engineers felt that a good demand would exist as soon as the advantages of electric light were better understood. In this we quite concur, and the works which were started on the dog-in-the-manger principle will become a valuable asset to the Corporation. The chairman of the Electric Lighting Committee (Alderman William Dodson Kendall, J.P.) has piloted the electric lighting scheme through very stormy waters. This gentleman was chairman of the Local Board in the year 1890-91, and was a member of the committee which promoted the movement for the incorporation of the borough, and took an active part in securing the charter. In November, 1892, on the first elections taking place for members of the Council of the new borough, his was the first name put upon the return of elected members. At the first Council meeting in the same month he was elected an alderman of the borough. At the same meeting an Electric Lighting Committee was formed, and he was unanimously elected its first chairman, and remained so from November, 1892, to November, 1896, when he relinquished that position after the defeat of the first electric lighting scheme, in which he had taken a deep interest, and his place was for one year taken by the present vice-chairman of the committee (Mr. Councillor Oldfield). In November, 1897, Alderman Kendall was again unanimously elected chairman, and has occupied that position to the present time. Besides his various services to the public in his capacity as Local Board member and alderman of the borough, he is a director of several public companies, including the important financial undertaking known as the Lancashire Trust, and he was also a director and one of the promoters of the company called the New Mutual Telephone Company, which was formed with a view to establishing in Manchester and the surrounding towns an independent telephone service in competition with the National Telephone Company—a company whose efforts were unfortunately unsuccessful, as, after a large expenditure of money, and obtaining the consent and support of about 118 local authorities concerned, the company was recently refused a license by the Postmaster-General. Mr. Kendall



View of the Engine Room, Eccles Electricity Works.

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has from the year 1893 been a consistent advocate for municipal electric lighting, and was ever in the forefront of the battle when the strongest opposition had to be faced in the years prior to 1897, in which year, after a long and weary struggle, he had the satisfaction of seeing his cause victorious, and the necessary borrowing powers granted by the Local Government Board. He has made himself in the course of the great fight numerous opponents, but no enemies, for everybody has recognised with what courtesy and amicability he has treated friend and foe alike. Another gentleman who has done all in his power to further the electric lighting scheme is Mr. G. W. Bailey, the energetic town clerk of Eccles.

The Electricity Works.

A site for the works was selected on the Bridgwater Canal. This allows of cheap transport of coal to the works, and the canal water is also available for condensing purposes. The buildings, which with the small amount of money available had to be restricted in extent, were designed by Messrs. Woodhouse and Willoughby, of Manchester. Only one quarter of the site has at present been built over, so that there is ample room for the extensions which will be required almost as soon as the present works get fairly under way. The principal features in the buildings are an engine-room 44ft. long by 25ft. wide, a boiler-house 42ft. long by 45ft. wide, an accumulator room, and a range of offices. The whole of the building work was executed by Messrs. G. Macfarlane and Co., of Manchester. The steam generating plant was supplied by Messrs. Tinkers, Limited, of Hyde. The boilers are two in number, and of the Lancashire type, embodying every modern improvement. These are 28ft. long by 7ft. 6in. internal diameter, having two flues through, each 3ft. diameter. The longitudinal seams of shell are butt-jointed, with covering strips inside and out, secured with four rows of rivets. The circular seams are lap-jointed and single riveted; each ring of shell is formed of one plate $\frac{5}{8}$in. thick. The flues are formed of solid-welded and machine-flanged rings made of plates $\frac{15}{32}$in. thick, the front and back rings being $\frac{9}{16}$in. thick. The end plates are $\frac{5}{8}$in. thick, each formed of one plate. Both ends are single riveted to the shell, the front end being attached by an external angle ring, and the back end being flanged. Each boiler is equipped with a full complement of mountings and fittings of the latest and most improved type. The working pressure of the boilers is 125lb. per square inch; test pressure, 210lb. per square inch. The main steam-pipe is 8in. diameter, and is provided with steam-traps at each end. Valves are fitted in the main steam-pipe, so that any section can be shut off without interfering with the working of the other. The feed pump is of the horizontal type, and capable of delivering 7,000lb. of water per hour against a boiler pressure of 125lb. per square inch. An injector of the "Sirius" type has also been provided as a stand-by, capable of delivering 12,000lb. of water per hour. The condensing plant was also supplied by the same firm, and consists of an ejector condenser for each engine. The condensing water is forced through the condensers at the requisite pressure by a centrifugal pump, which is direct coupled, and driven by a separate vertical engine. The two condensers are each capable of dealing with 6,000lb. of steam per hour, and were supplied by Messrs. T. Ledward and Co. as sub-contractors.

The alternate-current system was selected by Mr. Clirehugh as the most appropriate for Eccles on account of the scattered nature of the town, which consists mostly of residential districts. It was therefore decided to supply by means of a 2,000-volt alternating system, and, as the day load would necessarily for some time be very small, to provide for that load by accumulators and a motor-alternator. The contract for the electrical-generating plant was placed with Messrs. Browett, Lindley, and Co., who obtained the electrical machines from Messrs. Johnson and Phillips. Two sets of compound engines of 200 h.p. each, coupled direct to Johnson and Phillips's alternators with direct-coupled exciters, have been supplied. These have an output of 120 kw. at 2,000 volts and a frequency of 50 complete cycles per second. The size of the cylinders of the engines are 13in. and 22in. bore by 16in. stroke, and the speed is 200 revolutions per minute. The engines, which are of Messrs. Browett and Lindley's well-known make, are governed by the latest form of the "Begtrup" patent shaft governor, which combines the principle of inertia and centrifugal force in such a manner as to obtain the closest possible governing under all variations of load, the maximum variation not exceeding $1\frac{1}{2}$ per cent. under any circumstances. The engines are of the open type with cranks set at right angles and counterbalanced, and they are fitted throughout with self-lubricating devices to all parts, the whole being constructed according to the firm's standard practice, and similar to a large number of engines in other central lighting stations. One of the sets can be seen in the illustration of the engine-room.

The motor-alternator is designed to give 25 kw. at 200 volts when at a speed of 600 revolutions. The motor is one of Messrs. Johnson and Phillips's two-pole continuous-current type, taking 100 volts at the terminals. It will deliver 140 volts when used as a generator for charging cells, it being then driven as a dynamo by the alternator.

The accumulators in the station were supplied by Messrs. Pritchetts and Gold, and consist of a set of 56 cells in solid lead boxes, each containing 55 plates of the firm's usual type. The outputs of these cells are as follows: 170 amperes for nine hours, 200 amperes for seven hours, 273 amperes for four hours, or 420 amperes for two hours. The ampere-hour efficiency guaranteed by the makers is 93 per cent.

Mains.

The cables used at Eccles were manufactured and laid down by Messrs. W. T. Glover and Co. The cables are of the Diatrine insulated type, lead covered and laid in wooden troughs filled in solid compound. The cables are all concentric. The private lighting is served direct from high-tension distributors, which supply transformers on the consumers' premises. In one or two cases short lengths of low-tension mains have been laid down to supply several houses near together. The public lamps, which are lit by two incandescent lamps, are supplied from four transformers in pits under the streets. Low-tension concentric distributors at 200 volts convey current from these, with branches to the lamps, which are connected two in series across the mains. Some 200 street gas lamps are being converted to electric.

The advice of Mr. Clirehugh as to the ultimate success of the installation is very well borne out. Thus, while after much opposition, it was decided to spend only £11,000 and to supply 5,000 8-c.p. lamps, and 200 street lamps, the advocates of electric lighting seem justified in their persistence, for already 4,000 8-c.p. lamps are applied for.

The system of charging adopted is 7d. a unit for the first hour's average consumption, and 2d. a unit for the remaining hours. The electrical engineer in charge is Mr. Leonard H. Coomb, who has taken an active part in superintending the works during construction.

APPLIED ELECTRO-CHEMISTRY: A RETROSPECT AND A PROSPECT.

BY E. EDSER.

Although inventors cannot be said to have neglected the wide field opened up by investigators of the phenomena attending electrolysis, yet the successful applications of electrolytic methods to commercial problems have not, up to now, been very numerous—that is, when compared with the number of possible applications. Indeed, up to within a few years ago electroplating appears to have been almost the only successful venture in this direction. Enough has lately been done, however, to show that many chemical industries may possibly be revolutionised at no very distant date; and enough, also, to show that a successful laboratory experiment cannot always be taken as a guarantee of success on a commercial scale.

Further than this, electrolytic theories have not yet been reduced to that state of definiteness which may be found, for instance, in the applications of electrical science to dynamo construction. Many inventors of electrolytic and allied processes might take as their motto the words of the

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dying Rabelais, "*Je vais chercher un grand peut-être.*" Sometimes investors go on a similar quest, only to find, for instance, that the presence of gold in the ocean (to the extent of a fraction of a grain to a ton of sea-water) is no guarantee of its transference to their pockets. The unfortunate point about such misadventures is that they tend to reflect a certain amount of discredit on other attempts of a more promising nature.

During the last year an undertaking of some magnitude—the Ashcroft process of zinc extraction, installed at Cockle Creek, New South Wales—has been abandoned. It is easy to form correct judgments after the event, but it must, one would think, have been tolerably certain that the success of this process would almost entirely depend on the presence of a pretty large proportion of silver in the ore supplied, the cost of electrical energy per ton of deposited zinc leaving only a small margin for profit on that metal. But Mr. Ashcroft's process was so interesting, from a purely scientific point of view, that little trouble seems to have been taken to determine the nature of the ore; and the presence of an impurity—manganese—was sufficient to upset the cycle on which the process was founded; with the result which we have seen.

It is interesting to note that the Siemens-Halske process for treating the same ore, using sulphuric acid or zinc sulphate, instead of the ferric sulphate employed in the Ashcroft cycle, is still in the trial stage in Australia.

One of the branches of applied electro-chemistry which has received the greatest attention is that relating to the production of caustic alkali and bleaching powder. Several processes appear to have justified, to a great extent, the hopes that have been entertained for their success. The Hulin modification of the Vautin process, in which molten lead is used as a cathode, will probably, early in the present year, be worked on a large scale at Clavaux, where a water power of 5,000 h.p. is available. It will be remembered that this process depends on the electrolysis of a mixture of fused sodium chloride and lead chloride. The sodium forms an alloy with the electrolytically separated lead, which readily diffuses into the metal forming the cathode. The electrical pressure per crucible amounts to seven volts.

In England the Hargreaves-Bird and the Castner-Kellner processes appear to be progressing favourably. Their respective disadvantages lie in the rather high resistance due to the diaphragm in the first, and the large quantity of mercury necessarily employed in the second. Their success may be considered to have proved that the electrolytic production of caustic alkali and bleaching powder on a commercial scale, by the wet method, is now no longer merely a brilliant possibility. A great advantage possessed by electrolytic processes such as these, lies in the comparative absence of the atmospheric pollutions which render the neighbourhood of a chemical alkali works so objectionable.

A difficulty occurs in the production of bleaching powder by electrolytic methods, in so far as the oxidation of the anode carbons, which always occur more or less during the process, results in an evolution of carbonic acid gas, which in its turn produces calcium carbonate from the slaked lime or even from the calcium chloride already formed. Mr. Swinburne has pointed out how this can be avoided. Let the mixture of chlorine and carbonic acid gases be led through a small chamber containing slaked lime, before entering the main chlorinating chamber. A mixture of bleaching powder and calcium carbonate will be produced in the small chamber, the proportion of the carbonate continually increasing till a point is reached where the whole must be replaced by fresh slaked lime. Thus no chlorine is lost, the total cost being increased only by that of the extra slaked lime, whilst pure bleaching powder is obtained in the main chamber.

Closely allied with processes for the production of caustic alkali are those for the production of chlorates, percarbonates, iodoform, and chloral. If a sodium chloride solution be electrolysed in a single cell, using, for instance, a carbon anode and an iron cathode, sodium hydrate is produced as the result of a secondary reaction (that of the sodium, primarily separated at the cathode, on the water of the solution). The chlorine liberated at the anode reacts with the hydrate to form sodium hypochlorite and sodium chlorate, the relative proportions of these products varying with the temperature of the liquid. Further than this, perchlorates can be obtained by the electrolysis of chlorates. The production of percarbonates by the Constam-Hansen process is very interesting, as affording a rather striking example of a result obtained as predicted from the dissociation theory of electrolysis. According to this theory, a strong solution of potassium carbonate (K_2CO_3) will be partially dissociated into the ions K and KCO_3, the latter during electrolysis being separated at the anode. Under suitable conditions, two of the KCO_3 ions may combine to form $K_2C_2O_6$. The best conditions appear to be obtained by using a platinum anode, and effecting the electrolysis at about – 15deg. C. When the potassium percarbonate is placed in water at 45deg., a regular stream of oxygen is given off. It may therefore be used either for the commercial production of oxygen, or as a powerful oxidiser.

When an alcoholic solution of potassium iodide is electrolysed, iodoform is formed according to the equation

$$C_2H_6O + 5I_2 + H_2O = CHI_3 + CO_2 + 7HI.$$

It was at first supposed that passing a current of CO_2 through the electrolyte was essential to the success of this process. Everything really depends on whether or not a porous cell is used. In the case where no porous cell is employed, the solution rapidly becomes alkaline, due to the cathode reactions, and a stream of CO_2 is necessary to convert the caustic alkali into carbonate. Where a porous cell is used, this precaution becomes unnecessary.

The secondary reactions occurring during electrolysis are beginning to receive the attention which they deserve. It frequently happens that a compound can be obtained by chemical means only as a result of a long series of operations, sometimes involving the introduction of substances which must subsequently be carefully removed; a good example is furnished by the chemical manufacture of fuchsine, or magenta, as it is often called in England. Sometimes the same compound can be directly obtained, as the result of a primary or secondary reaction in an electrolytic cell. Baier u. Co., of Elberfeld, are now manufacturing a large number of aniline dyes by electrolytic methods. Most German colour works are sufficiently alive to the possibilities held out in this direction to provide facilities for electro-chemical research on their premises.

The electric furnace is sufficiently well known to require little more than mention here. Aluminium (and chromium as a secondary product), carborundum, calcium carbide, and diamonds are the products of greatest importance heretofore obtained. The diamonds, owing to their small size, can be counted as little more than scientific curiosities. Chromium, which may now be obtained on a commercial scale, is perhaps destined to play an important part in the future. We may especially notice the interesting fact discovered by Hittorf, that it may exist either as the most electro-positive or the most electro-negative metal, or in a neutral state.

The electrolytic separation of gold and plantinum has been successfully accomplished. Amongst other interesting details which have come to light in this connection, it may be noted that under special circumstances gold has an anomalous electro-chemical equivalent. It is perhaps not impossible that this property is shared by other metals.

In any electrolytic decomposition a certain minimum E.M.F. is necessary, corresponding to an infinitely small value of the decomposing current. This E.M.F. will be augmented, when a finite current is employed, by the drop in voltage within the cell, calculated according to Ohm's law. In any commercial enterprise it will, of course, be practically impossible to reduce this drop of voltage to zero; an important question then is, what is the most economical current density to use in any particular case?

It will sometimes happen, as in the case of the steel facing of engraved plates, etc., that the current density is controlled by the mere nature of the operation to be performed. When this is not so, we may determine the best conditions as follows: The cost of a cell may roughly be taken as proportional to the size of the cathode. The interest on this cost, together with depreciation and cost of

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attendance, may be taken as proportional to the same quantity. If no alterations are made in the other dimensions of the cell, the energy consumed in effecting the decomposition will be proportional to a constant multiplied by the current, plus a term varying inversely with the size of the cathode and the square of the current used. The minimum value of the total cost of production can then readily be determined. It will be found that the most economical current density is proportional to the square root of the following expression: interest on cost of cell, etc., divided by the product of the resistance of the cell per unit cathode area and the cost of electrical energy.

Hence it will at once be evident that the best current density to employ in any particular case will vary with the situation of the works, a high current density, and consequent large drop in voltage within the cell, being admissible where energy is cheap. At the same time it may be noticed that the most economical current density will not vary in direct proportion to the cost of energy, but as the square root of that quantity, so that the large variations which actually occur in this respect can hardly admit of defence.

A great deal of interest was evinced during the course of last year in connection with the Jacques carbon cell. This consisted of an iron vessel containing, immersed in fused caustic alkali, a cathode and anode of iron and carbon respectively. It was claimed by the inventor that by this means the consumption of coal could be utilised for the direct production of electric energy with a very high efficiency. The importance of such an invention, if found to justify the claims made for it, would unquestionably be very great; the furnace being the part of an ordinary electrical installation where by far the greatest losses occur. Although there was much discussion on this subject, it is difficult to form any definite conclusions, since most of the disputants contented themselves with calculations based on theoretical considerations, or with statements supported by little experimental evidence. It was even maintained that the E.M.F. generated was due to thermo-electric causes, though its value would appear to be far too high to justify such an assumption. On the whole, it may be said that though the possibility of obtaining electric energy directly from the consumption of coal has not been brought much nearer, yet it is possible that another effort, based on a careful consideration of the best theoretical conditions for such a venture, may finally solve this problem.

NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

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CXXXI.

From the point of view of steam supply and coal consumption, the contention as to the advantage of charging accumulators under constant power appears very plausible. But from the point of view of electro-chemistry and battery management, it appears clearly a fallacy. In the first place, the electro-chemist can generally indicate one or more profitable applications in which "waste power" can be utilised, and by means of which a tolerably level load line can be ensured. And, in the second place, charging under constant power is practically very nearly the same thing as charging under constant current, an unscientific system which should be relegated to ancient history. The objects in view should be to economise time by charging under high current density during the period when this is perfectly safe—besides, as is contended, producing a better active material—and to reduce the current within the limits of safety, as regards the life of the battery, during the period when the charge is nearly effected, and when high current density means waste of power, "gassing" from the electrodes or "boiling" of the electrolyte, and more or less disintegration of the plates. In charging under constant potential difference (Fig. 2 in the last section) the means for securing these objects are somewhat overdone: the current is initially too high, and towards the end of the charge time is wasted by its being too low. In charging by constant current the above desiderata are carefully ignored: the current is initially far too low, and is finally far too high. Charging under constant power is an improvement, but does not attain to the happy mean between the two other systems. The following diagram may illustrate the system of charging under constant power which is advocated by M. Simon. It will be observed that the voltage increases as the current decreases, but that the increment and decrement are very slight. This is further shown by the dotted line above the diagonal indicating ampere-hours actually

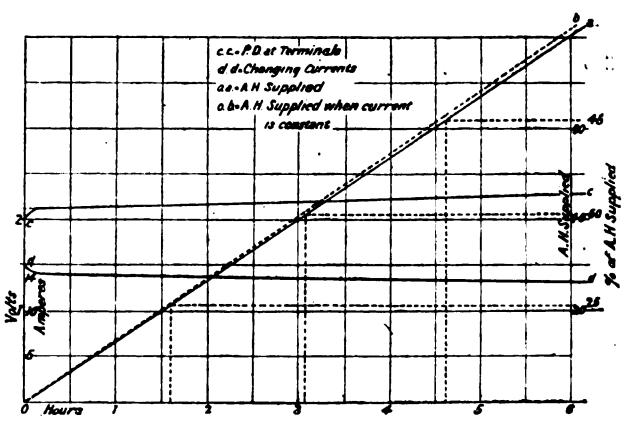

FIG. 3.

supplied in a given time; the dotted line indicates the ampere-hours that would be supplied if the current were constant. The power—*i.e.*, the product of amperes into volts, or E C—is constant at 30 watts.

CXXXII.

It may not be immediately obvious why, in the system of charging under constant power, the increase of E and the corresponding decrease of C must necessarily be so limited as to render this system of charging almost equivalent, practically, to that of charging under constant current. The following considerations may render this point quite clear. If E be the potential difference produced at the battery terminals by the charging dynamo, e the counter E.M.F., or back E.M.F. of the accumulator, and r the resistance of the latter, at any given period, the charging current will be:

$$C = \frac{E - e}{r}.$$

Now, if we want to diminish C we can do so only by diminishing $E - e$, since r cannot be increased at will, and, if the product, C E, is to be maintained constant, we cannot diminish C by diminishing E, since this value must be *augmented* proportionately to the diminution in C. How then can C become diminished?

The answer to the question is mainly to be found in the gradual increase of e as the charging progresses. The value $E - e$, and consequently the value of C, is thus diminished. The value r is also involved in this effect; for, although we might expect that it should become diminished by reason of the increased density of the acid electrolyte which results from the liberation of acid set free by the conversion of sulphate of lead into peroxide of lead and spongy lead in the operation of charging, as a matter of fact the resistance increases owing to the liberation of oxygen and hydrogen from the anode and cathode surfaces; and the increase of r would, of course, diminish C.

Neglecting r, when the opposing E.M.F. (e) has increased to $n\,e$, we have

$$C\,E = \frac{C}{n} \times (n\,E - n\,e).$$

Now, supposing that e augments from two volts to 2·3 volts, then $e = 2$ volts, $n\,e = 2{\cdot}3$ volts, and $n = \frac{2{\cdot}3}{2} = 1{\cdot}15$ (reciprocal = ·87).

We have then

$$C\,E = C \times {\cdot}87 \times (1{\cdot}15\,E - 1{\cdot}15\,e);$$

and the current can be diminished only by 13 per cent. of its original value, whilst E is increased by 15 per cent. of its original value.

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CXXXIII.

When charging currents of high density—*e.g.*, Δ = ·034—are employed, and are continued until the completion of the charge, the counter E.M.F. may attain a value considerably higher than 2·3 volts, as is shown by the following curve, obtained by the Committee of the Frankfort Exhibition during the charging of a Correns accumulator.

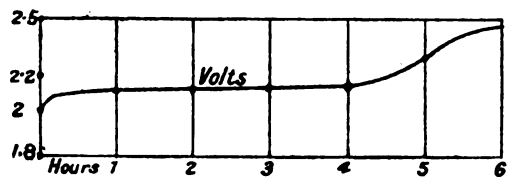

FIG. 4.—Rise of Back E.M.F. During Charge.*

Anything approaching the maximum value here shown should never be obtained in practice. Referring to Fig. 2, it will be seen that the constant P.D. at the battery terminals during charge is only 2·23 volts; and the back E.M.F. cannot, of course, attain quite that value. With a density of ·026 for the charging current, the back E M.F. does not obtain a value higher than 2·32 volts, the P.D. at the battery terminals being then about 2·42. And I think it will be generally admitted that it is bad practice to maintain even this density of current until the completion of the charge.

CXXXIV.

In the system of charging under constant current, the internal resistance of the battery rapidly augments towards the completion of the charge, in spite of the augmented density of the electrolyte. M. Loppé endeavours to account for this effect by showing that, although the quantity of free acid may have increased, the resistance of the cell may also be increased by the accumulation of this acid around the positive electrode, and the consequent weakening of the acid in the vicinity of the spongy-lead element. In opposition to this view, it may be pointed out that acid is set free from both electrodes, although it must be admitted that the acid tends to accumulate in the vicinity of the positive electrode. If the acid around the spongy-lead element have a density of only 1·016, whilst that around the peroxide element is of density 1·424, the electrolysis of sulphate of lead in the former element must almost have ceased; if acid be still liberated from the peroxide element the capacities of the elements have not been duly proportioned, and in any case the current is being wastefully applied. But the evolution of gases occurring under these conditions is probably of itself sufficient to account for the rise of resistance. The following diagram, based upon some experimental results obtained with the 1888 type of E P.S. cell in the laboratory of Prof. Ayrton, exhibits, in terms of the initial resistance of the cell, the rise of resistance with a constant charging current of density ·026.

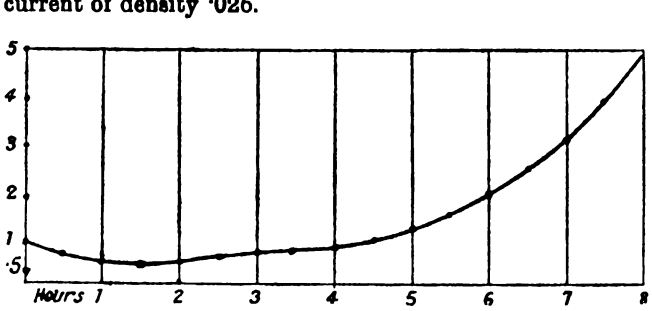

FIG. 5.—Rise of Resistance During Charge.

With a charging current of about the above-mentioned density, the following formulæ for the internal resistance of lead accumulators will, I think, be found approximately correct under ordinary conditions, more especially in the case of "pasted" elements.

If S be the total active peroxide surface in square inches, the mean resistance of the accumulator during charge will be $\frac{1{\cdot}54}{S}$ ohm.

The initial resistance will be

$$\frac{1{\cdot}197}{S} \text{ ohm.}$$

The minimum resistance, occurring shortly after the commencement of the charge, will be

$$\frac{{\cdot}855}{S} \text{ ohm.}$$

And the maximum resistance, when the charging is completed, will be about five times the minimum resistance, or

$$\frac{4{\cdot}27}{S} \text{ ohm.}$$

* Loppé, "Accumulateurs Electriques," p. 136.

ALTERNATING-CURRENT DISTRIBUTING MAINS.*

BY DR. H. ANDRIESSEN.

An arrangement of connections for concentric alternate-current cables was patented on behalf of the firm "Land- und Seekabelwerke, A.-G., Köln-Nippes," which aims at the diminishing, or, rather, obviating, of the objectionable phase distortion between current and E.M.F. in alternate-current networks. The lagging behind of the current as compared with the E.M.F. arising through inductive load, principally contributed by motors and the choking coils of arc lamps, has shown itself the most troublesome attribute of the alternating-current system. In effect, this phenomena necessitates the generators being designed for a greater current capacity than can be rendered serviceable in the mains. As a consequence, a larger initial outlay for construction is requisite than would be the case in providing for the same output were the load non-inductive. There certainly exists a known means whereby this lagging of the current may be obviated. Condensers, indeed, effect a lead of the current on the E.M.F. It is therefore only necessary to arrange a condenser of suitable capacity in parallel with the generator in order to rectify the phase distortion caused by the inductive load. But this plan could scarcely be applied on a large scale, since condensers of sufficient capacity and durability are both too expensive and occupy too much space. On the other hand, it is not difficult to considerably increase the capacity of the cable employed in the network. The capacity of lighting mains may be increased by employing an insulating material, which, together with like properties as to insulation, combines a higher dielectric constant than ordinary insulation. The construction of cable also adapts itself to the attainment of this end—greater capacity. Nor will it have escaped the attentive observer that latterly no hesitation has been shown in raising the capacity of alternate-current cables.

By a simple method the "Land- und Seekabelwerke" obtain this increased capacity of cable networks—*i.e.*, through the medium of a modified disposition of ordinary concentric cables. While, hitherto, the concentric cables of alternate-current systems have been so connected up in the junction boxes that the inner conductor with inner conductor, and outer conductor with outer conductor, formed electrical contact, the disposition patented by the above-mentioned firm consists, on the other hand, in connecting the inner with the outer conductor and outer with the inner conductor at the junction points. Hereby the capacity between the lead and return line of the net is, as may be proved, considerably raised.

In Fig. 1 are shown two concentric cables (I. and II.), whose inner conductors (double lines), outer conductors (single lines), and lead coverings (earth) are denoted by J L, A L, and B *l* M respectively. For the sake of clearness, the several capacities are represented in the form of small condensers. Let the capacity of the inner relative to that of the outer conductor in Cable I. be C_1, and the capacity of the outer conductor relative to the lead covering be C_2. Further, let the corresponding capacities of Cable II. be C_1' and C_2'. If the cables are so connected that the inner conductor of Cable I. forms electrical contact with the inner conductor of Cable II. and the

From the *Elektrotechnische Zeitschrift*.

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outer conductor of Cable I. with the outer conductor of Cable II., then the capacity between the inner and outer conductors is $C_1 + C_1'$. But if, on the other hand, the conductors are connected crosswise in the junction boxes (Fig. 1), then each line wire is comprised of inner and outer conductors. For the sake of distinction, we may call the one line the lead and +, and the other return and −. This terminology may be unjustifiably applied to alternate-current work, but it is convenient. Hence the capacity between "line +" and "line −," as readily apparent,

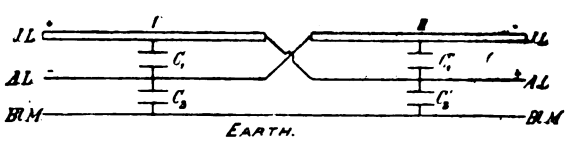

FIG. 1.

$= C_1 + C_1'$, plus the resultant of the two series-coupled condensers, C_2 and C_2'. In Fig. 2 the inner and outer conductors, constituting one arm, are arranged in contiguous straight line. This figure treats of the same case as Fig. 1, and enables it to be plainly recognised that the capacity between "line +" and "line −" comprises a fraction which must be determined from the series-coupled condensers, C_2 and C_2'. As is well known, the resultant of two series-coupled condensers is calculated according to the same law as the resultant of two parallel resistances. The condenser in question has, therefore, the following capacity:

$$\frac{1}{\frac{1}{C_2} + \frac{1}{C_2'}}.$$

Hence the total capacity between the lead and the return line in the case under notice is:

$$C_1 + C_1' + \frac{1}{\frac{1}{C^2} + \frac{1}{C_2'}}$$

It may be as well to confirm this statement by communicating the results of actual measurements. Two lighting cables constructed to withstand 3,000 volts pressure, the conductors of which each had 120 mm.^{2} sectional area of copper, and whose insulation consisted of impregnated paper, were employed for the measurements. Cable No. 1 had a length of 335·5m., its capacities being $C_1 = 0{\cdot}113$ microfarad and $C_2 = 0{\cdot}298$ microfarad; Cable No. II. was 334m. long, while its capacities amounted to $C_1' = 0{\cdot}113$ and $C_2' = 0{\cdot}294$ microfarad. Their capacities were determined with the aid of a battery giving a constant current

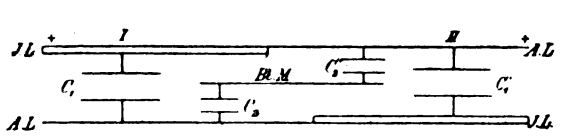

FIG. 2.

at approximately 80 volts terminal pressure, by comparison with an auxiliary condenser of known capacity. After the inner conductor of Cable I. had been jointed to the outer conductor of Cable II., the outer conductor of Cable I. to the inner conductor of Cable II., and the outer conductor I. connected to earth, the measurements gave as capacity of the inner conductor I. to the earthed outer conductor I. (that is to say, the sought capacity between the lead and return line of the circuit), 0·372 microfarad. A calculation based on the individual values relative to the condensers yields with sufficient conformity—

$$C_1 = C_1' + \frac{C_2\, C_2'}{C_2 + C_2'} = 0{\cdot}374 \text{ microfarad.}$$

With the method of connection common to ordinary practice the capacity of the two cables would $= C_1 + C_1'$ $= 0{\cdot}226$ microfarad. According to this the cross-wire method of connecting enables the capacity to be increased by about 6 per cent. The figures would read still more favourably had provision been made originally for a higher capacity during the construction of the cable. Should in a given case the capacity rendered available through this disposition be too great, it is an easy matter, by constructing a cable with an outer conductor comprising wires of lesser diameter, to reduce its capacity to that limit where the phase distortion of the current, as compared with the E.M.F., disappears. In arranging a system on the above described principle it will be advantageously to lay the cable lengths in duplicate in order that the charging currents flowing through the lead coverings may have only a short course through the coverings of two lengths. Otherwise, equalising currents would flow to more remote lengths, and so give rise to earth currents. By well jointing the lead coverings in the junction boxes, all disturbing influence upon telephone wires may thus be averted, especially as the charging currents which permeate the lead coverings possess no considerable intensity.

As the capacity of the leading line—pertaining to a network arranged on the above principle—to earth is the same as that of the return line, it follows that the E.M.F. of the lines to earth is also the same—*i.e.*, equal to half the machine's E.M.F. With the customary arrangement of concentric cables, the potential difference of the inner conductor to earth is, on the contrary, equal to the machine's E.M.F. Thus the disposition under notice offers the additional advantages that the leading and return line are of equal value, and that the inner conductor is only loaded with half the machine's E.M.F., whereby danger through accidental contact with the same is correspondingly diminished.

In conclusion, attention may be directed to another interesting feature. When calculating the total capacity according to Fig. 2, it was quite unnecessary to take into consideration the fact that between condensers, C_2 and C_2', the lead covering, and, therefore, earth potential, was present. This would likewise have exerted no influence had the capacities, C_2 and C_2', been considerably diverse. The potential differences between the conductors and to the lead coverings even remain the same if the latter are insulated from earth, a condition which, indeed, seldom occurs in practice. In the latter eventuality these are parallel with the series-coupled condensers, C_2 and C_2', further three series-coupled condensers extant—leading line earth, earth lead covering, lead covering return line—whose resultants may be ignored so far as magnitude is concerned, but which effect a difference of potential between the lead covering and earth. This E.M.F., which for the rest may appear to like extent with the usual method of connecting, attained one-third of the machine's E.M.F. in a specially-organised test. Thus the fact is once more demonstrated that all E.M.F. ratios appertaining to alternate-current work may be elucidated by taking into consideration the capacity ratios.

The above cited tests were conducted by the author in the excellently-equipped laboratories at the cable works of F. Clouth (now Land-und Seekabelwerke, A.-G., Köln-Nippes").

INSTITUTION OF ELECTRICAL ENGINEERS.

Ætheric Telegraphy.

BY W. H. PREECE, C.B., F.R.S. (PAST-PRESIDENT).

I have never submitted to the Institution of Electrical Engineers any record of my long and continuous researches on signalling through space. My reports have been made from year to year to Section A of the British Association. Some of them not having been printed, it is not to be wondered at that all my work is not known, and so much of it is occasionally reproduced by others. I will confine my remarks in this paper to ætheric telegraphy, and to its electromagnetic form alone.

In 1884* disturbances—that is, stray currents producing extraneous noises on the telephone—were detected on the circuits erected over the house-tops, produced by currents in telegraph wires buried in iron pipes in the streets. Messages sent on the telegraph wire were actually read on the telephone circuit, though the wires were nowhere in contact. Exhaustive experiments were made to prove that

* "Induction between Wires and Wires," B.A. report, Birmingham, 1886.

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these results were due to induction and not conduction. This was done by making the circuits metallic. They were separated from each other by a span of 80ft.

Many preliminary laboratory experiments were made with coils of many turns, but in 1885 square coils of insulated single wire, each side being of 440 yards length, were laid horizontally on the ground in the neighbourhood of Newcastle, and conversation by telephone was effected from one to the other through a space of one-quarter of a mile. Disturbances between these squares were appreciable at 3,000ft., and even at a distance of 10¼ miles between parallel lines of telegraph connecting Durham and Darlington. In 1886* experiments were carried out across the Severn for a length of 14 miles between Bristol and Gloucester, the parallel wires being separated by a mean distance of 4·5 miles. Primary currents of 0·449 ampere were rapidly made and broken by mechanical means, producing on the telephone a continuous note which could be conveniently broken up by a Morse key into dots and dashes, as in Cardew's vibrator. Disturbances were observed in the secondary circuit. The circuits were metallic and of many miles in length, that on the Gloucester side being completed through Stroud, and that on the Welsh side through Monmouth. Here we had just reached the limit of disturbance with the means at our disposal. It afforded a convenient measure of the range of audibility. The unexpected fact was shown that, whether the circuits were metallic or earthed at the ends of the parallels, the results were the same. This was confirmed subsequently by innumerable experiments, especially by some results obtained between Arran and Kintyre in 1894. All our experience since has shown that a coil of one single turn of thick copper wire, and of the largest possible diameter, gives the best result, and signals to the greatest distance. Moreover, it will be shown that the greater portion of this coil may be made up by the earth. In a single turn thus formed we have the full beneficial effect of electromagnetic as well as of electrostatic induction, we have the advantage of earth conduction, and we reduce capacity and inductance to their minimum. In closed coils of many turns we have only electromagnetic induction, and we make inductance a maximum. In the autumn of the same year (1886) the vast expanse of sand at Porthcawl, in South Wales, was used to further develop the law determining these effects Two horizontal squares of 300 yards per side were placed 300 yards apart, and subsequently one of them was suspended on scaffold poles 15ft. above the other, which was covered with water at high tide. No difference was detected in the strength of signals, whether the space were air or water, or a combination of air and water. Subsequent experiment (1893) showed that through 15ft. the effect in air was distinctly better than through water.

The conclusion then arrived at was that the magnetic field extends uninterruptedly through the earth, as it does through the air, and that if the secondary circuit had been in a coal-pit it would have been equally evident. In fact, Mr. Arthur Heaviside succeeded in 1887 in communicating between the surface and the galleries of Broomhill Colliery, 350ft. deep. But subsequent experiments showed that the conclusion arrived at was not true for water, for though we have spoken in Dover Harbour telephonically through 36ft., at 400ft. off the Goodwin Sands, no practical signals could be detected. Hence the effect must diminish in water with some high power of the distance. A new telegraph line of copper wires running parallel to the Great Western Railway in 1886 offered convenient opportunities to experiment further. The fact that parallel wires followed the same law as metallic coils facilitated such experiments. Horizontal coils of large diameter lying on the ground are impractical things, and I was glad to get rid of them.

It was determined that with two parallel wires of one mile length, the primary wire being excited by one ampere, the limit of audibility was reached at 1·9016 miles, and that

$$x = 1{\cdot}9016\sqrt{\frac{C_1 l}{r_2}}$$

gave a fairly accurate empirical formula to determine the maximum distance, x, which should separate any two wires of length, l, C_1 being the primary current, and r_2 the resistance of the secondary wire. This was amply confirmed by experiments repeated in the Severn Valley in the same year, and it established the fact that it was advisable to use copper conductors of the largest gauge that could be obtained. It was also determined that a very important element of success was the rate at which the currents rise and fall, and that every cause of retardation, such as capacity and self-induction, should be eliminated from the circuits.

A great many experiments were made in Lizvane, in Glamorganshire (1887), Loch Ness (1892), the Conway estuary (1893), Frodsham, on the estuary of the Dee (1894), Wimbledon (1894). But the most satisfactory results were obtained in the Bristol Channel (1892), between

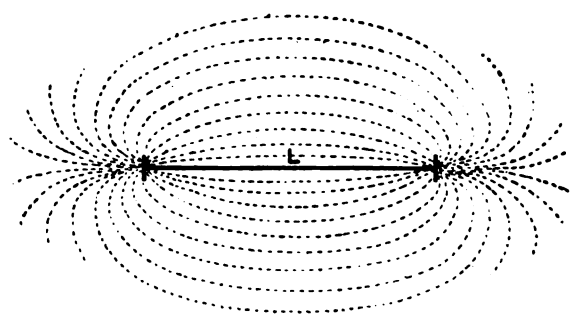

FIG. 1.

Lavernock and Flat Holm, 3·3 miles apart, between which places messages passed freely. In fact, at the present time this line has been re-erected and made permanent. It is in actual practical daily use, and has never failed ever since it was established. The Pyke and Harris alternator, which was used in 1892, has been replaced by dry cells. The frequency has been raised to 400. The rate of rising and falling of the current has been immensely improved. The resistance of the circuit has been made as low as possible. There is no measurable capacity, and self-induction is eliminated. Hence the signals are simply splendid, and their rate of working dependent only on the skill of the operator.

The conception of the function of the earth as the completion of the circuit of a single coil has been thoroughly formulated. The earth acts simply as a conductor, and *per se* it is a very poor conductor, deriving its conducting property principally, and often solely, from the moisture it contains. On the other hand, the resistance of the "earth" between the two earth-plates of a good circuit is practically

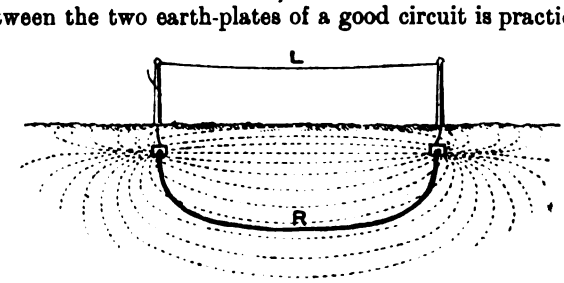

FIG. 2.

nothing. Hence it follows that the mass of earth which forms the return portion of a circuit must be very great, for we know by Ohm's law that the resistance of a circuit increases with its specific resistance and length, and diminishes with its sectional area. Now, if the material forming the "earth" portion of the circuit were, like the sea, homogeneous, the current-flow between the earth-plates would follow innumerable but definite stream lines, which, if traced and plotted out, would form a hemispheroid. These lines of current have been traced and measured. A horizontal plan on the surface of the earth is of the form illustrated in Fig. 1, while a vertical section through the earth is of the form shown in Fig. 2. With earth-plates 1,200 yards apart these currents have been found on the surface at a distance of half a mile behind each plate; and, in a line joining the two transversely, they are evident at a similar distance at right angles to this line. Now this hemispheroidal mass could be replaced

* Note "On Induction between Wires and Wires," B.A., Manchester, 1887.

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electrically by a resultant conductor (R, Fig. 2) of a definite form and position; and, in considering the inductive action between two circuits having earth returns, it is necessary to estimate the position of this imaginary conductor. This was the object of the experiments at Frodsham.

If the material of the earth be variable and dry the hemispheroid must become very much deformed and the section very irregular, the lines of current flow must spread out further, but the principle is the same, and there must be a resultant return. The general result of the experiments at Frodsham indicate that the depth of the resultant earth was 300ft., while those at Conway are comparable with a depth of 350ft. In the case of Frodsham the primary coil had a length of 300ft., while at Conway the length was 1,320ft. At Loch Ness and between Arran and Kintyre, where the parallel lines varied from two to four miles, the calculated depth was found to be about 900ft. The depth of this resultant must therefore increase with the distance separating the earth-plates, and this renders it possible to communicate by induction from parallel wires over much longer distances than would otherwise be possible.

In establishing communication by means of induction there are three dispositions of circuit available—viz., (*a*) single parallel wires to earth at each extremity; (*b*) parallel coils of one or more turns; (*c*) coils of one or more turns placed horizontally and in the same plane. The best practical results are obtained with the first arrangement, more especially if the conformation of the earth admits of the wires being carried to a considerable height above the sea, whilst the earth-plates are at the sea-level. By adopting this course the size of the coil is practically enlarged, and even if it be necessary to increase the distance between the parallel wires to effect this object the result is still more beneficial. Two wires of a definite length were first made up into two coils forming metallic circuits, then uncoiled and joined up as straight lines opposed to each other, with the circuit completed by earth. The inductive effects, and the distance between which they were observable, was very many times greater with the latter than with the former arrangement.

One very interesting fact observed in Loch Ness in 1894 was that there was one particular frequency in the primary circuit that gave a decided maximum effect upon the telephone on the secondary circuit. It was a case of tuning. It was so effective as to secure the transmission of speech across a space of 1¼ miles. Effects of resonance were observed during the experiments in Arran in 1894.* A metallic circuit was formed partly of insulated wire 500ft. above the sea-level, and partly of ordinary line wire, the rectangle being two miles long and 500ft. high. Wires on neighbouring poles at right angles to the shorter side of the rectangle, although disconnected at both ends, took up the vibrations, and it was possible to read all that was signalled on a telephone placed midway in the disconnected circuit by the "surgings" thus set up. In March, 1895, the cable connecting Oban with the island of Mull broke down. A guttapercha-covered wire, 1½ miles long, was laid along the ground from Morven, on the Argyllshire coast, while on Mull the ordinary overhead iron wire connecting Craignure with Aros was used. The mean distance separating the two wires was about two miles. There was no difficulty in communicating. Public messages were sent for a week until the cable was repaired.

Perhaps the most important experiment attempted was that to communicate between England and Ireland. A circuit was made up from Carlisle to Haverfordwest, and another in Ireland, from Belfast to Wexford. The whole telephonic system of the country was stopped from midnight to 2 a.m. one Sunday morning in June, 1895. Attempts were made to signal, but it was impossible to distinguish a signal through the wonderful, incessant, and strange sounds that filled the telephone and overpowered everything else. No telegraph was at work anywhere. The hum of two or three electric light installations working on the alternate-current system was evident, but there was a weird, strange babel of noises that was mysterious and disappointing. I am strongly of opinion that these sounds were due to disturbances excited by primary electrical effects outside our globe. I have not thought the experiment worth repeating. It can have no practical value, but I had arranged, in the event of its success, to communicate between England and Europe, and then between Europe and America.

* "Signalling through Space," B.A., Oxford, 1894.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

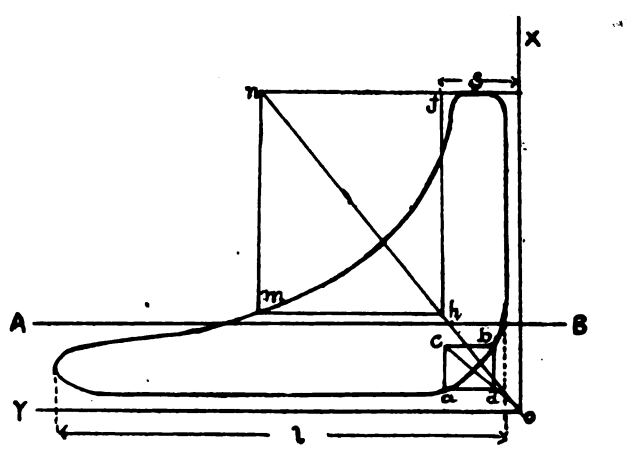
130. How can two compound-wound dynamos in series be used as a balancer on the three-wire system? Would such a balancer work well in parallel with accumulators?—D. S.

131. What is the best method of measuring the resistance of the armature of a dynamo? Give working instructions.—J. C. R.

ANSWERS.

Question No. 124.—Show clearly how to calculate from the indicator card the amount of water used per stroke per indicated horse-power in (*a*) condensing engines, (*b*) non-condensing engines.

Best Answer to No. 124 (*awarded* 10*s.*).—Throughout the stroke of a piston the weight of water (as steam) in the cylinder is constant, although pressure and volume change, and it is determined by the capacity of the cylinder and ports at the point of cut-off, and the pressure of the steam supplied. Assuming, to start with, that the expansion of steam in a cylinder is isothermal, or that the curve is a true hyperbola, and neglecting the effects of condensation in cylinder, etc., we may get the approximate steam consumption from the indicator diagram as follows: Let the figure represent



the indicator diagram taken from one end of the cylinder, A B being the atmospheric line. The length, *l*, gives the actual stroke of the piston. But at either end of the cylinder are clearance spaces (including the ports) which must be filled with steam, and which influence its expansion. To determine the equivalent length of the cylinder, including clearance, take two points, *a b*, on the compression curve of the card. Form a rectangle, *c d*, with *a b* as diagonal, sides parallel with or vertical to the absolute pressure line, Y O, which should be sealed off from A B. Draw the other diagonal, *c d*, and produce it to cut the absolute pressure line at O. From this point draw a perpendicular, X O. Then the horizontal distance from X O to the admission line of the diagram is the equivalent length of the clearance. This construction is on the

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assumption that the compression curve, *a b*, is a true hyberbola. On the assumption that the expansion curve is also a hyperbola, and by a similar construction, the point of cut-off is found. Take a point, *m*, on the expansion curve and erect a perpendicular. Draw a line parallel to O Y touching the top of the diagram, and cutting the perpendicular at *n*. Joint O *n*. Draw *m p* and *p t*, completing the parallelogram, *m t*. Then *t* is the true point of cut-off.

The hyperbola from this point may fall inside the actual line of expansion up to the point *m*. This would show that the volume of steam is reduced excessively, and that therefore there is a lot of condensation in the cylinder. If, on the other hand, the hyperbola is outside the actual curve, it points to leaky valves, for by some means the weight of steam in this end of the cylinder has been added to during the stroke. The horizontal distance, S, to the perpendicular, O X, gives the equivalent length of the cylinder filled with steam at full pressure. This, multiplied by the area of the cylinder, gives the volume of steam per stroke admitted on one side of the piston—*i.e.*,

If d = diameter of cylinder (in feet);
v = volume of steam (cubic feet); and
S is expressed in feet;

then $$v = \cdot 7854\ d^2 \times S.$$

Now, $$V = \frac{330 \cdot 36}{p^{\cdot 941}} \text{ (empirical)};$$

where p = absolute pressure in pounds per square inch;
V = volume of 1lb. steam in cubic feet.
And if v = volume of steam in one end of cylinder in cubic feet

$$w = \frac{v}{V},$$

where w = weight of the steam in pounds,

or, $$w = \frac{v\, p^{\cdot 941}}{330 \cdot 36}.$$

Hence w, the total water per stroke used on one side of the piston, is got from the formula, $\log w = 2 \log d + \log S + \cdot 941 \log p + \log \left\{ \frac{\cdot 7854}{330 \cdot 36} \right\}$

Now, by the usual method of dividing the diagram into 10 equal horizontal divisions, taking the vertical distance between the lines of the diagram at the middle of each division and averaging these lengths, we get the mean pressure of steam in the cylinder throughout the stroke.

Then $$\text{H.P.} = \frac{p^1\, l\, a\, n}{33{,}000},$$

where p^1 = this mean pressure;
l = length of stroke (feet);
a = area of piston (square inches);
n = number of revolutions per minute; and
H.P. = horse-power developed by action of steam on the one side of the piston;

then the water per horse-power per stroke is simply obtained by the division of this horse-power by the total water per stroke.

To ensure an accurate result the diagrams from both ends of the cylinder should be worked as above if the engine is double-acting, and the mean water per horse-power per stroke taken as the result. In calculating the area of the piston, allowance must be made for the space taken up by the piston rod, if it passes through the cylinder on the side of the piston you are working.

In the above we have assumed that the curves of compression and expansion of the steam are hyperbolæ. This is not strictly so. Added to this, steam is used in heating up the comparatively cold walls of the cylinder, which is not accounted for in the diagram. For these and similar losses a correction should be applied to the results above obtained.

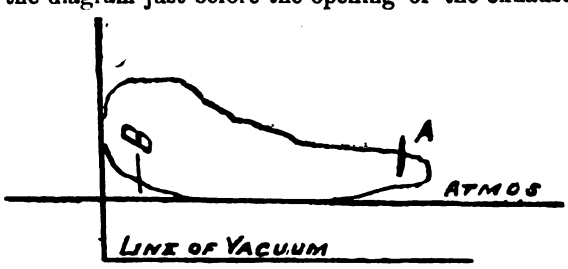
The "Mechanical Engineer Pocket Book" for 1899 gives the following formula:

If d = diameter of cylinder in inches;
r = ratio of expansion;
N = number of revolutions per minute;
C = a constant;
= 6 to 8 for unjacketed engine;
= 4 for jacketed engine;
= 2 to 4 for Corliss engine;
= 12 for very bad engine;

then actual steam consumption = steam shown by indicator diagram multiplied by $\left(1 + \frac{C \log^e r}{d \sqrt{N}}\right)$.

The method above described is equally applicable to condensing and non-condensing engines; as p, in calculating the total water, is an absolute pressure, and p^1 is obtained from the differences of the absolute pressures in the cylinder on the forward and back stroke.—J. A. SEAGER.

Answer to No. 124 (*awarded* 5*s.*).—First, take a point on the diagram just before the opening of the exhaust, A.



Note the pressure measured from the line of perfect vacuum, and calculate the steam space of the cylinder up to that point. This is made up of the cross-sectional area × length of stroke up to that point + the room wasted in clearance at the steam end of the stroke brought to cubic feet. Next find from tables the weight of 1ft. of steam of the absolute pressure of point A, and multiply this by the volume in cubic feet already found. This will give the weight of steam for forward stroke. But we must deduct from this the steam saved for compression by the early closing of the exhaust. This is found in the same way. Take a point on the card (B in the diagram) where it is certain the exhaust valve is closed, note the absolute pressure, and multiply the area of cylinder by the remaining length of stroke to be completed, and add the waste room in clearance space, brought to cubic feet; then as before find by tables the weight of 1lb. of steam at absolute pressure, B; then multiplying this by the volume found will give the weight of steam saved. Having found the weight per stroke it is simple to find the weight per horse-power. In the case of an engine with one cyclinder:

$$\text{H.P.} = \frac{\text{mean pressure} \times \text{length of stroke} \times \text{area} \times 2 \text{ (revs. per min.)}}{33{,}000}$$

and

$$\frac{\text{weight of steam per stroke} \times 2 \text{ (revs. per min.)}}{\text{horse-power}} = \text{weight per H.P.}$$

As the pressure measured for calculating the weight is absolute—*i.e.*, measured from vacuum line—there is no difference in calculating the steam *per stroke* in a condensing or non-condensing engine, but it must be remembered, when calculating the horse-power of an engine, that in a condensing engine, owing to the reduction of back pressure by the partial vacuum behind the piston, work is done below the atmospheric line, so the mean pressure below the atmospheric line must be calculated and added to the mean pressure above. If we find the weight of steam in this way, we have, of course, found the weight of water used in the form of steam in the cylinder. Now, although this may pass as a method of finding the water consumption of an engine, it becomes very inaccurate as a means of discovering the necessary supply to a boiler, for the following reasons: (1) a certain amount of water is lost from a boiler by more or less priming, or, in other words, the percentage of the wetness of the steam is seldom so small as to be negligible; (2) condensation due to radiation after leaving the boiler; (3) condensation due to work done in cylinder; (4) condensation due to heating cylinder walls.—L. M.

Question No. 125.—How do you determine the secondary drop in volts between full and no load in a transformer?

Best Answer to No. 125 (*awarded* 10*s.*).—There are few electrical measurements in common use which are more

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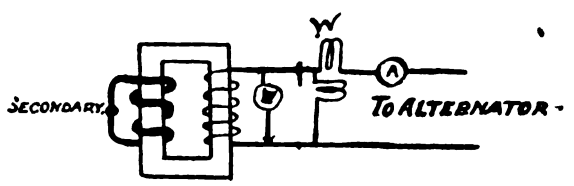
unsatisfactory or indirect than the drop tests of transformers. The ordinary workshop method, as used by most of the large transformer makers, is simply to read the difference in secondary voltage on the transformer at full load and no load, the primary voltage being kept constant. But this is very rough, for in order to get at the drop, which in a 100-volt transformer may be something like two or three volts, the quantity actually measured is the full secondary voltage (100). In order to get reliable figures with this method, a large number of readings become necessary.

A far more accurate method, though less direct and involving a wattmeter measurement and a certain amount of calculation before the drop can be got at, is the following: Short-circuit the secondary winding on itself, making a thoroughly good joint between the two ends. Put an ammeter or dynamometer, a wattmeter, and a voltmeter in the primary circuit, the connections being as shown in the diagram. Apply sufficient volts to the primary to pass the full primary current (as read on the ammeter, A).



Then read the wattmeter and voltmeter. From these readings and the measured primary and secondary copper resistances the drop is then calculated thus:

Let E and e be primary and secondary voltages;
A and a be primary and secondary currents;
r_1 and r_2 be primary and secondary resistances;
V be the applied primary voltage in the above short-circuit test;
W be wattmeter reading in same test;
l be the reactive voltage drop on primary at full load.

Then the voltage, V, is made up of two parts, one being $\frac{W}{A}$ in step with the current, and the other being l, practically at right angles to the current. Thus:

$$V = \sqrt{\left(\frac{W}{A}\right)^2 + l^2}$$

or,

$$l = \sqrt{V^2 - \left(\frac{W}{A}\right)^2}$$

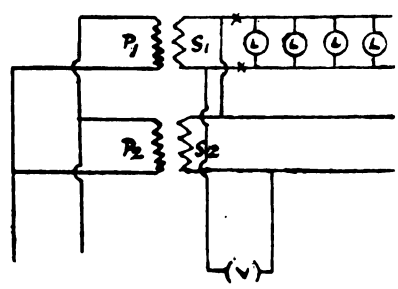
and $\frac{l \times 100 \times e}{E}$ gives this reactive drop as a percentage of the secondary voltage. The secondary copper drop is $a\,r_2 \times \frac{100}{e}$ as a percentage of the secondary voltage, and the primary copper drop is $A\,r_1 \times \frac{100}{E}$ as a percentage of the primary (or secondary) voltage. To combine these three and get at the total drop, set off a horizontal to represent the secondary voltage, draw a perpendicular at one end representing the reactive drop, l, as a percentage of secondary volts, then completing the triangle, the hypotenuse represents the no-load secondary voltage, neglecting the copper drop. Calling this last 100 per cent. the base (or full-load secondary voltage, neglecting copper drop) is given by $\sqrt{(100\,\%)^2 - (l\,\%)^2}$. From this it is only necessary to subtract the primary and secondary percentage copper drops to get at the actual full-load secondary voltage as a percentage of the no-load voltage, the complete expression for this being

$$\sqrt{(100\,\%)^2 - (l\,\%)^2} - \left(a\,r_2 \times \frac{100}{e} + A\,r_1 \times \frac{100}{E}\right).$$

It may be well here to refer to a paper by A. R. Everet in the *Electrical World* of New York, vol. xxxi., No. 23, in which the correction for the primary current being out of phase (as in open magnetic circuit transformers) and other refinements are fully dealt with.

When large numbers of transformers have to be tested, as in a manufactory, it would be well worth while to keep a small standard transformer whose drop curve would be determined carefully once for all, and which could then be run coupled in parallel with the transformer under test. By measuring the current given by the standard transformer when the one it was in parallel with gave full load, the drop of the latter could at once be read off the standard curves. This method would, in fact, be preferable to either of the others, for, besides being extremely accurate, it is simple (a couple of current readings only being necessary), and shows the drop in a practical way, which appeals to the station engineer.—Q.

Answer to No. 125 (*awarded* 5*s.*).—In order to measure the secondary drop between full load and no load, an electrostatic voltmeter is connected across the secondary circuits, and its reading taken when the primary terminal potential difference is also known. The transformer is then



loaded up to its full load on its secondary side, and the primary potential difference being kept at the same amount, the secondary potential difference will be found to have fallen, and the amount of difference between its value when the transformer is fully loaded and its value when the transformer is on open circuit is called the secondary drop. The diagram shows the connections for measuring the drop. Two identical transformers and a low-reading electrostatic voltmeter are required. The two transformers are connected up, their primary circuits being in parallel, and their secondary circuits opposed to one another through the voltmeter. The voltmeter does not read secondary volts of either transformer, but the difference between the two differences. If one transformer is fully loaded up, the voltmeter will read directly the secondary drop, and as both transformers are affected equally by any variation of the primary voltage, it does not affect their difference, consequently there is no difficulty in getting the measurement accurately.—F. BRUTON.

FORTHCOMING EVENTS.

FRIDAY, JAN. 6.

London Chamber of Commerce.—At 12 noon, meeting of Electrical Section. For business see Notes.

TUESDAY, JAN. 10.

Institution of Civil Engineers.—At 8 p.m., "High-Speed Engines," by John Handsley Dales, A.M.I.C.E.

Rontgen Society.—At 11, Chandos-street, at 8 p.m., "The Present Position of the Röntgen Rays in Military Surgery," by J. Battersby, M.B.

WEDNESDAY, JAN. 11.

Liverpool Engineering Society.—At Royal Institution, Liverpool, at 8 p.m., "Employers' Liability," by Mr. R. D. Cripps.

THURSDAY, JAN. 12.

Institution of Electrical Engineers.—At Institution of Civil Engineers, at 8 p.m., further discussion on the three papers on "Space Telegraphy," by Dr. Oliver Lodge, Mr. S. Evershed, and Mr. W. H. Preece.

FRIDAY, JAN. 13.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Lecture by Dr. Archibald Barr, M.I.C.E, on "The Application of the Science of Mechanics to Engineering Practice."

Annual Dinner.—The London office staff of the National Electric Free Wiring Company, Limited, held their first annual dinner in the Japanese Room at the Holborn Restaurant on the 30th ult. A number of visitors were present, and a most enjoyable evening was spent. The manager, Mr. B. H. Jenkinson, was in the chair, the vice-chairman being the secretary, Mr. Percy B. Wilson. The usual loyal toasts over, the manager proposed that of "The Chairman and Directors of the Company." This was enthusiastically received with musical honours, and very ably replied to by the secretary. Recitations and songs were afterwards rendered by members of the staff.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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1899—THE OUTLOOK.

To our Readers, a Happy and Prosperous Year.

The exact words of "Old Mother Shipton's" prophecy we do not remember, nor would it serve any useful purpose to search for them, but, among other things, she is said to have foretold that carriages would move without horses. The introduction of steam brought about the fulfilment of that prophecy—if, indeed, the prophecy was ever made—but we venture to think that the action of steam was never so surprising to the untutored mind as is that of electrical energy used to propel vehicles. In the one case, the least educated could see the stoker piling the coals into the furnace, and has some little comprehension of the powers of steam, even if his observation has been solely upon the ubiquitious tea-kettle. With electricity it is very different. Only a wire, and a whirligig which makes the wheels go round. And when the investigator asks "What is it," he gets as reply a shrug of the shoulders and "Don't know." Whatever the amount of ignorance acknowledged, or the pretence of knowledge shown, one thing is certain, and the progress of the past year shows it most conclusively. It is that, so far as Great Britain is concerned, the era for the use of electrical traction has really commenced. Previously the indications were thought to be favourable, but the advance during 1898 has been enormous and certain. There can be no going back, and the advance will be rapid. Whatever may in the abstract be thought of the policy of municipalities undertaking the construction and working of tramways, nothing is more certain than that all the principal English towns have decided that such work is to be carried out by them. The enormous advantages to the citizens in having the control of gas, electric light, and water undertakings in their hands, combined with the spirit existing in a "nation of shopkeepers" to make money, has undoubtedly led the municipalities to this conclusion. By-and-by the real influence will be put on one side, and the ostensible reason for embarking in tramway work will be attributed to the necessity for better regulating and working street traffic.

What are the reasons for the conclusion that a great increase of activity will take place in the application of electricity as a motive power? These are not far to seek. The most important municipalities in the kingdom have given their allegiance to electrical working. Witness Dublin, Glasgow, Blackpool, Liverpool, Sunderland, Halifax, Bradford, Sheffield, Hull, Bristol, Plymouth, and so on—names which suggest themselves at random—while there is little doubt but that the Metropolis will ere long enter the ranks of the convinced, and at any rate partially adopt electric traction. An examination of the parliamentary Bills lodged for consideration during the next session will show that, while schemes are put forward for railways proper involving the expenditure of from ten to fifteen millions of pounds, the schemes put forward in which electricity will or may be the motive power involve an expenditure which we may roughly estimate at from five to ten millions of pounds. It is not usual

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for business men, be they merely promoters or having a very definite purpose, to so extensively put forward schemes without they have ascertained the tendency to be in the direction towards which they are working. They expect to get the money for most if not all the schemes which may be sanctioned; and when we come to consider the demands which this work, not to speak of lighting schemes, will bring upon the various manufacturing works, it will be acknowledged that, given no labour troubles, there will be no slackness of work for a long time to come. Of course a large number of schemes will not be sanctioned, but, putting these aside, there remains enough to ensure prosperity to the factories providing a cut-throat policy be not pursued. The moral to the state of things existing at the beginning of 1899 is twofold. First, the owners of factories should look ahead and see how they are able to cope with the probable demand; and, secondly, that as it is almost certain that the existing factories will be unable to meet the demand, whether extensions should not be started and equipped so that urgent orders be not sent abroad. Under the favourable outlook, and with order books full, there ought to be little or no difficulty in getting the capital necessary for this object.

THE PRESENT POSITION OF TELEPHONY.

The telephone question is always with us—changed, in some of its aspects, no doubt, but apparently still far removed from a final Answer. In respect to it, "Are you there?" the enquiry which on the London Exchange so seldom elicits anything satisfactory, is never asked in vain. The Select Committee of 1898 consequent upon the Glasgow enquiry of 1897, which declared the National Telephone Company's service in the Glasgow district to be unsatisfactory, resulted in certain recommendations which, if endorsed by Parliament and given effect to in a sufficiently liberal spirit, are calculated not only to give a fillip to the user of the telephone in the British Isles, but to make the foundation of a British telephone manufacturing industry possible. One of the most disgraceful and injurious consequences of the existing monopoly, and its support by the permanent officials of the Post Office and a partizan Press, has been to throw into foreign hands the supply of the telephone apparatus used in this country and in the Colonies. Licenses to municipalities will, by providing more consumers, offer greater inducements to the investment of capital in telephone factories, so that some appreciable share in production may after a time be regained for our capitalists and our workers. This result alone would outweigh any slight inconveniences which might arise from the existence side by side of competing systems. We should like to see competition by the Post Office a real and living thing, too, as recommended by the Select Committee. Theoretically, telephones should be part and parcel of the Post Office telegraph system; practically, there is probably little prospect of the Post Office competing with any effect. In the past the Department's exchanges have been both dear and inefficient, while the evidence given before the Select Committee by the permanent officials reveals such obstinate predilections for the discredited monopoly that it is difficult to believe in anything acceptable coming from them.

A strong effort will doubtlessly be made during the coming session to induce Parliament to purchase the National Telephone Company's undertaking at the market value of the shares, but the Treasury may be relied upon, we think, to veto such an impudent proposal, the acceptance of which would condemn the public to dear telephones indefinitely, as the price paid for the system (the greater part of which would have to be reconstructed out of the public funds) would furnish a standing excuse for not reducing the rates to the figures which have proved adequate abroad. The Government will probably take the view that a period of competition by such municipalities as desire it will be the best means of clearing the air. Many contested points would be resolved by the touchstone of experience; and in a few years' time a final decision, consistent with the interests of all parties, would be far more practicable than at present. Of course, the National Telephone Company will object, for even a short spell of competition will infallibly reveal the preposterous nature of their present charges.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

COPPER MORTGAGES.

SIR,—In your paper of Dec. 2 last, there is a letter from Mr. Horace Allen about "Cable Mortgages," in which he claims in very strong terms that Mr. B. H. Thwaite was the originator of the idea (in his paper of Nov. 12, 1892, read at Manchester). Accidentally looking over a copy of Prof. G. Forbes's Cantor lecture of Jan. 25, 1892 (nine and a half months previous) I came across this statement: "I think that far more copper would be put down in mains if people realised the low rate of interest at which money could be raised in debentures on them." I observe that Prof. Forbes forgets this remark, for which he did not even claim the invention.—Yours, etc.,

ALEXANDER WILSON, M.E., A.M.I.C.E.

Nunhead, S.E., Jan. 3, 1899.

REVIEWS.

Submarine Telegraphs: Their History, Construction, and Working. Founded in part on Wunschendorff's "Traite de Télégraphie Sous-Marine," and compiled from authoritative and exclusive sources. By CHARLES BRIGHT, F.R.S.E. Crosby Lockwood and Son, London. Price £3. 3s.

The author of this monumental book possesses many of the characteristics that are necessary to ensure success in authorship. Youth, ambition, and energy go far to enable a man to make his mark, add to these the records left by a father who was a pioneer in cable work, personal contact with other pioneers, and a working knowledge of submarine telegraphy as at present practised, and you get, if the information obtained has been properly assimilated with balance sufficient to separate bias from reality, about as good a combination as it would be possible to find in one to write the history of cable work. If our author fails in his history at all, his failing is in having a bias towards his father's work. When we consider that the whole history of submarine work is contained in the closing half of this century, and that from the unsuccessful work in 1850 a temporary gleam of success was obtained which

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proved sufficient to induce further efforts, and to give rise to a system which now threads every silent sea and joins the shores of all nations in the civilised world, the more closely we examine this, or, indeed, any other industry, the more clearly is proved the inability of scientific men to give great assistance, at any rate, in the earlier stages of development. Men of a business turn of mind, men whose motto is "Try; you can only fail," do try and fail, improve on their failures, and finally succeed. Then the scientific man comes along, and lays down the laws which must be followed to ensure success. The success, however, is more or less assured before his laws are available. The pioneers in cable work were rule-of-thumb men. They were grand men, for, undeterred by one failure, they refused to acknowledge defeat, and continued trying till they spelt success. Mr. Bright has revived one name from the forgottenness in which it had fallen, and placed it in its proper position—Mr. T. R. Crampton, the man whose energy rescued the Bretts from despair, and led to the laying of the first really successful cable across the sea—viz., from Dover to Calais. There is one point with regard to the history of cable projects from 1845 to 1850 that we should like to see cleared up. Was the South-Eastern Railway negotiating with Paris at the same time as the Bretts? That the South-Eastern was somehow mixed up in the matter we have reason to know, but that is all we do know. Of these early pioneers we were indebted to Whitehouse for a sight of the joints and weights and pieces of the 1850 cable. Crampton we knew well, but could never get him to talk much of these early days. However, their names, with others, find due place at the hands of Mr. Bright. Before turning to the contents of this mighty book, let us first say that perhaps the best *résumé* of the work of early cable-laying will be found in the "Companion to the Almanack" for various years in the fifties and sixties. A good deal of interesting matter is given by Tal. P. Shaffner in his "Telegraph Companion," vol. ii., not only as regards the then existing submarine telegraphs and the proposed lines, but also with regard to telegraphy generally at that time. But to the book. The second chapter is devoted to "The Dawn of Ocean Telegraphy," and describes in considerable detail the history, both commercial and technical, of the early cables—Atlantic, Mediterranean, Indian, and Persian Gulf. The descriptions are good, and the illustrations excellent. It seems to us, without venturing into too critical an investigation, that credit has been given fairly all round to those who took part in the operations. At any rate, several of the gentlemen who were actively engaged in the work are still living, and, if need be, can correct the author. Our impression is that his statements will be found to be fairly accurate—as accurate, indeed, as a human compiler with an accountable bias can expect to be. Lord Kelvin, Messrs. Saunders, Collett, Gerhardi, not to mention others, are still active survivors of these pioneers, while F. C. Webb's writings on some of the work can be referred to. The next chapter deals with the successful laying of the Atlantic cables, as well as a number of other cables, but it is needless to travel through the history of failures which paved the way to full success. These will be found duly recorded in that portion of this treatise which deals with the subject—that is, to the end of Chapter III. The next chapter is almost entirely commercial, and deals with subjects upon which differences of opinion may legitimately exist, such as tariffs, international conventions relating to cables, the relation of contractors to the companies, the social and political influences of cables, purely commercial cables, strategic influences, and so on. Some paragraphs, however, are devoted to the current literature of electrical matters, and one glances at "Induction Telegraphy," but, as may be supposed, only in a most cursory manner. From a purely technical point of view, the remaining parts of the book—Parts II. and III.—dealing with the materials used in and the construction of the cable, and with the instruments, systems and working of cables respectively, which form about two-thirds of the whole work—are interesting, but hardly as trustworthy as the earlier part of the book. The busy worker is far too apt to say 'ancient history" about anything that happened the day before yesterday, and to despise the "way" in which things were done last year, and too often is a fool for his pains. There is much to be learned from the older heads and hands, and to know what they have done is frequently to know what to avoid. But while this is quite true, it must always be remembered that progress is continuous, and too many act as if the way a thing was done the day before yesterday is the perfect way, incapable of improvement; and this style of looking at things is as bad as the "ancient history" style. The reader of the second half of this book will have to be careful in guarding against misprints, as well as some loose writing. Thus we are told "the resistance of a wire of given material varies *directly* [the italics are ours] with the *bulk or* area," etc. A corrected explanation immediately follows; but, in the first place, increase of bulk does not necessarily mean increased area, and, of course, the word *directly* should read *inversely*. Putting aside these—some of them superficial and easily discernible errors, others altogether misleading—there is a good deal of information about the various items which are treated. If the work was not deliberately indicated as historical, more might be said of these errors. The same remark applies to Part III. as to Part II., except that in this part too much reference has been made to schemes and ideas not strictly historical, but still very largely in the experimental stage. Perhaps, however, the work would have been deemed incomplete without such references, but surely in a book that so professes completeness it is unjustifiable to refer to current literature. Surely the author should give his own description, and offer some critical opinions upon the subject. Readers consult such a book to see a well-balanced judgment upon the questions, if they are discussed at all. Still, with the exceptions briefly referred to, the book contains within its covers a vast mass of information which it is extremely handy to have in such a form. Should a second edition be called for, the various misprints and errors should be put right, various paragraphs referring to work of purely an experimental and even of an hypothetical character left out, and a carefully critical exposition of the position and probabilities of such things as "wireless telegraphy" given. The basis of the book is stated to be Wunschendorff's "Traite de Télégraphie Sous-Marine." The type, printing, and illustrations are excellent.

LOUD-SPEAKING TELEPHONE.

As we go to press the following communication comes to hand from Dr. Oliver J. Lodge: "In the talking and singing experiment which I showed to the Institution of Electrical Engineers on Dec. 8, I did not make it clear whether or not I was using any of the magnifying telephones that were on the table in addition to the sound-board telephone. In answer to inquiries, will you allow me to say that I was not. There was no magnification in the case. The speech currents were taken direct round the little coil attached to the deal board and suspended in a magnetic field. And only one such coil was in that instance used. The articulation of a sound-board telephone can be decidedly good as well as loud, and there need be no nasal twang such as is caused by a resonant trumpet or cone."

ELECTRIC LIGHTING COMPANIES' SHARES.

In our first issue for 1898 we commented on the great increase which had taken place in the market values of the shares of the London electric lighting companies during 1897. To show how these securities have varied during the past year, we have had another set of curves prepared, which give the middle prices each month. From these curves it will be seen that the rise continued during the first few months of the year, and that since then there has been a general set back in all cases. The points of interest in the curves are many. Thus, the peaks shown at the beginning of the year are due in each case to the issue of the annual balance sheets and

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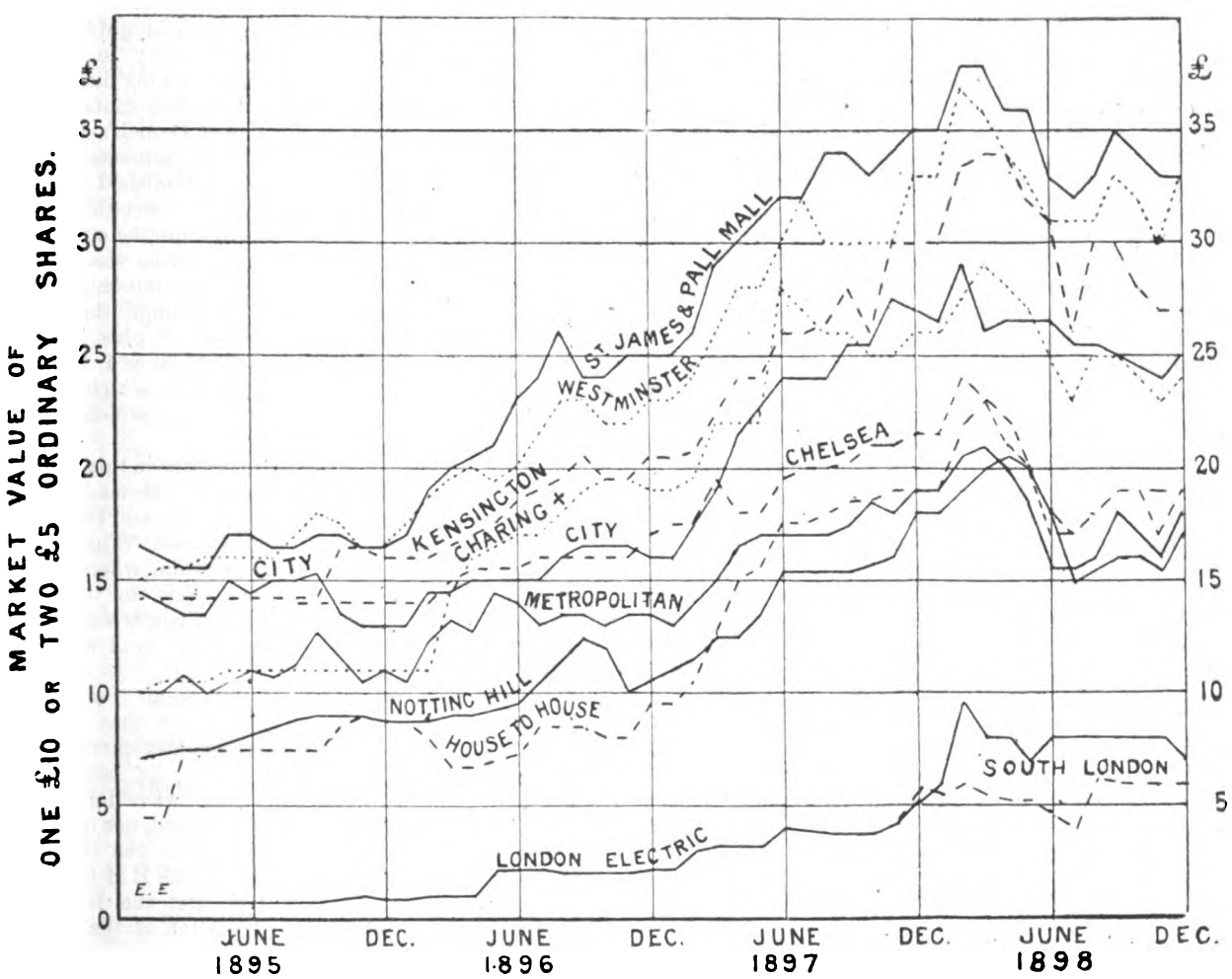
the declaration of dividends. After these dividends had been paid, the value of the shares fell somewhat, as is natural, but the big drops seen to occur in June and July were due to the attempt of the Marylebone Vestry to obtain powers to compete with the Metropolitan Electric Supply Company. This caused a fall in the Metropolitan shares, and the other companies had their securities fall in sympathy. As they would also have been open to competition had the test case brought by the Marylebone Vestry been successful, this is not a matter for surprise. As soon, however, as the application of the Vestry for a provisional order had been refused, the shares began to advance in price, until checked again by the dispute with France over Fashoda. Thus various causes have tended to keep the price of shares down, but as the causes have now practically passed away a further rise may be expected. This we say because all the companies, as far as we have heard, have had a prosperous year's trading, and the demand for connections shows that in no case has the limit in number of consumers been approached at present. In fact, in many cases companies have connected more new lamps to their mains during 1898 than in any previous year. During the year the London Electric Company has been reconstructed, and the curve for 1898 represents the value of two shares of £3 face value, instead of £5 as heretofore. We have added the South London Company to the list, and in this case the shares are at present only £3 paid. Thus they stand at par, while those of the London Electric Company are worth considerably more than their face value.



GAS OR ELECTRICITY.

Mr. Charles W. Offord, the secretary and general manager of the Enfield Gas Company, presented to his board of directors last month a reassuring statement as to the cost of electric lighting, and on the present position of electrical undertakings. This report is naturally much appreciated by the gas journals, who apparently prefer calculations favourable to the gas industry to facts obtained from practice. We have not space to print Mr. Offord's report, and, candidly, it is not worth printing. How far his report is biassed towards gas interests can be seen by the following extract alone: "For the purpose of giving analytical information regarding the present position of undertakings supplying electric light, I have used as my text-book a 'Manual of Electrical Undertakings,' which embraces all undertakings in the United Kingdom actually supplying electric current, or possessing unexercised powers to do so. I have passed by all accounts of corporations and other local authorities, and have noticed only those of companies, for the reason that companies, though naturally anxious to present to the public the best view possible of their affairs, cannot improve that view at the expense of the ratepayer, directly or indirectly, by a plainly shown contribution from the rates, or by equal, but hidden, assistance." This last sentence, imputing fraud in making up municipal accounts, is most uncalled for; and on reading further we at once see the author's reason for passing over the municipal electric lighting undertakings. They are obtaining too favourable financial results to meet his views. Even some of the companies err the same way, and these are struck out because they are not comparable with Enfield. The accounts of the 20 companies whose districts the author does consider comparable are then given in tabular form. Of these, only two—*i.e.*, those at Reading and the Crystal Palace District—have their expenses above their revenue, and some six show a loss after paying debenture interest.

The list includes such companies as the Crystal Palace District Company, the Woolwich Electric Lighting Company, the Hastings Electric Lighting Company, and others at Pontypool, Reading, and Kelvinside. Our readers know that several of these concerns were pioneers, and lost money through faulty equipments put in during the earlier years of their existence. Others, again, which appear on this list are new companies which have not had time to get really profitable loads on the stations. Yet, in spite of

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this, the 20 companies, as a whole, show a net profit on the aggregate capital of about 3½ per cent. After this we have to refer to a further list of stations of which figures are not obtainable. Of these Mr. Offord says: "I think it may be safely conjectured that, having no good results, they decline to publish failure." Surely even this would be better than Mr. Offord's own procedure, as he has had good results before him, and prefers to publish only the worst available. His great failure is that of the Rottingdean Company. A reference to Mr. Garcke's excellent manual shows that this concern has a capital of £1,000, and a plant capacity of 16 kw. Leaving the financial figures, we next come to Mr. Offord's comparative figures as to the cost of electricity and gas. The first prominent fact is that in future the standard gas-burner is to be one of 100 c.p., and that it will always give this light for a consumption of four cubic feet of gas per hour. This puts a good light on the problem, and a further shade is put over the electric light by comparing these burners with incandescent lamps only taking 3½ watts per candle-power. The arc lamp evidently has not yet been brought to the notice of Mr. Offord, neither does he know of high-efficiency incandescent electric lamps. The comparison is proceeded with on the above lines, and all renewals, both of electric lamps and gas mantles, are neglected as being equal. The results obtained is that gas at 3s. 11d. per 1,000ft. is some 11½ times cheaper as an illuminant than electricity at 6d. per Board of Trade unit. The actual costs are calculated for a 100-c.p. light running 1,000 hours. The resultant figures are not worth the paper they are written on, for the usual reason, that they do not apply in any practical case. In the first case, assuming that the 100-c.p. lamp was wanted, it could not be obtained for 1,000 hours with a consumption of 4,000 cubic feet of gas without an unlimited supply of mantles. Secondly, in the greatest number of cases it is distributed light that is wanted, and the use of a 100 c.p. burning in one room will not light a house as the greater number of electric lamps will do. There are two things we should like Mr. Offord to send us, and these we should be pleased to publish. The first is a copy of the tests he has made to substantiate his estimate for gaslighting, with the particulars as to the number of mantles used; and the second a calculation of the effect on his company's balance-sheet of the general adoption of a burner giving 100 c.p. per four cubic feet of gas. After all, paper figures are not what are wanted, but results from practical competition. We electrical engineers know that the gas runs us hard in matters of cost at present, and yet we know that this has not in any way stopped the rapid increase of electric light stations which do pay. If Mr. Offord wants to read an able article on the electric side, he cannot do better than look up Mr. R. Hammond's contribution to the January number of the *Engineering Magazine*.

HIGH-VOLTAGE POWER TRANSMISSION.*

BY CHAS. F. SCOTT.

(Continued from page 849, Vol. XXII.)

Simultaneous with these choke-coil discharges one could hear, if standing under the line some little distance from the transformer house, a slight snap, which seemed to be a phenomenon rather of the whole line than of any particular spot in it. Sometimes there was a corresponding snap over the lightning arresters. As the lightning arresters make more or less noise at all voltages, this snap over them may have been present at all times, but in some cases not sufficiently well marked to be heard above the continued hissing of the lightning arresters.

After the preceding results had been obtained, the two power transformers were connected up with their high-tension windings in series, the point of connection between them being grounded, and with their low-tension windings in multiple. With this arrangement voltage was impressed on one of the circuits, power being supplied by the smooth armature at 7,200 alternations. The voltage was run by means of the machine field to 90,000.

As the power taken by the lines at this voltage overloaded the motor used to drive the generator, a span was cut out of the circuits at a little distance from the station, leaving about 500ft. of wire in them. The voltage was run up to 133,000 volts, and held there for some minutes; but the current finally jumped from the outside terminal of each transformer to the iron, smashing the heavy glass tube with which these terminals were insulated.

Discussion of Results.

The following is taken from Mr. Mershon's discussion of the results of his tests: "There is evidently a certain critical voltage at which the loss occurring between wires begins to increase very rapidly; indeed, it seems as though there might be something of the nature of a polarisation similar to that which occurs in the case of an electrolyte; that there is something of this nature in the case of air or other gases subjected to an electrostatic stress is well known, and it has been taken as an explanation of the fact that in the experimental determination of sparking distances in air a certain minimum potential is necessary to establish an arc, no matter how small be the sparking distance. Also Varley has done some work on tubes containing gases. This work was done with a series of Daniell's cells yielding 300 to 400 volts. The voltage was impressed upon electrodes sealed into the tubes. He established the following facts: first, that each tube required a certain potential to leap across; second, that the passage for the current having been once established a lower potential was sufficient to continue the current; third, if the minimum potential which would maintain a current through the tube be P and the voltage varied to P plus 1, P plus 2, etc., to P plus N, the current will vary in strength as 1, 2, 3, etc., N; P always meaning the lowest value at which the current will continue, and is less than that at which the current starts.

"If such a condition of affairs obtains in this case, the loss curves of the preceding sheets must be made up in two parts—one the loss over the insulators and cross-arms, the other the loss occurring through the air. The first part of the loss curve up to or near the point where the abrupt bend begins, must be the loss over the insulators and cross-arms alone; beyond the point where such a bending occurs, the loss curve must be made up of a combination of the two losses referred to.

"If the action which takes place in air is similar to that obtained by Varley, we might expect that both (1) the position of the critical bend on the loss curve and (2) the law which the loss follows above the bend, would be affected by the form of the E.M.F. wave impressed upon the line; for the former (1) must depend, not upon the mean square of the voltage impressed upon the line, but upon the mean square of that portion of the E.M.F. wave which is above a certain critical voltage, and the latter (2) must depend upon the form of that portion of the E.M.F. wave above a certain critical voltage, because, as Varley shows, the minimum voltage at which this peculiar loss begins differs slightly from the minimum voltage at which it will continue after the action has been established. If it were not for the latter consideration, it would be comparatively easy to determine the equation for such loss—at least, in the case of a pure sine wave—and it might be that there is a sufficiently small difference between the voltage at which this loss will begin, and the voltage at which it will discontinue, for such an equation to hold practically. That the loss depends upon the maximum value, if not upon the form of the E.M.F. wave, is shown by several of the loss curves in connection with their corresponding wave forms. This is particularly noticeable in one or two cases where the loss on two lines in multiple is less than that on one line, and although some of these comparisons will have to be made between curves taken on the two different watt-meters, and are therefore not strictly comparable, they may be compared after such correction as is mentioned below in discussing the wattmeters. In any case the curves are comparable qualitatively as regards the position of the critical point.

"It might be objected that the results are rendered

* Paper read before the American Institute of Electrical Engineers.

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questionable by the curves in Fig. 7. The curves were taken under presumably similar conditions, except that one was obtained by means of the Thomson wattmeter, and the other by means of the Weston wattmeter. This discrepancy is attributed to a charging current passing through the shunt resistance of the Thomson wattmeter. That the amount of capacity current necessary to produce the discrepancy is small, appears upon the following considerations: in one case the loss obtained upon a circuit at 38,000 volts when using the Weston wattmeter is 90 watts, and under the same conditions, but using the Thomson wattmeter, the loss is 215 watts. The difference in the loss obtained by the two wattmeters is therefore 125 watts. The current is about 0·25 of an ampere. Now 0·25 of an ampere if in step with the E.M.F. would give on the Thomson wattmeter at 38,000 volts a reading of 9,500 watts, therefore the capacity current through the shunt resistance necessary to produce the discrepancy of 125 watts is 125 divided by 9,500, or about 1·3 per cent. of the current in the shunt resistance. The shunt resistance has a value of 1,202,300 ohms; at 38,000 volts the current through it would be about 0·032 ampere; 1·3 per cent. of this, or 0·00416 ampere, is that required to produce the discrepancy noted. In further support of this method of accounting for the discrepancy, the results obtained at different numbers of alternations using the Thomson wattmeter show a variation for different numbers of alternations of the losses below the bend in the loss curve, and which are thought to occur over insulators and cross-arms. There should be no variation in such loss for a variation in frequency.

"Any discrepancy occurring in the Thomson wattmeter by reason of a capacity current in its shunt resistance, will be affected to a greater or less extent by change in the wave form.

"It is believed that all the phenomena connected with this work may be studied in a tube which has been partly exhausted. The work could then be done with comparatively low voltage and using direct current, which would much simplify the measurements. The contents of the tube might be partially rarefied air or other gas, as the action would undoubtedly be similar in all gases. With such a tube might be studied the law of variation in distance and form of electrodes, also in material and surface of the same.

(To be continued.)

JAMES BOWMAN LINDSAY, ELECTRICIAN, ASTRONOMER, LINGUIST, 1799-1862.

BY J. J. FAHIE, M.I.E.E.

Lives of great men all remind us,
We can make our lives sublime;
And, departing, leave behind us,
Footprints on the sands of time.

These stimulating words of Longfellow are true, but, like many other beautiful aphorisms, they are subject to limitations, for, unfortunately in not a few cases, the footprints are so slight, or are in such out-of-the-way places, that they soon get covered over—especially in the mud hurry-scurry of these latter days. The poet Gray more truly says:

Full many a gem of purest ray serene,
The dark unfathom'd caves of ocean bear;
Full many a flower is born to blush unseen,
And waste its sweetness on the desert air.

The subject of this paper is curiously illustrative of both these sentiments, for while Lindsay left some footprints (now sadly blurred), much of his sweetness was lost on the desert air of a prison schoolroom. But the fault was not his entirely, for I am of opinion that had he lived in London or some other great centre of intellectual activity, and had he been better favoured by fortune and friends, his marks on the sand of time would have been deep and indelible. As it is, his name is now hardly known in the world of science and letters, which, under more favourable circumstances, he would have done so much to enrich; and even in his adopted town of Dundee, where his life was spent, his great talents, and the many endearing qualities of his noble but simple nature, are not so generally appreciated as assuredly they deserve to be—possibly because of the recondite character of his studies, in which there could not be many to sympathise, as there were few capable of understanding them. Yet it is certain that of the many worthy sons which Dundee has given to Britain Lindsay was the greatest, and she should be proud to inscribe his name in her temple of fame.

Quite recently, in the course of some historical researches, I have collected a number of facts bearing on the life and works of this truly remarkable man which will enable me to give some idea of his personality, and a tolerably full account of his literary and scientific (electrical) pursuits. These, as I have already hinted, should not be judged on their results alone, considerable as these are, but rather as indications of still greater achievements which under a more favourable environment we might have expected with certainty. For much of my materials I am indebted to the kindness of Dr. Robert Sinclair and Mr. A. H. Millar, both of Dundee, and to one or two other local admirers of Lindsay whose names will be mentioned in the course of my narrative.

James Bowman Lindsay was born at Carmyllie, near Arbroath, on Sept. 8, 1799, and but for the delicacy of his constitution would have been bred a farmer. At an early age he evinced a great taste for reading, and every moment that he could spare from his work as a linen weaver was devoted to his favourite books. Often, indeed, he would be seen on his way to Arbroath with a web of cloth tied on his back and an open book in his hands, and, after delivering the cloth and obtaining fresh materials for weaving, he would return to Carmyllie in the same fashion. Encouraged by these studious habits, Lindsay's parents wisely arranged that he should go to St. Andrew's University, Aberdeen. Accordingly, in 1821 he entered on his studies, and, self-taught though he had hitherto been, he soon made for himself a distinguished place among his fellow-students, particularly in the mathematical and physical sciences, in which departments, indeed, he became the first student of his time. In the long summer vacations he generally returned to his occupation of weaving, though latterly he took up teaching, and thus enjoyed more time for the prosecution of his own studies. Having completed the ordinary four years' course, Lindsay entered as a student of theology and duly completed his studies in the Divinity Hall, but he never presented himself for a license, his habits of thought inclining more to scientific than to theological pursuits.

Coming to Dundee in 1829, he was appointed science and mathematical lecturer at the Watt Institution, then conducted by a Mr. McIntosh. Soon after Alexander Maxwell, the historian of Dundee, became a pupil, and this is the picture he has left us of Lindsay: "When I was with Mr. McIntosh, I attended classes that were taught by Mr. Lindsay, a man of profound learning and untiring scientific research, who, had he been more practical, less diffident, and possessed of greater worldly wisdom, would have gained for himself a good place amongst distinguished men. As it was, he remained little more than a mere abstraction, a cyclopædia out of order, and went through life a poor and modest schoolmaster.

"By the time I knew him he was devoting much of his attention to electricity, to the celerity with which it was transmitted to any distance, and to the readiness with which its alternating effects may be translated into speech—and I have no doubt he held in his hand the modern system of the telegraph, but it needed a wiser man than he to turn it to practical use. He also produced from galvanic cells a light which burned steadily for a lengthened period.

The scope of his teaching is shown by the following notice which appeared in the *Dundee Advertiser* of April 11, 1834:

"J. B. Lindsay resumes classes for cultivating the intellectual and historical portions of knowledge and instruction on April 14, 1834, in South Tay-street, Dundee.

"In a few weeks hence a course of lectures will be formed on frictional, galvanic, and voltaic electricity; magnetism; and electromagnetism. The battery, already powerful, is undergoing daily augmentation. The light obtained from it is intensely bright, and the number of lights may be increased without limit.

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"A great number of wheels may be turned [by electricity], and small weights raised over pulleys.

"Houses and towns will in a short time be lighted by electricity instead of gas, and heated by it instead of coal; and machinery will be worked by it instead of steam—all at a trifling expense.

"A miniature view of all these effects will be exhibited, besides a number of subordinate experiments, including the discoveries of Sir Humphrey Davy."

In March, 1841, Lindsay was appointed teacher in the Dundee Prison on a salary of £50 a year, a post which he held for upwards of 17 years, till October, 1858. It is stated that shortly after taking up this office he could have obtained an appointment in the British Museum, a situation which would have been most congenial to his tastes, and which would certainly have led to a lasting recognition of his great abilities; but being unwilling to leave his aged mother, he declined the offer—a rare example of devotion and self-denial.

Lindsay was a bachelor, and lived alone, buried, it might be be said, in his books, collections of which, in history and philosophy, science and languages, were heaped in every corner of his dwelling—a small house of three apartments (11, South Union-street). The kitchen was filled with electrical apparatus, mostly the work of his own hands, and his little parlour was so crowded with books, philosophical apparatus, and other instruments of his labour, that it was difficult to move in it. To provide these things, he denied himself through life the ordinary comforts and conveniences, bread and coffee, and other simple articles, forming the principal part of his diet. His house in time acquired a celebrity as one of the curiosities of Dundee, and men of learning from distant parts, not only of the kingdom, but of the world, often came to pay him a visit.

In July, 1858, on the recommendation of Lord Derby, then Prime Minister, her Majesty granted Lindsay an annual pension of £100 a year, "in recognition of his great learning and extraordinary attainments." This well-deserved bounty relieved him from the drudgery of a prison teacher, and henceforth to the close of his life he devoted himself entirely to literary and scientific pursuits.

Although never robust, Lindsay on the whole enjoyed tolerably good health through life, but trouble came at last. On June 24, 1862, he was seized with diarrhœa, which carried him off on June 29, 1862, in the sixty-third year of his age.*

The departments of knowledge in which Lindsay excelled were languages, chronology, including mathematics and astronomy, and electricity.

His *Pentecontaglossal Dictionary* was begun in 1828, and ranged from England to far Cathay in the East, and to New Zealand in the South, comprising the whole Teutonic family of languages, ancient and modern Greek, Latin, and its modern representatives, Hebrew, Russian and the Slavonic tongues, Arabic, Persian, Thibetan, Chinese, Sanscrit, etc. This was truly his *magnum opus*.

On the near completion of this work it was Lindsay's intention to make a tour over Europe, visiting all the universities, and securing orders; thus, as he thought, saving the initiatory expense of the publishers, and bringing a knowledge of the work directly within view of all students. He hoped, also, to visit more remote places to fill up his blanks by actual converse with the natives. But *l'homme propose et Dieu dispose*, this was not to be; and he seemed to have a presentiment of it himself. Towards the close of his life he said to a friend who often visited him, "I may not live to finish it, in which case I think it ought to be placed in some permanent gallery, possibly the British Museum, so that students may consult it with freedom at pleasure." Thirty years later, in 1893, the manuscripts were collected and handed over to the trustees of the Albert Institute, Dundee, in the library of which they are now preserved.

Another work, *The Chrono-Astrolabe*, was published in January, 1858, and for a time attracted some attention, especially on the part of astronomers, but it is now seldom heard of.

Although languages and chronology took up much (I am inclined to think too much) of Lindsay's time, still electricity and its applications were his first, as they were always his favourite study. Amongst some notes and memoranda, bound up with his manuscripts in the Albert Institute, Dundee, he says—but here I will let him speak for himself in an extract which has been lithographed for me by the kind permission of Mr. John MacLauchlan, the chief librarian:

"Previous to the discovery of Oersted, I had made many experiments on magnetism, with the view of obtaining from it a motive power. No sooner, however, was I aware of the deflection of the needle and the multiplication of the power by coils of wire than the possibility of power appeared certain, and I commenced a series of experiments in 1832. The power on a small scale was easily obtained, and during these experiments I had a clear view of the application of electricity to telegraphic communication. The light also drew my attention, and I was in a trilemma whether to fix upon the power, the light, or the telegraph. After reflection I fixed upon the light as the first investigation, and had many contrivances for augmenting it and rendering it constant. Several years were spent in experiments, and I obtained a constant stream of light on July 25, 1835. Having satisfied myself on this subject, I returned to some glossological investigations that had been left unfinished, and was engaged with these till 1843. In that year I proposed a submarine telegraph across the Atlantic, after having proved the possibility by a series of experiments. Enquiries on other subjects have since that time engaged my attention, but I eagerly desire to return to electricity."

The first public announcement of Lindsay's success in electric lighting was contained in the *Dundee Advertiser* of July 31, 1835, as follows:

"Mr. Lindsay, a teacher in town, formerly lecturer to the Watt Institute, succeeded on the evening of Saturday, July 25, in obtaining a constant electric light. It is upwards of two years since he turned his attention to this subject, but much of that time has been devoted to other avocations. The light in beauty surpasses all others, has no smell, emits no smoke, is incapable of explosion, and not requiring air for combustion can be kept in sealed glass jars. It ignites without the aid of a taper, and seems peculiarly calculated for flax houses, spinning mills, and other places containing combustible materials. It can be sent to any convenient distance, and the apparatus for producing it can be contained in a common chest."

This paragraph appears to have attracted considerable attention, and to have gone the rounds of the Scottish newspapers, for in the same journal of Oct. 30 the following letter from Lindsay himself appeared:

ELECTRIC LIGHT.

SIR,—As a notice of my electric light has been extensively circulated, some persons may be anxious to know its present state, and my views respecting it.

The apparatus that I have at present is merely a small model. It has already cost a great deal of labour, and will yet cost a good deal more before my room is sufficiently lighted. Had circumstances permitted, it would have been perfected two years ago, as my plans were formed then. I am writing this letter by means of it, at 6in. or 8in. distant; and, at the present moment, can read a book at the distance of 1½ft. From the same apparatus I can get two or three lights, each of which is fit for reading with. I can make it burn in the open air, or in a glass tube without air, and neither wind nor water is capable of extinguishing it. It does not inflame paper nor any other combustible. These are facts.

As I intend in a short time to give a lecture on the subject, my views on the further progress will be unfolded then. A few of these, however, may be mentioned just now.

Brilliant illumination will be obtained by a light incapable of combustion; and, on its introduction to spinning mills, conflagrations there will be unheard of. Its beauty will recommend it to the fashionable; and the producing apparatus, framed, may stand side-by-side with the piano in the drawing-room. Requiring no air for combustion, and emitting no offensive smell, it will not deteriorate the atmosphere in the thronged hall. Exposed to the open day, it will blaze with undiminished lustre amidst tempests of wind and rain; and, being capable of surpassing all lights in splendour, it will be used in lighthouses and for telegraphs. The present generation may yet have it burning in their houses and enlightening their streets. Nor are these predictions the offshoots of an exuberant fancy or disordered imagination. They are the anticipated results of laborious research and of countless experiments. Electricity, moreover, is destined for mightier feats than even universal illumination. J. B. LINDSAY.

Dundee, Oct. 28, 1835.

At the time when Lindsay took up the subject, and for many years after, the voltaic electric light was nothing more than a rare and costly laboratory experiment, just as it left the hands of Humphrey Davy, its discoverer. To show this I need only mention a few historical facts.

On Sept. 22, 1800, Humphrey Davy wrote: "I have found that this substance [well-burned wood charcoal] possesses the same properties as metallic bodies in producing the shock and spark when made a medium of communication between the ends of the galvanic pile of Signor Volta (*Nicholson's Journal*, October, 1800, p. 150). In further experiments of the same kind he found that when, instead of the metals, pieces of well-burned charcoal were employed, the spark was larger and of a vivid whiteness (*Journal of the Royal Institution*, 1802, vol. i., p. 106).

In some experiments described in the *Philosophical Magazine*, 1801, Moyes, of Edinburgh, remarked that the voltaic pile was at the height of its strength if sparks were seen in the light of day, even when taken with a piece of charcoal held in the hand (vol. ix., p. 219).

In March, 1802, Citizen Robertson, a celebrated aeronaut, a friend of Volta, and one of the founders of the Galvanic Society of Paris early in this century, publicly exhibited the electric light from two pieces of charcoal with a pile of 120 elements of zinc and silver (*Journal de Paris*, March 12, 1802).

In the same year Curtet, according to Quetelet, observed the light between carbon points (*Encyclopædia Britannica*, ninth edition, vol. viii., p. 58.)

(*To be continued.*)

* Norrie's *Dundee Celebrities of the Nineteenth Century*, Dundee, 1873.

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ELECTRIC LIGHTING PROVISIONAL ORDERS.

The following is the complete official list of the applications for provisional orders which have been deposited with the Board of Trade for consideration during the 1899 session :

Title of Order and Description of Area.	Applicants.
Alloa Electric Lighting Order.—The Burgh of Alloa.	The Commissioners of the Burgh.
Arbroath Electric Lighting Order.—The Parliamentary Burgh of Arbroath.	The Corporation.
Ashford (Kent) Electric Lighting Order.—The Urban District of Ashford.	The Urban District Council.
Audenshaw Electric Lighting Order.—The Urban District of Audenshaw.	The Urban District Council.
Aylesbury Electric Lighting Order.—The Urban District of Aylesbury.	The Urban District Council.
Barmouth Electric Lighting Order.—The Urban District of Barmouth.	David Davies, Esq.
Barnstaple Electric Lighting Order.—The Borough of Barnstaple.	The Urban Electric Supply Company, Limited.
Bexley Electric Lighting Order.—The Urban District of Bexley.	The Urban District Council.
Bognor Electric Lighting Order.—The Urban District of Bognor.	The Urban District Council.
Bournemouth Corporation Electric Supply Order.—The Borough of Bournemouth.	The Corporation.
Brentford Electric Lighting Order.—The Urban Sanitary District of Brentford.	The Urban District Council.
Broadstairs, Westgate, and Birchington Electric Power Distribution and Lighting Order.—The Urban Districts of Broadstairs and St. Peter's, and the contributory places of Westgate-on-Sea and Birchington-on-Sea.	The Isle of Thanet Light Railways (Electric) Company, Limited.
Burslem Electric Lighting (Extension) Order.—The Parish of Wolstanton.	The Corporation.
Camborne Electric Lighting Order.—The Urban District of Camborne.	The Camborne Electricity Supply Company, Limited.
Carshalton Electric Lighting Order.—The Urban District of Carshalton.	The Electrical Power Distribution Company, Limited.
Castleford Electric Lighting Order.—The Urban District of Castleford.	The Urban District Council.
Cheltenham (Extension) Electric Lighting Order.—Borough of Cheltenham.	The Corporation.
Cheriton Urban District Electric Lighting Order.—The Urban District of Cheriton.	The Urban District Council.
Christchurch, Pokesdown, and District Electric Lighting Order.—The Municipal Borough of Christchurch, the Urban Districts of Pokesdown and Winton, and the Rural District of Christchurch.	The Bournemouth and Poole Electricity Supply Company, Limited.
Clontarf Electric Lighting Order.—The Township of Clontarf.	The Township Commissioners.
Cromer Electric Supply Order.—The Urban District of Cromer.	The Urban District Council.
Crowborough Electric Lighting Order. The Parishes of Frant, Rotherfield, Buxted, Mayfield, Withyham, and Hartfield.	The Crowborough District Gas Company, Limited.
Darfield Electric Lighting Order.—The Urban District of Darfield.	The Urban District Council.
Dukinfield Electric Lighting Order.—The Urban District of Dukinfield.	The Urban District Council.
Dumfries Electric Supply Order.—The Royal Burgh of Dumfries.	The Corporation.
Durham Corporation Electric Lighting Order.—The Municipal City of Durham.	The Corporation.
East Barnet Valley Electric Lighting Order.—The Urban District of East Barnet Valley.	The Urban District Council.
Eastbourne Electric Supply Order.—The Borough of Eastbourne.	The Corporation.
East Retford Electric Supply Order.—The Borough of East Retford.	The Corporation.
Electrical and General Engineering Company Order (*see* Hendon).	
Erith Electric Lighting Order.—The Urban District of Erith.	The Urban District Council.
Failsworth Electric Supply Order.—The Urban District of Failsworth.	The Urban District Council.
Farnborough Electric Lighting Order. The Urban District of Farnborough.	The Urban District Council.
Fenton Electric Lighting Order.—The Urban District of Fenton.	The Urban District Council.
Finchley Electric Lighting Order.—The Local Government District of Finchley.	The Urban District Council.
Glossop Corporation Electric Lighting Order.—The Borough of Glossop.	The Corporation.
Gateshead Electric Lighting Order.—The Municipal Borough of Gateshead.	The Electrical Power Distribution Company, Limited.
Gorton Electric Supply Order.—The Urban District of Gorton.	The Urban District Council.
Grays Thurrock Electric Lighting Order.—The Urban District of Grays Thurrock.	The Urban District Council.
Guildford (Extension) Electric Lighting Order.—The Rural Districts of Guildford and Hambledon.	The Guildford Electricity Supply Company, Limited.
Halesowen Electric Lighting Order.—The Rural District of Halesowen.	The Rural District Council.
Handsworth Electric Supply Order.—The Urban District of Handsworth.	The Urban District Council.
Hartlepool Corporation Electric Lighting Order.—The Municipal Borough of Hartlepool.	The Corporation.
Haslemere and District Electric Lighting Order.—The Parishes of Haslemere and Shottermill and portions of the Parishes of Frensham and Thursley.	E. O. Preston, Esq.
Haslingden Electric Lighting Order.—The Municipal Borough of Haslingden.	The Corporation.
Hawick Electric Lighting Order.—The Burgh of Hawick.	The Urban Electric Supply Company, Limited.
Heaton Norris Electric Lighting Order. The Urban District of Heaton Norris.	The Urban District Council.
Hendon Electric Lighting Order.—The Parish and Place of Hendon.	The Electrical and General Engineering Company.
Heywood Electric Supply Order.—The Borough of Heywood.	The Corporation.
Horsham Electric Lighting Order.—The Urban District of Horsham.	The Urban District Council.
Ilkeston Electric Supply Order.—The Borough of Ilkeston.	The Corporation.
Inverness Electric Lighting Order.—The Royal Burgh of Inverness.	The Corporation.
Keighley Electric Supply Order.—The Borough of Keighley.	The Corporation.
Kilmarnock Electric Lighting Order.—The Burgh of Kilmarnock.	The Corporation.
Kirkcaldy Electric Lighting Order.—The Municipal Burgh of Kirkcaldy.	The Corporation.
Knutsford Electric Supply Order.—The Urban District of Knutsford.	The Urban District Council.
THE COUNTY OF LONDON.	
Battersea and Fulham Electric Lighting Order.—The Parish of St. Mary, Battersea, and the Parish of Fulham.	The County of London and Brush Provincial Electric Lighting Company, Limited
Bermondsey Electric Lighting Order. The Parish of Bermondsey.	The Vestry.
Bethnal Green Electric Lighting Order.—The Parish of Bethnal Green.	The Vestry.
Blackheath and Greenwich District (Extension) Electric Lighting Order. Portion of the Lee District.	The Blackheath and Greenwich District Electric Lighting Company, Limited
City of London Electric Lighting Order.—The City of London and the Liberties thereof.	The Charing Cross and Strand Electricity Supply Corporation, Limited.
City of London, St. Luke, Middlesex, and Holborn Electric Lighting Order.—The City of London, the Parish of St. Luke, Middlesex, and the Holborn District.	The Smithfield Markets Electric Supply Company, Limited.
County of London (East) Electric Lighting Order.—The parishes of St. Mary, Stoke Newington, Hackney, and St. Matthew, Bethnal Green, and the Districts of Poplar and Whitechapel.	The County of London and Brush Provincial Electric Lighting Company, Limited
County of London (South-East) Electric Lighting Order.—The parishes of Bermondsey, Rotherhithe, St. Paul, Deptford, and St. Nicholas, Deptford, portion of the Parish of Lambeth, and the Districts of Lewisham and Lee.	The County of London and Brush Provincial Electric Lighting Company, Limited
Kensington Vestry Electric Supply Order.—The Parish of St. Mary Abbotts, Kensington.	The Vestry.
Lewisham District Electric Lighting Order.—The Lewisham District.	The Board of Works.
Metropolitan Electric Supply (City) Lighting Order.—The City of London.	The Metropolitan Electric Supply Company, Limited.
Plumstead Vestry Electric Lighting Order.—The Parish of Plumstead.	The Vestry.
Longton Electric Supply Order.—The Borough of Longton.	The Corporation.
Ludlow Electric Supply Order.—The Borough of Ludlow.	The Corporation.
Lye and Wollescote Electric Lighting Order.—The Urban District of Lye and Wollescote.	The Urban District Council.

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Title of Order and Description of Area.	Applicants.
Lymington Electric Lighting Order.—The Borough of Lymington.	The Lymington Electric Light and Power Company, Limited.
Maerdy Electric Lighting Order.—Portion of the Parish of Ystradyfodwg.	The Mardy Electric Light Company, Limited.
Mansfield Corporation Electric Lighting Order.—The Borough of Mansfield.	The Corporation.
Merthyr Tydfil Electric Lighting Order.—The Urban District of Merthyr Tydfil.	The Merthyr Electric Traction and Lighting Company, Limited.
Mexborough Electric Lighting Order. The Urban District of Mexborough.	The Urban District Council.
Midland Electric Power Distribution and Lighting (Extension) Order.—The Borough of West Bromwich, the Urban Districts of Amblecote, Brierley Hill, Handsworth, Perry Barr, Quarry Bank, and Smethwick, the Rural District of Kingswinford, and a portion of the Rural District of Walsall, in the County of Stafford; and the Borough of Dudley, the Urban Districts of Lye and Wollescote, Oldbury, and Stourbridge, and the Rural District of Halesowen, in the County of Worcester.	The Midland Electric Corporation for Power Distribution, Limited.
Mirfield Electric Lighting Order.—The Urban District of Mirfield.	The Urban District Council.
Musselburgh Electric Lighting Order. The Burgh of Musselburgh.	The Drake and Gorham Electric Power and Traction Pioneer Syndicate, Limited.
Newcastle-under-Lyme Electric Supply Order.—The Municipal Borough of Newcastle-under-Lyme.	The Corporation.
Newport (Isle of Wight) Electric Lighting Order.—The Borough of Newport (I. of W.).	The Ventnor Electric Light and Power Company, Limited.
Newton Abbot Electric Lighting Order.—The Urban District of Newton Abbot.	The Urban Electric Supply Company, Limited.
Partick Electric Lighting Order.—The Burgh of Partick.	The Kelvinside Electricity Company, Limited.
Pemberton Electric Supply Order.—The Urban District of Pemberton.	The Urban District Council.
Penzance Electric Lighting Order.—The Borough of Penzance.	The Urban Electric Supply Company, Limited.
Rawtenstall Electric Lighting Order — The Borough of Rawtenstall.	The Corporation.
Rhyl Electric Lighting Order.—The Urban District of Rhyl.	The Urban District Council.
Royal Leamington Spa Electric Lighting Order.—The Borough of Royal Leamington Spa.	The Corporation.
Royal Leamington Spa Electric Light and Power Order.—The Borough of Royal Leamington Spa.	The Midland Electric Light and Power Company, Limited.
Rugby Electric Lighting Order.—The Urban District of Rugby.	The Urban District Council.
Runcorn Electric Lighting Order.—The Urban District of Runcorn.	The Urban District Council.
Ryde Electric Lighting Order.—The Borough of Ryde.	The Corporation.
Ryde Electric Lighting Order.—The Borough of Ryde.	The Ryde Electric Light and Power Company, Limited
Sandown and Shanklin Electric Lighting Order.—The Urban Districts of Sandown and Shanklin.	The Ventnor Electric Light and Power Company, Limited.
Shipley Electric Lighting Order.—The Urban District of Shipley.	The Urban District Council.
Slough and Datchet Electric Lighting Order.—The Parishes and Places of Farnham Royal, Stoke Poges, Datchet, Slough, and Upton-cum-Chalvey.	Messrs. Laing, Wharton, and Down, Limited.
Stourbridge Electric Lighting Order.—The Urban District of Stourbridge.	The Urban District Council.
Sutton Coldfield Electric Lighting Order.—The Borough of Sutton Coldfield.	The Corporation.
Swinton Electric Lighting Order.—The Urban District of Swinton.	The Urban District Council.
Swinton and Pendlebury Electric Lighting Order.—The Urban District of Swinton and Pendlebury.	The Urban District Council.
Teignmouth Electric Lighting Order.—The Urban District of Teignmouth.	The Urban District Council.
Twickenham and Teddington Electric Lighting Order.—The Urban Districts of Twickenham and Teddington.	The Twickenham and Teddington Electric Supply Company, Limited.
Walker Electric Lighting Order.—The Urban District of Walker.	The Urban District Council.
Walton-on Thames and Weybridge Electric Supply Order.—The Urban Districts of Walton-on-Thames and Weybridge.	The Electric Works Company, Limited.
Wath-upon-Dearne Electric Lighting Order.—The Urban District of Wath-upon-Dearne.	The Urban District Council.
Wednesbury Electric Supply Order.—The Borough of Wednesbury.	The Corporation.
West Kent Electricity Supply Order.—The Parishes and Places of Bexley, Crayford, and Erith.	The West Kent Electricity Supply Company, Limited.
Weston-super-Mare Electric Lighting Order.—The Urban District of Weston-super-Mare.	The Weston-super-Mare Electric Light and Power Syndicate.
Winsford Electric Lighting Order.—The Urban District of Winsford.	The Urban District Council.
Worksop Electric Lighting Order.—The Urban District of Worksop.	The Urban District Council.

THE ELECTRIC LIGHTING OF WARRINGTON.

The following is an abstract of a report recently presented by Mr. A. H. Preece, A.M.I.C.E., to the Electric Lighting Committee of Warrington, for which we are indebted to a local paper, the *Examiner*:

Mr. Preece says the Corporation have already shown that they are fully alive to the enormous advantages of acquiring undertakings such as the supply of water and of gas. It now remains for them to establish a suitable electricity supply and an adequate tramway service. Legislation has done everything to assist municipalities in undertaking enterprises which are essentially for the benefit of the ratepayers, and they are neglecting their duties if they fail to take advantage of their opportunities. An adequate supply of electricity is one of the necessities of the age. It is a rival to gas, but there are no cases where the two industries have not flourished side by side. They each have their uses, and there is no fear of a successful electricity supply interfering with any gas undertaking. The supply of electricity in the hands of local authorities has been a phenomenal success. There are no cases of failure, but a few undertakings have been unable to meet the heavy payments for interest and sinking fund (which alone amount to nearly 6 per cent. in the capital expenditure) in the first year's trading. It is difficult for a commercial undertaking to pay working expenses and 6 per cent. beyond directly it starts. However, the records of the second and third year's working in nearly every case show good net profits. There are now over 80 local authorities, Mr. Preece points out, supplying electricity in their districts. Over 25 works are in progress, and many more are about to start. In the provinces alone, out of a total of 2,000,000 lamps connected to supply stations, over 1,500,000 are served by municipal works. The total capital invested in municipal works exceeds £4,000,000, and the Local Government Board are continually holding enquiries for further loans for new works and for extensions. It is interesting also to find numerous authorities negotiating, and, when possible, purchasing the successful undertakings recently established by companies in their districts. Such towns as Liverpool, Sheffield, Birmingham, Hastings, have had to pay very large premiums to obtain that which they thoughtlessly gave away a few years ago.

Proceeding to define his scheme for Warrington, Mr. Preece remarks that the compulsory area includes the following streets: Bridge-street, Bold-street, Sankey-street, Palmyra-square, Wilson Patten-street, and Horsemarket-street. This is only a small portion of the borough, but in it are included many of the principal public buildings and shops. It was extremely difficult to estimate the probable demand in this area, but in his opinion the first plant should be large enough to supply not less than 10,000 8-c.p. or 5,000 16-c.p. lamps burning at one time, or 12,500 8.c.p. lamps fixed in consumers' premises. In nearly every town it had been necessary to consider extensions before the plant had been in working order six months. In many cases the first plant had afterwards proved small, and hence uneconomical. It was not wise to have engines and dynamos of small sizes. The plant proposed would always be economical, however large the installation might become. The improved lighting of some of the streets gave everyone an interest in the undertaking. It was of advantage to all who used the streets, and it acted as a good advertisement to the industry. Hence he suggested that arc lamps, which gave a brilliant light, should be fixed about 70 yards apart in such streets as Bridge-street, Sankey-street, and Horsemarket-street. The lighting would be increased at least five times, and the cost would not be very much above the present cost. The scheme recommended as a start would therefore consist of a plant for 12,500 lamps, including 20 arc lamps in the streets. Adequate mains would also be provided in all the compulsory streets, with plenty of spare pipes for drawing in new feeders.

Referring to the site for the electrical works, Mr. Preece states that the site in the old gasworks is in every way suitable for the undertaking. It is central and there is plenty of room.

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The plans submitted with the report show the extent of the buildings and the proposed arrangement of the generating plant. There was space for at least 5,000 h.p. Thus the ultimate plant could supply 100,000 8-c.p. lamps and 1,000 h.p. for electric tramways. It was impossible to say what Warrington would be even 10 years hence, but it was doubtful whether it would require so much power by then. If it did so, the Electric Lighting Committee would be fully justified in requisitioning further portions of the site which were now given to other purposes.

The question of system Mr. Preece says is generally determined by the site. The central position of the old gasworks enabled him to recommend the low-pressure three-wire system. This system was of sufficient adaptability, now that 440 volts was permitted, to reach points over 1½ miles away. It also allowed the use of accumulators to store electricity and supply all the energy required after midnight. The pressure was suitable for tramways, so that the engines and dynamos could be used to generate electricity for lighting purposes and for the tramways.

Mr. Preece proceeds to give a detailed statement of the estimated capital expenditure incurred in erecting plant and laying mains, etc., for an estimated demand of 12,500 8-c.p. lamps. He estimates the total cost of the scheme as shown on the drawings, but exclusive of the buildings, as follows: machinery, mains, etc., £24,600; destructors and platform, £3,100; engineering and contingencies, £2,300—total, £30,000. Mr. Preece, after giving a brief description of the proposed arrangement of the works, gives a carefully prepared estimate of the probable financial result, and from comparative statements of the cost of working in other towns is able to show that, assuming the output at the low figure of 170,000 units, there would be a profit after paying working expenses and interest and sinking fund. He states that he has taken no credit for the destruction of the refuse, nor for the probable saving on coal. He had not the least doubt that a considerable benefit would be obtained from the combination.

Mr. Preece further points out that the streets in the compulsory area contain many important buildings and places of business; while many others are quite close to the compulsory area, which may be reached without difficulty or great expense. The total of 10,000 lamps should be easily obtained in 12 months after starting. In addition to the demand from private consumers for electricity for lighting, there was the supply of electricity for power purposes. In Warrington there were numerous factories, and if power was supplied at a cheap rate it was certain to be largely adopted, especially by the smaller firms. An electric motor was clean. It was easily placed directly on the spot where power was required. It could be adapted to any speed or gearing. It also did not require the same attention as an engine and a boiler, or even a gas-engine. There was a large gain in being able to turn the power on and off at a moment's notice, without causing waste of energy and consequent waste of money. The generating works had also been specially arranged with a view to supplying electricity to tramways. The lighting load was never required more than two or three hours per day at its maximum, and hence there is only a very short time available for the earning of the necessary profits. When electric tramways were supplied the staff and the plant were fully utilised, and everything was worked at its maximum efficiency for some hours every day. The result was that electricity could be produced at less than half the cost when only a lighting load was supplied. He recommended the committee to take immediate steps to carry out a scheme, at an estimated cost of £30,000, exclusive of the buildings; the scheme to be so arranged that power might be supplied to private consumers, and, when necessary, to electric tramways. He recommended that two refuse destructors should be erected in connection with the boilers for the generating plant, in order that the waste heat produced by the destructor of the town refuse might be utilised as much as possible. A cheap supply of electricity would bring electric light and electric power within the reach of everyone, and the conditions of working in all places of business would be immensely improved. Financial success was assured, and he felt convinced that the undertaking would prove in every way of immense benefit to Warrington.

COMPANIES' MEETINGS AND REPORTS.

ELECTRICAL COPPER COMPANY, LIMITED.

The second annual general meeting was held on Friday at the offices, 14, Sherborne-lane, Mr. William Jacks presiding.

The Chairman, having referred to the heavy loss which the Company had sustained by the death of Mr. H. M. Matheson, who had previously guided the affairs of the Company, said he could not pretend that the report was as favourable as they could have desired it to be. The process was, he said, a perfect success, but when they came to apply it on a large mechanical scale, difficulties arose similar to those which often occurred in connection with new inventions, but which had not been anticipated in their case. Some of the machinery was very complicated and not suitable for the purposes for which the inventors intended it, but the value of the machinery which had to broken up had amounted to only £392. No depreciation had been written off, first because all the machinery was new, and, in the second place, in regard to those machines which were defective or unsuitable, claims had been made on the suppliers. He had told them the worst that could be said about the Company. A great change for the better had been made within the last three or four months in the mechanical management, by which they had been enabled to introduce economies which had very materially changed the complexion of their accounts. They had only within the last few months overcome the difficulties to be expected in the application of the process on a large scale. They had now produced 100 tons of copper, and they had orders on their books for 30 tons more, many of them being repeat orders. Their policy for the future was to prove to other manufacturers the superiority and cheapness of the Company's process, and, without entering into irritating competition with them, to sell them the patents for a lump sum or for a fixed royalty. He concluded by moving the adoption of the report.

Mr. H. B. Fulton seconded the motion, which was adopted.—*The Times.*

UNITED RIVER PLATE TELEPHONE COMPANY.

The half-yearly meeting of this Company was held on Tuesday at Winchester House, E.C., under the presidency of Mr. J. Irving Courtenay.

The Chairman explained that the meeting was not for the purpose of receiving a report and accounts, but for placing before the shareholders the position of the Company. He said the Company might with confidence look forward to fair progress and to a sound business. The field in the River Plate was constantly widening, and the demands increasing in every direction for telephone services, switchboards, cables, and plant. Both subscribers and revenue had increased during the last half-year, and the financial position of the Company was stronger now than it had ever been. Twenty-eight thousand pounds of the 5 per cent. debenture stock had been allotted in anticipation of expenditure on their central office building, and the balance of £20,000 might probably be required in another six months. In view of the large expenditure before the Company the directors did not feel it prudent as yet to recommend the payment of an interim dividend.

The proceedings closed with a vote of thanks to the chairman.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Edinburgh.—The Magistrates and Council invite tenders for various work in their electric lighting station in Macdonald-road. Tenders by Jan. 9, 1899.

Burnley.—The Corporation invite tenders for the supply and delivery at their electricity supply station of underground cables. Tenders by Jan. 10, 1899.

Southampton.—The Corporation invite tenders for the supply of transformers and fittings, particulars of which will be found in our advertisement columns. Tenders by 16th inst.

Glasgow.—The Corporation invite tenders for providing and erecting generating plant at one or other of their new electricity works. Further particulars appear in our advertising columns. Tenders by Jan. 21, 1899.

Govan.—The Commissioners invite tenders for boilers, engines, dynamos, etc., for electric lighting. Specifications, etc., may be obtained from Mr. W. Arnot, C.E., 79, West Regent-street, Glasgow. Tenders by 23rd inst.

Lowestoft.—The Mayor and Corporation of the borough of Lowestoft are prepared to receive tenders for the supply and erection of various plant, all details of which appear in our advertisement columns. Tenders by Feb. 6.

Tunbridge Wells.—Tenders are required by the Corporation for the erection of three telephonic fire-alarms within the borough. The position of the fire-alarms required will be as follows: (1) Grosvenor Bridge, (2) St. James's Church, (3) The Royal Oak. Tenders by Jan. 11.

Rochdale.—Tenders are required by the Gas Committee for the erection of buildings required for the proposed electricity works. The plans may be seen on application to Mr. T. Banbury Ball, the manager, at the Gasworks, from whom copies of bill of quantities may be obtained on payment of the sum of £3. 3s., which will be returned on receipt of a bona fide tender. Tenders by noon on Jan. 17.

Barrow-in-Furness.—Tenders are required by the Corporation for the wiring of the free library, Cornwallis-street. Plan of the building may be seen at the office of the Borough Electrical Engineer, Town Hall, and specification may be obtained from Mr. C. F. Preston, town clerk, Town Hall, Barrow-in-Furness, on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders by 12 noon on Jan. 20.

Hull.—The Corporation invite tenders for the following work in connection with the tramways—viz. (Contract No. 16) pipes and

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fittings for power station and condensing mains from dock; (20) builders' work for two car-sheds and other buildings, area about 4,000 square yards; (21) steel roof trusses, steel columns, etc., for above car-sheds. Particulars, etc., may be obtained from Mr. A. E. White, city engineer, Town Hall, Hull. A deposit of £1 for each contract will be required, which will be returned on receipt of a bona fide tender. Tenders before noon on Jan. 13.

London.—The London County Council invite tenders for the manufacture, delivery, and erection complete of four gas-engines, with starting appliances, at the proposed Victoria-embankment electric lighting station, in the parish of St. Martin-in-the-Fields. Persons desiring to submit tenders may obtain the drawings, specification, form of tender, and other particulars at the Engineer's Department, County Hall, Spring-gardens, S.W., upon payment of £2. This amount will after the Council or its committee has come to a decision upon the tenders received, but not before, be returned to the tenderer, provided he shall have sent in a bona fide tender and not have withdrawn the same. Tenders will be received up to 10 a.m. on Jan. 31.

London.—The London County Council invite tenders for the manufacture, delivery, and erection complete of four continuous-current dynamos one motor-generator, two switchboards with switches, measuring instruments, and other work required for the proposed Victoria-embankment electric lighting station, in the parish of St. Martin-in-the-Fields. Any person desiring to submit a tender may inspect the drawings and obtain the specifications, forms of tender, etc., on application at the Engineer's Department, County Hall, Spring-gardens, S.W., and upon payment of £2. This amount will, after the Council or its committee shall have come to a decision upon the tenders received, but not before, be returned to the tenderer, provided he shall have sent in a bona fide tender and not have withdrawn the same. Tenders by 10 a m. on Jan 31.

Shanghai.—The Shanghai Municipal Council invite tenders for a concession for constructing and working about 23 miles of electric tramways on the trolley system in the streets of Shanghai. The special attention of tenderers is drawn to the fact that the tender (if any) recommended by the Council will require ratification by the ratepayers. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 being deposited with Messrs. Pook and Co., which sum will be retained by the Council, and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China (telegraphic address Dynamo, Shanghai; "ABC," fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Tramway Concession," must be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, and received by 12 noon on March 15.

Shanghai.—The following resolution in reference to the telephone system in Shanghai was passed at the last annual meeting of the ratepayers of the Foreign Settlements at Shanghai, north of the Yang-king-pang: "Resolution VIII.—That the Council be and is hereby authorised to enter into negotiations with the China and Japan Telephone Company or any other company, and in its discretion grant a franchise with a view to the community being supplied with an adequate and efficient telephone service at a fixed maximum charge." In accordance with the above resolution the Shanghai Municipal Council invite tenders for a concession for a period of 30 years for the exclusive right of establishing and working a telephone system in Shanghai. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 sterling being deposited with them, which sum will be retained and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China. Telegraphic address, Dynamo, Shanghai (ABC, fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Telephone Concession," to be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, by 12 noon on March 31.

RESULTS OF TENDERS.

Stirling.—The Corporation have accepted the following tenders for the erection of the electric lighting station: Hamilton, mason and brickwork; Short and Fairful, joiners; R. Frater, plumber; J. Davie and Sons, ironwork; R Foster, plasterer; Blair, slater; J. Dowell, painter. Total, about £3,000.

Leeds.—The Corporation Tramways Committee have accepted the following tenders for the final contracts for works in connection with the electric equipment of the Headingley and Chapeltown and Hunslet tramways: Messrs. W. T. Henley's Telegraph Works Company, North Woolwich, underground pipes and conductors, £8,966; Messrs. Greenwood and Batley, switchboards and auxiliaries, £5,330.

Accrington.—The following tenders have been accepted by the Legal and Parliamentary Committee of the Accrington Town Council: (Section C) steam engine and dynamos, £5,321. 10s., items of allowances deducted, £2 330, Messrs. Johnson and Phillips—net tender, £2,991. 10s.; (Section D) storage battery, Chloride Electric Storage Syndicate, £910; (Section E) electrical instruments, £991, items of allowances deducted, £350, Crompton and Co.—net tender, £641; (Section F) cables and street boxes, £6,050, items of allowances deducted, £1,500, W. T. Glover and Co.—net tender, £4,500.

BUSINESS NOTES.

Dublin.—The electric lighting of Amiens-street Station has been decided upon.

Birmingham.—The Council have decided to light the Council-chamber by electricity.

Southport.—The Preston Town Council have decided to oppose the Southport and Lytham Tramroad Bill.

Southgate.—The North London Electricity Company have for the present withdrawn their application for parliamentary powers.

Southport.—The Town Council have sealed a mortgage securing to the Public Works Loan Commissioners the sum of £21,178 on electricity account.

Barnstaple.—The Town Council have decided to oppose an application for electric lighting powers, and to apply for powers themselves as soon as possible.

Colonial Office.—Mr. Chamberlain has finally approved of the electric lighting to be installed throughout the Colonial Office. Hitherto electricity has been only in partial use.

Calendar.—Messrs. Croggon and Co., Limited, Liverpool and Glasgow, have issued a small wall calendar illustrative of electric bells, indicators, and electric light wiring sundries.

Crompton and Co., Limited.—The directors have declared an interim dividend at the rate of 5 per cent. per annum upon the shares of the Company for the half-year ending Sept. 30 last.

Personal.—Mr. H. W. Miller has resigned the post of engineer and manager to the Guernsey Railway Company, Limited, having accepted an appointment with the British Thomson-Houston Company.

Peterborough.—The electrical engineer is proceeding with the preparation of the plans and specifications of the electricity supply works. The specifications are to be printed and circulated as early as possible.

Newcastle.—The estimates for street-lighting for the year adopted at the Wednesday meeting of the City Council include the following item: cost of electric lighting 24 arc lamps at £42 each, £1,008.

Poitiers (France).—A public adjudication of tenders will take place next month for the construction and working of new tramways. Particulars may be obtained from the Prefecture de Vienne, Poitiers, France.

Central London Railway.—The Central London Railway Company's Bill for the purpose of obtaining an extension of time until June, 1900, provides for powers to pay interest out of capital during the additional period of construction.

Dissolution of Partnership.—Messrs. Boyd and Alcock, electrical engineers, etc., Willesden House, Llandudno, have dissolved partnership by mutual agreement. Mr. Alcock is carrying on business on his own account at the above address.

Charing Cross and Strand Electricity Supply Corporation, Limited.—The coupons on the 5 per cent. debentures of the above Corporation, numbered 1 to 700, due Jan. 1, are being paid at the Union Bank of London, Charing Cross branch, 66, Charing-cross, S.W.

Bury St. Edmunds—The Local Government Board have sanctioned a modified scheme of electric lighting for Bury St. Edmunds. This embraces the compulsory area — the central portion of the borough. The amount of loan sanctioned is reported to be between £15,000 and £16,000.

The Exchange.—All electric shares are in demand for investment account. Current prices are in most cases several points lower than they were six months ago. A general improvement is expected in the New Year, as most companies are expected to show considerably increased profits.

Telegraph Extensions—A correspondent of the Press Association says the Postmaster-General announces that the money placed at his disposal by Parliament for telegraph extensions for the current financial year is already exhausted, and that it will not therefore be possible to put any fresh extension in hand until after March 31 next.

Halifax.—The electric tramways have now been working six months. During that time 1,643,573 persons travelled on the cars, and the income was £6,853 4s. 7d. The Corporation have obtained powers to extend the system to other parts of the town, and it is stated that the carrying out of the work will not be delayed longer than necessary.

Brierley Hill.—At a recent meeting of the District Council the resolutions passed by the Council on July 4 and Dec. 5, refusing the Council's assent to, and opposing the grant of, a provisional order under the Electric Lighting Acts to the Midland Electric Corporation for Power Distribution were again discussed, but nothing further was done.

Chelmsford—There appears to be considerable friction between the Council and the electric lighting company, complaints being made alleging that the contract for lighting the borough was being carried out unsatisfactorily, while the breaking up of the pavements for the purpose of laying new mains is also complained of. The Lighting Committee have the matter in hand.

Aberdeen—The members of the Watching and Lighting Committee of the Town Council inspected on the 29th ult. the new system of overhead electric lighting which has recently been fitted up in George-street. At a subsequent gathering the usual speeches were made, and the greatest satisfaction was expressed with the manner in which Mr. Anderson had carried out the work.

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Sheffield.—The representatives of the Sheffield Corporation formally took possession of the Electric Light and Power Company's undertaking on Saturday morning, and handed over to the representatives of the company a cheque for over £260,000. This payment is at the rate of £213. 8s. for each £100 invested by the shareholders. The company had only been in existence seven years.

Donnison, Berlyn, Sillem, and Co.—This firm have removed their North of England branch offices and showrooms to more extensive premises at 66, South John-street, Liverpool. We are informed that their London general manager, Mr. B. Garland Matthews, has been ordered by his doctor to change his residence for South Africa on account of continued ill-health, and has consequently been compelled to resign.

Rotherham.—At the last meeting of the Town Council it was stated that the Corporation had had repeated applications from outside companies with regard to tramways, and they had raised objections on the plea that they intended some time to apply for a provisional order to carry out a tramway scheme for themselves. The Council was now awaiting the report of Prof. Kennedy with respect to the supplying of electricity.

H. W. Sambridge and Son.—Mr. George W. Webb, of 153, Leathwaite-road, S.W., has been appointed sole representative in London for the well-known and old-established firm of Messrs. H. W. Sambridge and Son, Highgate-street, Birmingham, manufacturers of chandeliers, gas fittings, electric light fittings, curb suites, fire brasses and dogs, fire screens, jardinières, kettles, stands, etc., in brass and wrought iron.

Ayr.—Last Thursday a considerable part of the town was for a time thrown into darkness through a breakdown of the electric light in circuit No. 1, which embraces Newmarket-street, the lower part of High-street, part of Sandgate-street, and the whole of Newton. The failure was due to a fuse blowing in the Hope-street sub-station. This caused a temporary short-circuit, and blew the main works fuse. The current was restored within 35 minutes.

Edison and Swan United Electric Light Company, Limited.—We are informed that this Company have recently laid down further special plant to enable them to cope with the increasing demand for their new type F measuring instruments. These instruments are cased in cast brass, and the dials are silvered and engraved (not painted). All bearings are jewelled, and the greatest care is taken in calibration. From what we see, the prices are very moderate.

Perth.—A joint meeting of the committees appointed by the Town and County Councils respectively for the purpose of considering and watching over the Highland Water Power Bill, which so materially affects the River Tay, was held on the 30th ult. An engineer is to be appointed to report on the whole scheme and its bearings on the different interests at stake. It is also proposed to retain some eminent London authority to supplement, if need be, the work of the engineer.

Bristol.—The Museum Committee of the Corporation have accepted the tender of Messrs. Mendham and Co. for a large extension of the electric light into various rooms in the curator's department in the Bristol Museum. This firm have just completed the fitting of the electric light in the Pump-Room of the Clifton Grand Spa, use being made of the existing elaborate gas chandeliers; and also the fitting of electric bells for Lord Fitzharding at his mansion at Hounslow.

Warrington.—The Electric Lighting Committee of the Corporation have received a report from Mr. A. H. Preece on the subject of establishing an electrical supply undertaking in the borough, an abstract of which appears in another column. Mr. Preece has pointed out that owing to the difficulty in obtaining early delivery of machinery it is necessary to take immediate steps if the installation is to be ready next winter—a matter which should not be overlooked by the Electric Lighting Committee.

Tenders.—The National Electric Free Wiring Company, Limited, have secured the contract for the complete incandescent and arc lighting of the Preston Electric Railway and Tramway Carriage Works, Strand-road, Preston; also for the complete plant and wiring of Messrs. Margetson, Welch, and Co.'s premises in Long-lane, Bermondsey, and for the electric lighting of the Cooper's School of Art at Canterbury, and the installation of electric motors in Messrs. Lovibond's brewery at Greenwich.

Cheltenham.—The electrical engineer's report states the maximum load this winter at 367 kw. as against the maximum load of 267 kw. last winter, and the largest week's output at 16,740 units as against 11,130. Various extensions and lighting improvements have been agreed upon, and the electrical engineer is to bring up a schedule at the next meeting of the Council for all work sanctioned requiring loans for which application for sanction to borrow the sums required has not as yet been made to the Local Government Board.

Wolstanton.—At the last meeting of the Parish Council a letter was read from the Electric Traction Company stating that an application was being made to the Board of Trade for an extension of time for the laying of the additional lines until August, 1899. It was decided to object to any such extension being granted. A draft copy of the electric lighting order sought by the Burslem Town Council was received, and the clerk was requested to confer with the solicitor to the District Council with regard to the clause referring to the electric lighting of Wolstanton.

Northwich.—At a recent meeting of the Lighting Committee of the Urban District Council the clerk submitted a report by Mr. H. E. Humphrey upon the result of the electric trial lights fixed in High-street and Witton-street. The thanks of the committee were tendered to Mr. Humphrey for his exhaustive report, which will be further considered by the committee. A sub-committee was appointed to consider and report upon the general lighting of the district, and also as to the advisability or otherwise of acquiring the illuminating power of the district.

Western Australia.—A special dispatch to the *Financial News* states that Mr. Cook and Mr. Childs, the engineers representing the firm of Messrs. J. G. White and Co., of New York, who have undertaken the construction of the Perth electric tramways, have arrived there, and are very favourably impressed with the prospects of the undertaking. They state that, owing to the heat of the climate, the hilly nature of the city, the badness of the roads, and the large and scattered area within the city boundaries, Perth is a model city for a successful tramway enterprise.

Burslem.—The Town Council in committee have consented not to oppose the application of the promoters of the tramways extensions, etc., to the Board of Trade to prolong the time limited for the completion of the tramways until Aug. 7 next. A deputation from the tramways company has explained to the Council the difficulties they had had to contend with in carrying on the work. The chief one was that of obtaining suitable material in sufficient quantities, and the disputes which arose with the local authorities as to the kind of materials to be used had also delayed the completion of the work.

Carlisle.—Owing to a slight delay last week in the completion of the chimney of the electric light generating station at the Citadel Station, the full installation of the new light, which had been provisionally fixed for Monday the first week-day in 1899, has had to be postponed for a few days. It is hoped that the electric light, however, will be fully switched on at the end of this week. It is expected that the tramways company will be in a position to begin the actual work of laying the tramways in March next. They are at present busy making arrangements and preparations with that object in view.

Dudley.—The Railway, Tramway, and Electric Lighting Committee of the Dudley Town Council recommend the purchase of two acres of land at Springsmire for a site for an electrical generating station at £500. Considering the importance of the Corporation being in a position to supply electricity for traction purposes on the completion of the construction and electrical equipment of the tramway from Dudley Station to the borough boundary at Hart's Hill, the committee has instructed Mr. Wilson to make enquiries for the necessary machinery, and to report to the next meeting of the committee.

Wednesbury.—At the last meeting of the Town Council the Town Clerk announced that he had received a draft of the Bill proposed to be introduced into Parliament by the British Electric Traction Company, to enable them to take over the powers of the South Staffordshire Tramways Company. In addition to providing for the purchase of the undertaking of the present company, it arranged for a lease of the tramways, and gave the local authorities power to purchase at the end of 35 years. It was decided that this question and a communication referring to the Wolverhampton Tramways Bill should be referred to the General Purposes Committee.

Crewe.—A public enquiry, on the application of the Town Council to borrow £26 000 for electric lighting purposes, was held by Mr. H. P. Boulnois, Local Government Board inspector, on the 4th inst. The Town Clerk said that the Corporation had secured a site off Edleston-road covering 3a 2r. 17p, for which they were paying at the rate of £300 per acre. Mr. B. Hopkinson said he thought the site was extremely good and central. They proposed to erect a generating station covering about 8,000 square feet, the power to be supplied by two large engines and two small ones. The estimated expenditure in the limited area proposed to be covered was £24,198.

Manchester.—At the meeting of the City Council on Wednesday, Mr. Boyle (chairman of the Tramways Committee) said, in reply to a question, that the committee did not intend to buy tramcars in America or Germany or elsewhere if they could get them in England. They had consulted car builders in this country, and he believed they could get cars without going abroad.—The Lord Mayor has issued invitations to representatives of the municipalities of Lancashire and Cheshire with a view to organising an opposition to the Lancashire Electric Power Company's Bill. A conference will be held next Tuesday at the Manchester Town Hall, when the matter will be discussed.

Worthing.—The borough surveyor, having submitted reports from the engineers as to the cost and advisability of erecting a refuse destructor in connection with the electric lighting works, and as to the public lighting of the town, has been requested to examine the same, and advise the committee thereon with respect to the sanitary advantages and probable financial results attending the erection and use of a destructor. The Electric Lighting Committee will at their next meeting consider in detail the suggestions and recommendations of the engineers as to the area to be electrically lighted in the first instance, and the employment of arc or incandescent lamps on the parade and elsewhere.

Dewsbury.—At the monthly meeting of the Town Council on Tuesday the sub-committee reported that they had considered various schemes for electric tramways, and unanimously recommended as the best a route commencing at the borough boundary in Huddersfield-road, near to the Ravensthorpe Station of the Lancashire and Yorkshire Railway, thence passing along Huddersfield-road, Webster-hill, Old Westgate, Willington-road, Halifax-road, and Birkdale-road, to the western end of Green-lane. The estimated cost was £19,788, and they further reported that in their

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opinion the probable receipts would be sufficient to defray the annual cost incurred. This scheme was adopted.

Presentations.—On the occasion of his leaving Aberdeen to fill a situation on the staff of the new electricity works at Leith, Mr. James Spark, assistant at the Aberdeen Corporation electricity works, was the recipient of a handsome Gladstone bag as a parting gift from his fellow-workmen at Cotton-street.—On Saturday last Mr. D. P. Regan, engineer and superintendent of the National Conduit and Cable Company, New York and London, was presented at Dublin with an illuminated address and a case of instruments by the Irish employés of the company. This company has the contract for the conduit and cable work required by the Dublin United Tramway Company in their electrical extension.

Hereford.—The Electric Lighting Committee's report, which was adopted at Tuesday's meeting of the Town Council, stated that no less than 17 tenders had been received for the electric lighting for the city. The plant and work itself would amount to about £12,000, while other expenses would bring the total to about £20,000, and it was recommended that this sum be borrowed. The committee were agreed that the form of power should be steam. It is proposed to first lay the cables in High Town, Commercial-street, Eign-street, and Broad-street. The General Purposes Committee have been asked to consider any Bills promoted, whether by electric lighting companies or any other bodies, which might affect the rights of the Corporation as the owners of the works for the supply of electric light and power.

Pontypool.—At the last meeting of the Urban District Council a communication was read from the Pontypool Electric Light Company as to lighting the centre of the town. It suggested nine five-ampere lamps. The cost of the lamps would be £102. The company would supply the current at 3d. per Board of Trade unit; the lamps would be lit half an hour after sunset until 11.30 p.m. (1,821 hours). Twenty-six or 27 gas-burners would be done away with, and there would be a saving of about £90 in the gas bill in consequence, besides which the candle-power of light would be 9 000 as against 1,350. The matter was referred to a special committee to confer with the company as to terms, length of contract, etc. The special committee appointed for the purpose consists of the Chairman, Messrs. Hughes, Webb, Reid, and Eckersley.

Tunbridge Wells.—The Town Council have agreed to seek another loan of £25,000 for electric light extensions.—The electric light was used for the first time in King Charles's Church on the 25th ult. The *Kent and Sussex Courier* says: "We may anticipate that other places of worship will follow the example of King Charles in providing for the comfort of the worshippers by a perfect system of illumination, as well as avoiding a vitiated and overheated atmosphere. The soft mellow glow of the electric lamps contrasted most pleasingly with the pallid greenish hue of the incandescent gas, and judging from what one heard at the close of the service, the congregation are more than satisfied with the result of what was not a large expenditure. A visit to the church of King Charles will probably give those attending the remaining places of worship not yet possessing the new illuminant the necessary impetus to obtain this great advantage without further delay."

Gateshead.—The Parliamentary Committee's report, which has been adopted by the Town Council, states that the proposed provisional order enabling the Electrical Power Distribution Company to supply electric energy within the borough had been deposited by the company. The order did not, in various respects, agree with the terms upon which the Council had given their consent to the grant thereof to the company by the Board of Trade. The committee therefore recommended that the Council make an order for affixing the common seal to the documents requisite for obtaining such amendment of the provisional order as might be necessary to carry out the terms of the arrangement between the Corporation and the company. They also recommended that the deputation be authorised to take such action with respect to the above matter as may be necessary to carry out in its entirety the arrangements made with the Electrical Power Distribution Company for the supply of electrical energy within the borough.

Appointments Vacant.—The Bridgwater Rural District Council require the services of an experienced engineer to prepare plans, etc., for the purpose of applying for an order to enable their constructing a light railway of about seven miles in length. Applicants must state fee required for doing above work, and send application to Mr. T. M. Reed, clerk, Bridgwater, by 10th inst.—The Bristol Corporation invite applications for the post of station superintendent.—Two assistant electrical engineers are wanted to take charge of eight-hours' shifts at Hanley.—The Lighting Committee of the Corporation of Shrewsbury invite applications for the appointment of an electrical engineer and manager, who shall devote his whole time to the duties of the office, at a salary of £250 a year.—The Electric Lighting Committee of Portsmouth Corporation are prepared to take pupils who have had a previous mechanical training.—A manager and engineer is required by the Guernsey (Electric) Railway Company. Full details of these and other vacancies appear in our advertisement columns.

Lincoln.—The electric lighting of the streets, which has now been started, has gradually developed into a much larger concern than anticipated. Including supply to private customers, there will be a length of 10 miles of mains, and a plant capable of supplying 18,000 8-c.p. lamps when the works are finished. This will represent an outlay of nearly £60,000. The work is being executed under the supervision of Mr. C. S. Vesey Brown, the electrical engineer of the Corporation. The loan of £16,000 referred to in our issue of Dec. 9 has been apportioned as follows: Two 300-h.p. steam dynamos, including foundations, £5,000; two boilers, etc., £1,300; extension of economiser and switchboard, £500; cables, £8,000; consumers' connections, £2 500; and contingencies estimated at £1,700. In the works already erected room has been provided for 1,200-h.p engines and boilers and dynamos. The charge at present is at the rate of 6d. per Board of Trade unit for every unit used at the consumer's average maximum demand for one hour per quarter, and 2½d. per unit for all units used over and above this quantity.

Derby.—The Electric Lighting Committee's report, presented to the Town Council on Wednesday, states that the committee have had under consideration a report from their engineer (Mr. T. P. Wilmshurst) as to the extensions of the electric light buildings and plant necessary for meeting the increasing demand for current, and they are of opinion that the present station and land adjoining can be utilised for this purpose and for future extensions without a new site being provided for the tramway generating plant. The estimated cost of the proposed works, which includes structural alterations and additions to the buildings, new boilers, superheaters, and softeners, pumps, and steam-piping, engines, dynamos, mains, condensers, transformers, and meters, is £25,000. This amount will provide for the necessary buildings, works, and plant for the next few years. The estimates includes provision for buildings for the generating plant in case the tramways are worked by electricity, but does not include any item for the electric plant necessary for that purpose. The Council have decided to apply to the Local Government Board for £25,000.

Leeds.—The Corporation Sub-Tramways (Traffic) Committee have decided to equip the Beckett-street and York-road sections of the tramways with the electric overhead system of traction, and to proceed with the work at once. It is expected that the new system will come into operation by July or August, at the same time as that on the Headingley and Chapeltown line. It appears that, with reference to trials of three samples of seats intended for outside use on tramcars in wet weather, they were all pronounced unsatisfactory, and another newly-invented seat, which is stated to meet all requirements, is now to be tried. The total receipts on the Leeds tramways for Dec. 24, 25, and 26 were £1,124. 5s. 1d., as compared with £554. 16s. 3d. on the corresponding three days of 1897—an increase of £569. 8s. 10d. For the week ended Saturday last the receipts were £2 248. 2s. 1d., those for the corresponding period of 1897 being £1,677. 17s., an increase of £570. 5s. 1d. The Lighting Committee have been authorised to carry out extensions of sub-stations at an estimated cost of £16,409, and extensions of mains to the Hunslet district at an estimated cost of £8,408. The Lighting Committee have recommended the Council to sanction the expenditure of £14,296 upon further electric light mains and accessories.

Accrington.—The Health Committee of the Town Council, having visited Burnley, have adopted the Horsfall system of destructors, and have appointed a small sub committee to act jointly with a similar sub-committee which has been appointed by the Legal and Parliamentary Committee, with the object of settling details of Messrs. Horsfall's tender. The latter committee have decided that the Council be recommended to apply for borrowing powers for the further sum required to meet the necessary expenditure on electric lighting account. With regard to a notice from the Lancashire Electric Power Company of their intention to apply to Parliament in the next session for a Bill to authorise them to supply electrical energy for all purposes throughout large areas of Lancashire, including all the boroughs and most urban districts, the town clerk has been instructed to communicate with the various authorities named in the circular, with a view to ascertaining what course of action they proposed to take in the matter. A deputation has been appointed to attend a conference of the municipal corporations of Lancashire and Cheshire affected by the Lancashire Electric Power Construction Bill, to be held on the 10th inst., with a view to organising opposition thereto. Lord Kelvin has undertaken to advise the Corporation upon their combined scheme of electric lighting and destructors.

Redditch.—At the last monthly meeting of the Urban District Council it was decided to affix the seal of the Council to an indenture of mortgage to the Electric Works Loan Board for securing £10,911, the loan for public electric lighting purposes, the money for which had been obtained at 2¾ per cent., repayable in 25 years. The Council's seal was also affixed to an agreement with the Midland Railway Company for permission to lay an electric main over the company's bridge in Bromsgrove-road, also to an agreement with the National Electric Free Wiring Company for the establishment of a depôt in the district. The resolution of May 3 last, objecting to the proposed light railway passing down Evesham-street in its present narrow state, was rescinded, and it was resolved to support the proposed railway. The Council formerly strongly objected to the railway passing down Evesham-street, which, although the main street of the town, is for a considerable part very narrow. The promoters considered the Evesham-street route an essential part of the scheme, and subsequently an arrangement was made by which the promoters agreed to contribute £750 towards the cost of widening the narrow part of the street, an improvement which the Council decided to at once proceed to effect. The Clerk reported that the necessary agreements with the promoters of the light railway had been exchanged.

Catalogues.—From the Accident Insurance Company, Limited, St. Swithin's-lane, London, we have received a wall calendar, in which the tear-off date indicator is a prominent and useful feature, and also small calendars suitable for pocket use.—We have received

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from the Chloride Electricity Storage Syndicate, Limited, two lists of their makes of electric accumulators. The first one is devoted to the batteries used for ordinary lighting work, and the second is devoted to such accumulators as are suitable for yachts, launches, etc. We understand from the letter which accompanies these that five other sections are being issued. These will deal respectively with central-station accumulators, accumulators for traction purposes, accumulator accessories, and portable accumulators. The Chloride Company's type of storage battery is now so well known that a description would be out of place. Such description is, however, contained in the section devoted to lighting batteries, and is interesting reading. The object of the method of construction used by the company is that of obtaining the greatest possible surface exposed to the electrolysis, while at the end of the catalogue a series of drawings of wooden stands suitable for these accumulators of various sizes are given, and this will be very convenient to those preparing estimates of the spaces required for working complete batteries. In the list devoted to yacht and launch types, illustrations of some well-known yachts using these accumulators are given. These accumulators are closed in ebonite or lead lined boxes, and can be used for lighting and many other purposes. This list will be found very handy for reference.

Islington.—At the meeting of the Vestry to-day, a report will be submitted by the Electric Lighting Committee on the overground transformer stations, stating that correspondence has, at the instance of the committee, taken place between the Vestry's electrical engineer and the Board of Trade, and arising thereout between the Board of Trade and the London County Council, in regard to the proposal of the committee to erect overground transformer stations in the form of kiosks in the public thoroughfares; that the London County Council have made certain suggestions to the Board of Trade in connection with the committee's proposal to the effect that any approval which the Board might give to such erections should be subject to the sanction of the Council being first obtained thereto, and as the committee is unable to admit that the Council have any statutory or other right to veto in the matter, they recommend that a communication should be addressed to the Board of Trade intimating that the Vestry is unable to agree to the suggestions of the Council. It will also be proposed that, owing to the numerous applications which are received claiming compensation for personal injuries alleged to have been caused by negligence on the part of the Vestry, a qualified medical man be engaged to investigate such cases immediately they arise and to report thereon. Attention having been called to the fact that the incandescent lamp columns at the entrance to the Vestry Hall are frequently being damaged by passing vehicles, the present lamp columns are to be removed and an electric arc lamp fixed over the centre of the portico at the entrance to the Vestry Hall, at an estimated cost of £14.

Garston.—At Tuesday's meeting of the Urban District Council the minutes of several meetings of the Special Purposes Committee were read, giving the results of interviews with the British Insulated Wire Company with reference to the electric lighting of the district and the destruction of refuse The legal adviser, Mr. P. F. Garnett, submitted a report on the negotiations, in which the committee recommended the Council to enter into an agreement with the British Insulated Wire Company, Limited, for the transfer of the rights and obligations of the Council under the Garston Electric Lighting Order, 1897, for a period of 42 years, subject to certain conditions, and the approval of the Board of Trade. In the conditions it was stated that the company undertook to have electric light and refuse destructor works erected within a period of nine months from the date of the transfer, to the satisfaction of the Council, and on a site to be approved by the Council, to disinfect any clothing, etc., sent to them, to supply electricity to private consumers at 5d. per unit, and to the public lamps at 3d. per unit, to destroy ashpit refuse at 9d. per ton, not to create a nuisance, the Council to be empowered to repurchase the undertaking at the expiration of 42 years on terms specified in Section 2 of the Electric Lighting Act, 1888, or to purchase at the expiration of 21 years at an added premium of 21 per cent., or any subsequent year, the premium to be reduced one per year, two years' notice to be given of intention to purchase, and the company to pay to the Council all the costs of obtaining the order not exceeding £500. It was decided to postpone the matter until next week.—*Liverpool Courier.*

Weston-super-Mare.—At last week's meeting of the Council it was resolved that the common seal of the Council should be affixed to the agreement made between the Urban District Council of Weston-super-Mare and the Electrical Power Distribution Company, Limited. Notice of motion was given to the effect that the resolutions passed at the meeting of the Council for the transference of the Council's powers be rescinded. From the *Weston Mercury and Somersetshire Herald* we gather that the terms of agreement between the Council and the syndicate are briefly as follows: The syndicate are to (1) lease for 10 years; (2) pay all the costs of the provisional order; (3) pay Mr. Hawtayne's expenses in connection with the syndicate's application to the Board of Trade; (4) supply the whole town, if required, in 15 months, if the Board of Trade's sanction were obtained to the transfer; (5) give absolutely free wiring to all private houses and shops, and allow 10 per cent. off the price of the current to customers providing their own wires and fittings: (6) keep all standards, etc., in decorative repair and repair all roads to the reasonable satisfaction of the Council; (7) arrange that the main business streets shall not be interfered with during the season; (8) site for generating station to be mutually agreed upon; (9) price of current, inclusive of maintenance for public lighting, not to exceed 2½d. per unit, which is equal to gas at 1s. 3d. per 1,000; (10) price to private consumers, 2d. per hour after first hour at 8d., or, in other words, an average of 4d. per day for three hours; (11) give a bond that the work shall be carried out; and (12) allow repurchase by valuation and arbitration at the end of 10 years—the arbitrator to be appointed by the Board of Trade.

Colchester.—At Wednesday's meeting of the Corporation the Parliamentary and Footpath Preservation Committee reported respecting the application of the British Electric Traction Company, Limited, to the Light Railway Commissioners for an order to enable them to construct a light railway in the borough. The committee, after a preliminary consideration of the scheme, were of opinion that some tramways were desirable for the borough at large, but that the details of the project required careful examination. The town clerk had been directed to confer with the promoters, and report upon the whole subject. The Roads and Drainage Committee reported on the same matter, and named the streets which would be interfered with in the execution of the work. The committee were asked whether they assented to or dissented from the proposed undertaking and whether they had any objections to raise to their property being taken. Further consideration had been deferred until the Council had considered the recommendation of the Parliamentary Committee. Both reports were adopted. The Electric Lights Works Committee presented a report from the borough surveyor to the effect that the electric current was switched on to the mains on Dec. 1 last, and everything had gone on in a most satisfactory manner, and the light was giving every satisfaction. The Military Hospital was now being supplied from the central station in Osborne-street, and the temporary plant would shortly be removed. The total number of lights at the hospital was nearly 500, and as regarded consumers in the town, 50 had sent in applications for a total of 2,523 8-c.p. lamps, and of these 28 consumers had been connected. Extensions at a cost of £48. 10s. 8d. were recommended. The report was adopted.

Wrexham.—From minutes of the Electric Light Committee adopted at last week's meeting of the Town Council, it appears that the committee have considered a letter from Messrs. Jones-Parry and W. R. Evans, solicitors, stating that they were instructed by a client to approach the Corporation on the question whether they were prepared to either sell or grant for a term of years their powers for dealing with the question of electric light in the borough. Should the Corporation agree to entertain the matter, the electric lighting of the town would be proceeded with at once, and their client would be prepared to furnish the Corporation with a very substantial guarantee as to his ability to carry through the matter to their satisfaction. Enquiry had been made as to the Electrical Power Distributing Company, Limited, who had approached the Council with a view to a lease of the provisional order, and the information obtained as to such company was apparently satisfactory. Without any advertisements for the services of a consulting electrical engineer, there had been 18 unsolicited applications from gentlemen desiring to place their services at the disposal of the Council in advising on a scheme, and their applications were before the meeting. It was resolved that the town clerk be requested to obtain from Chester and other towns having electricity supplied by, or works belonging to, the corporations, as to the undertakings, cost of work, price charged to consumers, and whether the works were proving a success, financially and otherwise, and as to what electrical engineers had been called in, and whether the advice obtained had been acted upon, and found to be quite satisfactory, and generally as to the advantages or otherwise of the scheme and methods adopted, whether by lease of the undertaking or reserving it under the immediate management of the local authority. The committee recommended that as soon as the information is forthcoming a small committee be appointed to consider the applications of electrical engineers, and to recommend the selection, or otherwise to appoint an expert to advise the Corporation as to the course to be adopted. The recommendation of the General Purposes Committee, advising the Council to decline giving their consent to the proposed new electric tramways being made within the borough, had been referred back to the committee; but at a subsequent meeting of that committee a resolution was carried in favour of the whole scheme, but with the insertion of a clause giving the Council power to prevent the carrying out of the trams down Hope-street, High-street, and Yorke-street for two years.

Dundee.—In connection with the municipalisation of Dundee tramways, says the *Weekly News*, steps are now being taken to provide the necessary traction, and a scheme has been launched for the spending of over £15,500 to meet the requirements. The intention is to greatly extend the present electric lighting station in Dudhope-crescent-road. There is a large amount of vacant ground there on the site formerly occupied by the old cattle market, and when the new buildings are erected about 183 poles of land will be occupied. The extension will include sufficient accommodation to provide for the reception of a large quantity of new plant, and while the present plant is only suitable for lighting purposes, care will be taken in the ordering of the new appliances to have these of such a pattern as will make them suitable either for lighting or traction purposes. At the present time the horse-power of the station stands at 1,200, but when the additions are made the power will have been raised to 7,500. In making this large addition to the power of the establishment, the authorities have had more in view than the provision of the means for driving the cars by electricity. At the present time the demands for electric light in the city are more than taxing the capacity of the station. Almost the entire supply which it is capable of producing is now being taken, and it is an

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open secret that under any circumstances the Commissioners would have been obliged to put down more plant in order that the demand made for the illuminant might be met. The extension of the station proper will be made close to the existing buildings, and beside these will be provided the necessary workshops. The new plant proposed to be laid down consists of four boilers, 30ft. by 8ft.; one economiser, of 400 tubes; two engines and dynamos each of 450 h.p.; and one engine and dynamo of 700 h.p. The strip of the ground lying nearest to the Lochee-road is to be utilised as a car-shed. When the extensions are completed it is expected that over 50 cars will be required for the service, and of this number it will be possible to accommodate about 30 electric cars in the premises to be provided beside the electric station. In order to facilitate the arrangements, the car entrance to the shed will be from Lochee road and at the south corner of the buildings. The remainder of the cars will be housed at Maryfield and Lochee. The various proposals were considered at a meeting of the Tramways Committee of the Town Council on the 29th ult., when plans and specifications were submitted. These were generally approved, and a remit was made to Mr. Tittensor, electrical engineer, to prepare specifications for the work. Mr. W. Alexander, city architect, was also instructed to prepare working plans for the engine and boiler houses, and also for the car-sheds.

St. Marylebone.—At a meeting of the Vestry yesterday the debate on the following motions by Mr. T. H. Brooke-Hitching, chairman of the Electric Lighting Committee, was resumed: "That application be made to Parliament for the grant of a special Act to empower the Vestry of the Parish of St. Marylebone to erect and maintain electric lines and works, and to supply electricity for public and private, or public or private, purposes throughout the said parish. That the Vestry's solicitor be instructed to take the necessary steps to give effect to the foregoing resolution." A report was received from the Electric Lighting Committee recommending, with regard to the communication from the Vestry of Hammersmith upon the subject of the report of the Joint Committee of both Houses of Parliament on electrical energy (generating stations and supply), that the Vestry inform their members of Parliament of their concurrence in the views expressed by the Vestry of Hammersmith. There was also a notice on the agenda to the effect that the Electric Lighting Committee be instructed: (1) to enquire and report (*a*) whether the Metropolitan Electric Supply Company has power to sell, and, as vendor, can make a good title to that part of its undertaking which is situated in or supplies with electricity the parish of St. Marylebone, including the benefit of any provisional orders and confirming Acts, and whether the Vestry can legally purchase; (*b*) what is comprised in the company's undertaking, so far as it is situated in or supplies, or was intended and is adapted to supply, St. Marylebone, and whether what is specified or referred to in the report of the committee is wholly separate (or capable of being wholly separated, and, generally, by what work and at what approximate expense) from that part of the company's undertaking which is not situated in or used for supplying St. Marylebone; (2) if the company has power to sell and make a good title to what is, or can, at small expense be made, a wholly separate, independent, and exclusive undertaking for the supply of St. Marylebone with electricity, then before report to enter into a provisional contract with the company in the name, and on behalf, but subject to the approval of the Vestry, for the purchase of the benefit of such part of the company's provisional order, works, and undertaking, including a covenant not to compete with the Vestry, and not to use any part of its purchased or added plant (or to do so, subject to such limits, and on such terms as may be agreed, at a price to be hereafter agreed on between the company and the Vestry, or in default of agreement to be settled by submission of both parties to an arbitration under the Arbitration Act, 1889, or as may be otherwise agreed); (3) the committee to be at liberty to employ such experts, or obtain the benefit of such professional advice, as they may consider necessary for the purposes of this reference to the committee.

Glasgow.—The Tramway Committee of the Corporation have approved the recommendation of the sub-committee on electric traction to the effect that the overhead system be adopted throughout the city, and that the conversion of the tramways from horse traction to electric be proceeded with as speedily as possible. The sub-committee is to prepare a scheme for the conversion of the whole tramway system to electric traction, the work to be completed by the spring of 1901, when the international exhibition will be opened at Kelvingrove Park. In the meantime the sub-committee are to be on the lookout for any improvement of the conduit system which may be devised that would suit the special conditions along the route of the Central Railway, where the distance between the roof of the tunnel and the street level is too small to permit of the present system of conduits being laid. The following report of Mr. John Young, manager of the Corporation tramways, in reference to the results of the electric tramways service recently instituted along the Springburn route of the city, was submitted to the Town Council yesterday: "The overhead system was inaugurated on Thursday, Oct. 13, 1898, and has thus, up to Saturday last, 24th ult., been in operation for a period of ten weeks and three days. During the first week or two only a few of the electric cars were placed on the route, along with the horse cars. The number of electric cars was, however, gradually increased until a full service was given, when the horse cars were altogether withdrawn. The service now given is the same as was given under horse traction—viz., every three minutes. On Saturday there is a two-minute service. For the first few weeks, when the number of electric cars was small, and the service novel, the receipts per car mile were abnormally high. The drawings for the whole period from Oct. 13 to Dec. 24 have averaged 16·01d. per car mile. If we take the last five weeks, however during which time we may safely assume that the receipts had reached their normal, the average has been 14·88d. per car mile. For the corresponding five weeks of last year the receipts from the horse cars were 11d. per mile, but the average for the route throughout the period from Jan. 1, 1897, to Oct. 8, 1898, was 12 24d. per car mile. Taking the larger figure for the horse cars, the electric cars show an increased revenue of 2·46d. per car mile. It is still rather soon to give a definite figure as to the amount of the working expenses under electric traction, as the condensing plant has not yet been in operation; but after including a fair sum for maintenance and renewals, it may be taken that the total working expenses will not exceed 6½d. per car mile. The average working expenses under horse traction may be taken at 8½d. per car mile, although during the last financial year the amount worked out at slightly under that figure. This shows a saving in working expenses for electric as compared with horse traction of at least 2d. per car mile. There is no doubt that even with the small power station at Springburn, were all the available power utilised, as it will be when the route to Govanhill is opened, a still larger saving will be effected. The result, so far as we have gone, has been an increased revenue of 2·64d. (say 2½d.) per car mile, and a decreased expenditure of 2d. per car mile, being a total gain of 4 64d (say 4½d.) per car mile. This gain on the present mileage on the Springburn route (2·40 miles of double track) will amount to £10,000 per annum."—*Scotsman.*

Bristol.—The *Bristol Times and Mirror* has a long article on Bristol's new tramway system, in which it is said that the settlement of the points in dispute between the Bristol Tramways and Carriage Company and the Sanitary Committee is fraught with important consequences. Although some months have passed since the company obtained their Act authorising them to adapt existing lines, to make new ones, and to use electricity as the motive power of the cars all over the system, they have practically had their hands tied up to the present moment. True, the company have been laying relatively small sections of new road and reconstructing links of the old lines in various parts of the city where no question was likely to arise between them and the Sanitary Committee, but they have been unable to lay down and follow a regular and consistent plan. Until the matters of centre poles, bracket arms, and span wires had been definitely settled the company were unable to proceed with the most important sections of their work, or to order the necessary electrical plant. Now their hands are free, and the results will quickly be seen in the consecutive and rapid manner in which the work will be carried out. It will be remembered that the tramways company anticipated getting the whole of their system into operation by electricity within 12 months, say at the end of 1899; but inasmuch as the lines between Old Market the Tramways Centre, and Totterdown can be temporarily worked from the St. George's power station, by connecting the wires and cables with those in Old Market-street, it has been the intention of the directors to relay the Victoria-street line first, and to bring it into use with electrical power as soon as possible, without waiting for the erection of the central power station at Counterslip. But Victoria-street was one of the thoroughfares regarding which questions arose as to how the overhead wires should be carried, and the reconstruction of the tramway through it has necessarily had to be postponed for many weeks, during which negotiations have been pending. Now at last the company and the Sanitary Committee are in accord upon points formerly in dispute, and already plans of work have been prepared, and a definite method of carrying them out has been adopted. The directors, anticipating that the reconstruction of this line would have been taken in hand months ago, ordered the material necessary, so far as they could, and believing the track would be in working order by about the end of the present year, they ordered 20 new electric cars from America. These have been delivered, and are now housed in the Kingswood depôt ready for use. It is hoped and believed that electrical cars will be running between Totterdown, the Tramways Centre, Bristol Bridge, and Old Market-street long before the summer comes. As regards the working of the other sections, they must wait until the central power station is ready. The line through Redcliff onwards is to be laid concurrently with that through Victoria-street, and will be carried out to its completion unless anything very unforeseen takes place. As this work is in progress the directors will consider what other section or sections shall be taken in hand, so that as soon as it is completed another branch shall be commenced without delay and carried through uninterruptedly. The work already done, although it has been done in relatively small pieces, amounts in the aggregate to a considerable quantity. The site acquired for the central electrical power station has been cleared, and a commencement is immediately to be made to erect the new power station. The ground is to be piled; the superstructure is to have a steel frame with facings of bricks, and is to embody many of the most recent features introduced into kindred buildings in America. The chimney is also to be of steel, with an inner coating of bricks, the first of the kind in this part of the world. It may also be taken for granted that the machinery for generating electrical power will be of the latest type, and ample margin is to be made for any extensions that might hereafter be made beyond the scheme now being carried out. It is estimated that the cost of the completed scheme will be nearly £400,000. Although it would be possible to complete the whole of the lines in about six months, considerable time longer will be required to erect the central power station, equip

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it, and bring it into working order. Nevertheless, the directors hope and believe that everything will be finished and electrical cars running in every direction within 12 months. Board of Trade regulations will not allow of the cars going further from the source of electrical supply than the spot known as the Three Lamps because of electrical leakages and for other technical reasons. Consequently, it is probable that a service of horse-cars may be temporarily established between this point and Brislington; while the Knowle extension will probably have to remain idle, because of the steep gradients, until electrical power can be obtained from Counterslip to work it.

PROVISIONAL PATENTS, 1898.

DECEMBER 19.

26378. Improvements in conduit inspection fittings for electric wiring. Thomas Taylor, 12, Cherry-street, Birmingham.

26769. Improvements in and relating to electrically-operated clocks. Hjalmar Emanuel Andersson, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

26778. Improvements in starting apparatus for shunt and compound motors. Johan Jetmund Thoresen, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, May 20, 1898, being date of application in Norway.) (Complete specification.)

26787. Improvements in electric fuses for use in blasting or other like purposes. Hugh Gorham Ticehurst and Benjamin Theophilus Moore, 55, Chancery-lane, London.

26789. Improvements in and relating to electrical incandescence lamps. Victor Isidore Feeny, 60, Queen Victoria-street, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

26790. Current-conducting connection between electrical conductors. Victor Isidore Feeny, 60, Queen Victoria-street, London. (Allgemeine Elektricitäts-Gesellschaft, Germany. (Complete specification.)

DECEMBER 20.

26806 Improvements in steam or electric after steering gear for ships. William Bruce Thompson, 41, Reform-street, Dundee.

26807. Improvements in electric switches. Frank Lionel Monkhouse, 3, St. Nicholas-buildings, Newcastle-on-Tyne.

26858. The oxidised-carbon electric power process. Robert Harty Dunn, Overleigh-street (S.O.), Somerset.

26886. Improved means for manufacturing metallic ribbon, especially applicable for battery electrodes. The Porous Accumulator Company, Limited, and John Charles Howell, 55, Chancery-lane, London. (Complete specification.)

26914. Improvements in dynamo-electric machines, electric motors, and the like. Auguste Collavet, 6, Lord-street, Liverpool.

26930. An automatic telephone exchange and means relating thereto. Edmund Preismann, 1, Queen Victoria-street, London. (Complete specification.)

DECEMBER 21.

26947. A new process of treatment and method of working electric accumulators. Paul Gadot, 100, Wellington-street, Glasgow.

26948. Improvements in or relating to the brushes of dynamo electromotors and the like. Joseph Platt Hall, 70, Deansgate, Manchester.

26984 An improved change-over switchboard and light indicator for use in connection with electric lights on board ship. James Ernest Spagnoletti, Joseph Crookes, and James Lawrence, 70, Palace-chambers, Westminster, London.

27009. Interchangeable electric display apparatus. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (George Lafayette Mason, United States.)

DECEMBER 22.

27018. An electro-chemical method of disintegrating rocks carrying minerals. Charles Henry Logan, 256, Camberwell New-road, London.

27040 An improved electric bell. David Reid, 154, St Vincent-street, Glasgow.

27053. Improved overhead electrical wire holder. Frederick Foy, 39, Piercy-street, Duke street, Lower Broughton, Manchester.

27074. Improvements in electrodes for arc lamps. William Edwin Irish, 52, Chancery-lane, London. (Complete specification.)

27097. Improvements in arc lamps. Hans Realf Ottesen, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

DECEMBER 23.

27113. An improved process of the application of metals by electrolysis to or on the surface of earthenware, either in the biscuit or glost state. Gerald William Laybourn, 4, Woodland-street, Tunstall, Staffs.

27142. Improvements in or relating to electrically-driven ventilating vans. William Albert Burns, 120, Chancery-lane, London.

27183. A new material for electrical insulation. Arthur Smith, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

DECEMBER 24.

27254. Improvements in electric arc lamps. Charles Wood, 11, Burlington-chambers, New-street, Birmingham.

27268. Improvements in connection with alternate-current arc lamps and lanterns. William Morris Mordey and Henry Bevis 46, Lincoln's-inn-fields, London.

27269. Improvements in and connected with apparatus for measuring electricity. Henry Guillaume Kunkelmann, Charles Emmanuel François, and César René Loubern, 46, Lincoln's-inn-fields.

DECEMBER 27.

27276. Improvements in supporting and take-up devices for cable-suspended electric lamps. John Henry Dorion, 40, Chancery-lane, London.

27320. Improvements in and relating to electric motors and method of controlling same. Samuel Yoke Heebner, 77, Chancery-lane, London. (Complete specification.)

27334. Improvements in telephone receivers. Philip Middleton Justice, 55, Chancery-lane, London. (Allen Thomas Nye, United States.)

27335. Improvements in telephone transmitters. Philip Middleton Justice, 55, Chancery-lane, London. (Allen Thomas Nyè, United States.)

27336. Improvements in apparatus for use in telephone exchanges. Philip Middleton Justice, 55, Chancery-lane, London. (Allen Thomas Nye, United States.)

DECEMBER 28.

27360. An apparatus or improved manner of means for determining or ascertaining the velocity of air currents in coal mines and other situations, and for other purposes by novel electrical and other means. Joseph Thompson, 10, Leckwith-road, Canton, Cardiff.

27370. Improvements in the automatic compounding of monophase or polyphase alternators. Robert Bolton Ransford, 24, Southampton-buildings, Chancery-lane, London. (The Société Sautter, Harlé, et Cie., France.) (Complete specification.)

27390. Improvements in coin-freed apparatus for electric and fluid meters. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Société Anonyme Continentale pour la fabrication des compteurs a gaz et autres appareils, France.)

DECEMBER 29.

27414. Improvements in or relating to electric lamp bracket joints. James Clark, 115, St. Vincent-street, Glasgow.

27453. Improvements in electric motors. Henry Leitner, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

DECEMBER 30.

27469. A process for the electro-deposition of vanadium. Sherard Osborn Cowper-Coles, Grosvenor-mansions, Victoria-street, Westminster, London.

27473. Improvements in graduated resistance apparatus for starting or reversing electromotors. Duncan Stewart and Co., Limited, and Thomas Davidson Seaton, 121, West George-street, Glasgow.

27498. Improvements in electric incandescent lamps. Gabriel Zahikjanz, 37, Cursitor-street, Chancery-lane, London.

27526. Improvements in thermo-electrical building bricks or blocks. Joseph Matthias, 115, Cannon-street, London. (Complete specification.)

DECEMBER 31.

27541. Improvements in detachable and swivelling electric light fittings. John Frederick Wakelin and Charles James Weston, 5, Tottenham-street, London.

27556. Improvements in incandescent electric lamps. Romeo Bottelli, 11, Via Cusani, Milan, Italy.

27564. Improvements of controlling apparatus for electric lifts and other machines. John Sanders Stevens, Charles George Major, and Edwin Charles Stevens, Janus Works, Queen's-road, Battersea, London.

27577. Improvements in motor-driven vehicles and in electric motors therefor. Walter Ambrose Crowdus, 15, Copthall avenue, London.

27583. Improvements in electric arc lamps. Frederic Stanhope Worsley, 47, Lincoln's-inn-fields, London.

27586. Improved direct-coupled driving arrangement for electric automotors. Ernst Egger, 40, Chancery-lane, London.

27592. Improvements in controllers for electric motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (W. B. Potter, United States.) (Complete specification.)

27593. Improvements in systems of train control for electrically-propelled vehicles. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Frank E. Case, United States.) (Complete specification.)

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27599. **Improvements in electro-hydraulic brakes for railway vehicles and other purposes.** Camille Durey, 6, Lord-street, Liverpool. (Complete specification.)

27613. **Improvements in electric fuse holders.** Charles Howard, Norfolk House, Norfolk-street, London. (Complete specification.)

27614. **Electrolytic or battery liquid.** James Robinson Hatmaker, 30, St. James's-square, London.

27636. **Improvements in electric arc lamps.** Arthur Marshall Arter, 46, Lincoln's-inn-fields, London.

SPECIFICATIONS PUBLISHED.

1897.

28157. **Relay applicable to pneumatic or electric organs or to other apparatus.** Hope Jones.

28457. **Apparatus for regulating and controlling electric motors.** Higginbottom, Hindle, and Mannock.

28729. **Electrical switches.** Booth.

28859. **Resistance and contact apparatus for electric currents.** Duncan Stewart and Co., Limited, and Lyon.

29010. **Means or apparatus for conveying the boxes to and from electric furnaces.** Bastick and Thornton.

29251. **Connections for storage cells.** Wade and the Electric Motive Power Company, Limited.

29361. **Electric gas-lighting and controlling devices.** Kerridge.

30470. **Electricity meter shelf fixing, or box and main connection board or box combined.** Jones.

30572. **Joints for electricity conductors.** Fowler and the Mutual Electric Trust, Limited.

30926. **Fog signalling apparatus for railways.** Tomlins and the Electric Fog Signal Syndicate, Limited.

1898.

586. **Mounting of dynamo-electric machines.** P. R. Jackson and Co., Limited, and Lewis.

632. **Electric lamps and switches.** Walters.

698. **Electric illumination of railway trains.** de Szwantowski.

812. **Dynamo-electric machinery.** P. R. Jackson and Co., Limited, and Lewis.

1628. **Secondary batteries.** Crowdus.

1826. **Electric switches and cut-outs.** Cutter.

2427. **Variable electric resistances or rheostats.** R. Waygood and Co., Limited, and Unwin.

4646. **Apparatus for magnetic testing.** Ewing.

5379. **Manufacture of submarine telegraph and telephone cables.** W. T. Henley's Telegraph Works Company, Limited, Sutton, and Ludwig Lehmann Hartvigson.

5663. **Metallic conductors for protecting electric wires and cables.** Middleton and Huggins.

6991. **Electrical measuring instruments.** Weston.

6991a. **Index needles or pointers for electrical and other indicating or measuring instruments.** Weston. (Date claimed under Patents Rule 19, March 22, 1898.)

14833. **Junction boxes for electric cables, inspection chambers, and the like.** Franklin.

16245. **Electric sounding device.** Buckley and Croffert.

18231. **Electrical heating appliances formed of artificial stone.** Bachmann, Vogt, Weiner, König, Kirchner, and Jörg.

19537. **Dynamo electric machines.** Burke.

19938. **Safety devices for dynamo-electric machines.** The British Thomson-Houston Company, Limited. (Hewlett.)

19942. **Combined electric generator or motor and steam, air, or the like engine or compressor.** Mills. (Whitfield and Cowan.)

20202. **Electrical apparatus for operating railway points and signals.** Ducousso. (Date applied for under International Convention, Feb. 24, 1898.)

20446. **Means for supplying current to electrically-propelled railway vehicles.** Johnson. (Hutchins.)

20989. **Composition for electrically firing detonators.** Bickford-Smith.

21047. **Electric fuses.** The British Thomson-Houston Company, Limited. (Emmett.)

21410. **Controlling switches and apparatus for electric motors.** Hutchison.

21943. **Electrical contact breakers.** Haddan. (The Allgemeine Elektricitäts-Gesellschaft.)

22085. **Conductors and collectors for electric railways.** Myers.

22334. **Combined engine and dynamo, which may also be used as a motor and pump or compressor.** Mills. (Cowan and Whitfield.)

22461. **Primary batteries.** Johnson. (Dercum.)

22600. **Incandescent electric lamps.** The British Thomson-Houston Company, Limited. (Painter).

22601. **Electric arc lamps.** The British Thomson-Houston Company, Limited. (Spinney.)

22664. **Appliances for use in securing the copper bonds or conductors in electric tramway rails.** Munro, Brecknell, and Rogers.

22683. **Couplings for electric conductors.** The British Thomson-Houston Company, Limited. (Case.)

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1898.	Corresponding week 1897.	Increase or decrease.	Total receipts for half-year. 1898.	1897.
		£	£	£	£	£
Birmingham Tramway	Dec. 31	3,822	4,058	- 236	—	—
Blackpool and Fleetwood Tramroad	,, 31	216	—	—	14,476	—
Bristol Tramways and Carriage Co.	,, 30	3,194	2,654	+ 540	—	—
City and South London Railway	Jan. 1	1,036	1,050	- 14	—	—
Dover Tramways	Dec. 31	193	150	+ 43	8,550	—
Dublin U.T., elec. cars	,, 30	632	†640	- 8	17,433	14,798†
Dublin S.D. Electric Tramways	,, 30	782	536	+ 246	23,714	15,923
Halifax Corporation Tramways	,, 28	314	—	—	6,833‡	—
Liverpool Overhead Railway	Jan. 2	1,291	1,357	- 66	—	—
South Staffordshire Tramways	Dec. 31	954	718	+ 236	33,142*	32,924*

* Receipts since Jan. 1. † Horse cars. ‡ Since June 29

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	19½-20½
Bournemouth and Poole Electric Supply, Limited, Ord.	10	11-11½
—— 4½ per cent. Cum. Pref.	10	10⅝-11⅛
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	15½-16½
—— 6 p. c. Cm. Pf., 30,001-40,000 (all paid)	10	13-13½
—— 5 per cent. Perpetual Debenture Stock	100	119-121
Brush Electrical Engineering, Limited, Ordinary	2	1⅞-2
—— Non. Cum., 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	111-115
—— 4½ per cent. 2nd Debenture Stock	100	101-104 xd
Callender's Cable Company, Debentures	100	110-113 xd
—— Ordinary	5	9½-10½
Central London Railway, Ordinary	10	9½-10⅛ xd
——	6	5⅜ 6⅛ xd
—— Pref. Half-Shares	1	1⅛-1⅜ xd
——	5	4-4½ xd
—— ,, ,,	5	11½-12½
Charing Cross and Strand	5	8-8½
—— 4½ per cent. Cum. Pref.	5	9-10
Chelsea Electricity Company	100	118-115
—— 4½ per cent. Debentures	10	22-24
City of London, Ordinary	10	21-23
—— ,, 90,001-100,000	10	15½-16½
—— 6 per cent. Cumulative Pref.	100	125-130 xd
—— 5 per cent. Debenture Stock	100	67-69
City and South London Railway, Consolidated Ordinary	3	3½-4
—— Ordinary	100	133-135
—— 4 per cent. Debenture Stock	10	14½-15½
—— 5 per cent. Pref. Shares	10	14-15
—— ,, ,, '96	10	12½-13½
County of London and Brush Prov. Elec. Light Co., Ord.	10	12-13
—— ,, ,, No. 30,001-40,000	10	14½-15½
—— 6 per cent. Cum. Pref.	3	1½ 2½
Crompton and Co.	—	89-94 xd
—— 5 per cent. Debentures	100	125-130
Crystal Palace District, Ordinary 5 per cent. Stock	100	140-145
—— Preference 5 per cent. Stock	3	2½-2⅝
Edison and Swan United Ordinary	5	4-5
—— 5 per cent. Debentures	100	96-97 xd
—— 4 per cent. Deb. Stock, Red.	5	5-5⅛
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	2	2½-2⅝
Electric Construction, Limited	2	2⅝-3⅛
—— 7 per cent. Cumulative Pref.	100	105-107
—— 4 per cent. Perp. 1st Mort. Deb.	10	22-23
W. T. Henley's Telegraph Works, Ordinary	10	18-19
—— 7 per cent. Preference	100	110-115
—— 4½ per cent. Debentures	5	9-10
House-to-House Company, Ordinary	5	9½-10½
—— 7 per cent. Preference	6	16½-17½
Imperial Tramways, Limited	10	21½-22½
India Rubber, Gutta Percha, and Telegraph Works	100	102-106
—— 4 per cent. Debentures	5	13-14
Kensington and Knightsbridge Ordinary	3	3-3½
London Electric Supply, Ordinary	5	6-6½
—— 6 per cent. Pref.	100	102-104
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	10	17½-18½
Metropolitan Electric Supply, Limited, Ordinary	100	115-119 xd
—— 4½ per cent. First Mortgage Debenture Stock	5	5½-5⅝
National Telephone, Ordinary	10	13-15
—— 6 per cent. Cum. First Pref.	10	13-15
—— 6 per cent. Cum. Second Pref.	5	5⅜-5⅝
—— 5 per cent. Non. Cum. Third Pref.	100	99-102 xd
—— 3½ per cent. Deb. Stock, Red.	10	17-18
Notting Hill Electric Lighting Company, Limited	1	1⅛-1⅜
Oriental, Limited, 1879	5	7-7½
—— £5 Shares	4½	6⅛-6½
—— £4½ Shares, New	1	⅜-½
Oriental Telephone and Electric Company	5	6-6½
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	⅛	150-155
Royal Electrical Company of Montreal	100	105-107
—— 4½ per cent. First Shares Mortgage Debentures	3	2⅞-3⅛
South London Electric Supply, Ordinary	5	16-17
St. James's and Pall Mall, Limited, Ordinary	5	9-10
—— 7 per cent. Pref.	100	105-108
—— 4 per cent. Deb. Stock, Red.	12	37-41
Telegraph Construction and Maintenance	100	102-105 xd
—— 5 per cent. Bonds	100	111-114
Waterloo and City Railway, Ordinary	5	15½-16½
Westminster Electric Supply, Ordinary		

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NOTES.

Electric Power.—The Lincoln electricity works, which are only just beginning to supply current, have already got a power customer. This is the Lincoln Cathedral, where the organ bellows are being driven by a motor.

Eccles Electricity Works.—We have received an anonymous letter with respect to the description of the above works which appeared in our last issue. If our correspondent will send his name and address the letter shall be published.

Pacific Cable Contract.—A Bill has been introduced into the American Senate authorising a contract between the Government and the Pacific Cable Company for the transmission of official messages to Hawaii and Manila for 20 years after the construction of the cable.

The Working of Boilers.—We have received from the National Boiler Company the new edition of instructions respecting the working, treatment, and attendance of steam boilers. Such books cannot be too widely recommended, and should be read by all having to do with the working of boilers.

The London Chamber of Commerce.—The second monthly dinner of the present session will take place on Tuesday next, 17th inst, at the Trocadero Restaurant. After the dinner, which will commence at 6.30 p.m., the subject for discussion will be the progress of electricity. Mr. Thomas F. Blackwell will take the chair, and will be supported by Major P. Cardew, R.E., Mr. Sydney Morse, Mr. R. Percy Sellon, Mr. J. S. Raworth, Mr. R. E. Crompton, Mr. E. Garcke, Major S. Flood Page, and others. The charge for tickets is 7s. 6d.

Boiling Point of Liquid Ozone.—A paper on this subject from Mr. Louis Troost has appeared in *Comptes rendus*, and an abstract is given in the *Journal* of the Chemical Society. Ozone was liquefied in a vertical tube immersed in a bath of liquid oxygen, and the latter was then lowered until the readings of a galvanometer in circuit with a thermo-junction previously introduced into the tube were constant during the ebullition of the ozone. The boiling point of liquid ozone was thus found to be −119deg. at the atmospheric pressure.

Electric Fire-Engines. — The fire-extinguishing arrangements at St. James Hall have recently been thoroughly overhauled, and the water supply being of insufficient pressure to enable jets to be thrown into the roof and upper galleries, Messrs. Merryweather have just fitted one of their patent "Hatfield" pumps, driven by an electromotor. This pump is connected to the hydrant system, and enables jets to be thrown 40ft. above the roof at any time. The pump is placed in the basement, and a switch placed by each hydrant enables it to be started immediately from any part of the building.

Overhead Cables.—The Yarmouth Corporation have decided to erect a lofty overhead electric light cable which will cross the harbour in order to supply current to Gorleston. For this purpose two steel masts will be erected on either side of the river and the cable will be suspended from them. At the lowest point, in the centre of the span, the cable will be 170ft. above the highest spring tides, which will allow vessels an uninterrupted passage up the harbour. The distance between the poles is 400ft., and the cost of the work, for which tenders have been received, is £900. We presume that the shipping in the harbour was considered likely to damage a submerged cable.

Liverpool to Manchester in 18 Minutes.—Mr. F. B. Behr addressed the Liverpool Chamber of Commerce yesterday afternoon on his scheme for an express mono-rail railway between Liverpool and Manchester. We have several times described Mr. Behr's system, and fail to see in what its great advantage lies. When all the safety precautions necessary have been provided it really ceases to be a mono-rail system, and has as many or more rails and wheels than the ordinary railways. In other respects Mr. Behr deserves every commendation for the careful way in which he has overcome the difficulties in his way, and for the energy which he has displayed in obtaining trials for his system.

City and South London Railway.—The extension of this pioneer underground electric railway from the present terminus at Stockwell to Clapham Common is now fairly in hand. There are three shafts—one at Binfield-road, Stockwell; another at Bedford-road, Clapham Station; and a third at Clapham Cross. The tunnels are being driven in five directions, thus giving five working faces. Operations are proceeded with day and night, and it is confidently anticipated that the tunnels will be ready for effective use before the August Bank Holiday. The extension from King William-street to Moorgate-street will be open long before that date. The entire railway from Clapham Common to Finsbury-pavement will thus be open for traffic this autumn.

Tramway Frauds.—The arrangement of fictitious accidents on electric trams seems to be a recognised profession in some parts of the United States. The latest ingenious development of these frauds is described in the *Street Railway Review*. The procedure consisted in the use of a screw-driver to remove the screws securing the handle of the tramcar which is placed to assist the passenger in alighting. Having done this, the gentleman proceeds to fall off the car as lightly as possible, and to bend the handle in doing so. The next move was to apply for damages. Unfortunately, in the present case the doctor who examined him found the screw-driver up his sleeve, and further damage is likely to be imparted to the gentleman before he regains his liberty.

By Wire to Klondike.—The *Financial Times* on Tuesday last published a letter from an Edinburgh stock-broker, in which the ordinary shares of the Canadian, British Columbian, and Dawson City Telegraph Company were offered to the stockbroker's clients at par. His letter starts by referring to the overwhelming success in the floating of the 5 per cent. first mortgage debenture stock of this company. It suggests that the ordinary shares, which have been greatly sought for by the public, are likely to get 25 per cent. dividends, and announces that the engineer to the company has left for New York *en route* for Canada and Dawson City in order to superintend the construction of the line. Our contemporary rightly criticises this letter most severely, and warns all Scotsmen against trusting their money in the concern.

Tesla's German Patents.—The Reichsgericht of Germany has confirmed the decision of the lower courts declaring the Tesla polyphase motor patents invalid. The Court reviewing the case holds that the patents are void, owing to their not having been worked according to the requirements of the German patent law. The Court goes on to say, however, that even if the patent had been sustained on that ground, it would have been nevertheless invalidated, owing to the fact that the invention was not adequately described in the German patent specification, whereas the American patent specification is clear. It is understood, says the *Electrical Engineer* of New York, that the Helios Company, of Cologne, who control the Tesla patents in Germany, will no longer contest the suits which it has brought against several parties in Germany.

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Lightning.—A question has been addressed to the Weather Bureau of the United States of America as to the reason why certain kinds of trees are more liable to be struck by lightning than others. The gentleman who has taken up the matter states that, from the information at present available on the subject, oak trees are most frequently damaged by lightning, while birch trees are lowest on the list. Thus, he estimates that for every birch tree that is struck in a given time, 54 oak trees would be injured and 15 pine trees. Any subject connected with lightning is a difficult one to handle on account of the extreme vagueness of the reports usually obtainable. On the above question, however, it should not be difficult to get some reliable information together, and also to ascertain the reasons for the general conclusions which can be deduced.

Edison's Latest.—Mr. Thomas Alva Edison has, we understand from our contemporary *Electricity*, of New York, devised a scheme by which telephoning across the Atlantic Ocean will be possible. He explained in an interview (as usual) that at first the proposal seemed impossible. His attempts to construct a cable on new plans had not succeeded. But when the task was almost given up as hopeless, Mr. Edison conceived the brilliant idea of inaugurating a series of lightships across the Atlantic. These were to be relay stations, used to reduce the length of each cable. We presume that he would attempt to use telephonic relays, as devised by Dr. Lodge, on these lightships, but then speech would not be possible, as the cumulative effect of the various lengths of cable would damp out certain vibrations. The question, however, is rather one of finance, and Mr. Edison's greatest difficulty will be in finding anyone sufficiently foolish to waste their money in this way.

Large Transformers.—The largest known order for alternate-current transformers, which also consists of transformers of the largest individual outputs hitherto made, has, says the *Electrical Engineer* of New York, been placed with the Wagner Electric Manufacturing Company. The contract in question was placed by the Union Carbide Company for its carbide works at Niagara Falls, N.Y., for seven transformers of 2,000 h.p. each and two transformers of 500 h.p., complete with switchboards for operating them. The transformers are to be of the oil-filled type of apparatus, with water-coils for lowering the temperature of the oil. The contract was closed on definite specifications as to iron and copper losses. The temperature rise and also the insulation resistance were guaranteed, and the transformers are to be able to stand 50 per cent. overload in current. The Wagner Company, it will be remembered, built the 40,000-volt high-tension transformers which are now operating at Provo, Utah, and Telluride.

A Non-Fatal Shock.—It is well known that in the United States the craze for the marvellous has at times led the untechnical Press to exceed the bounds of truth. When, however, a man who has been almost killed by an electric shock relates his experiences to a reporter the pure truth only may be expected. The gentleman we have in mind is called Mr. Dwight L. Clough, and he is reported to have been caught in a 11,000-volt circuit at the power-house of the Buffalo and Lockport Railway. When, however, the reporter of the *Buffalo News* interviewed him, he explained that the report given out that a current of 11,000 volts passed through his body was erroneous. The correct measure of the current was 1,000 amperes under a pressure of between 800 and 900 volts. He added, "You see the ampere is the measure of volume, while the volt is the measure of pressure." The United States should be proud of a man of so strong a constitution that 1,000 amperes has not killed him. We feel reluctant to state definitely on the face of this how many milliamperes our experts consider a fatal amount.

Power Distribution Clauses.—The Bill deposited by the Leicestershire and Warwickshire Electric Supply Company, under which powers are sought to lay mains in the above counties and in Derbyshire, contains clauses of which the following are abstracts: The share and loan capital of the company is to be £1,000,000, of which £250,000 may be raised on mortgage. The profits of the company are to be limited to 10 per cent., subject to an increase of 5s. per cent. for every one-tenth of a penny per unit at which the energy may be supplied below the standard price of 2½d. per unit. The Bill further provides that "nothing in this Act shall be construed to confer upon the company the exclusive right to supply energy within the area of supply, or to hinder or restrict any other body, company, or person from supplying or increasing their present supply of energy within the said area, nor shall the company at any time hereafter, by reason of any competitive supply, be entitled to any compensation for alleged vested interest in respect of any of the powers conferred upon it by this Act."

Electric Motors in London.—The County of London and Brush Provincial Electric Lighting Company is placing every inducement in the way of its consumers of power. In a circular which this company has issued, headed "Electricity as a Motive Power," a great deal of useful information is given, and we note that in the St. Luke's, Clerkenwell, and Holborn districts the power circuits will be supplied at 530 volts. This voltage renders small motors somewhat more expensive, but for the larger sizes is more convenient. The company gives a list of manufacturing firms, all of whom may be relied upon to supply good and serviceable motors. We notice that four of these firms are prepared to give three months' free trial of their motors, on the condition that the consumer shall then pay for them if they run satisfactorily under normal loads. Of course, this is very reassuring to the consumer, and from the reputation of the four firms in question we are sure they will receive prompt cash in three months in every case. The County of London and Brush Provincial Company are now charging for current used for motors at the rate of 6d. per unit for the first hour's average demand, and 2d. per unit for all current in excess of this. On the eight-hour working day this works out at 2½d. per unit.

Teachers' Class.—The following Saturday morning class for teachers on "Magnets and Electric Currents" is announced in the *London Technical Education Gazette*. A course of 10 lectures will be given by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., in University College, Gower-street, beginning on Jan. 14, at 10 a.m. This class is intended for headmasters and assistant masters in London Board schools and for science masters in elementary science schools, who will be admitted free. The object of the course is to give instruction in modern methods of science teaching. It will consist in the delivery by the professor of a model lecture to exhibit methods of dealing with the subject, adapted for science teachers and teachers in Board schools who, having some knowledge of the subject, desire to receive instruction in the scientific construction and use of experimental apparatus and the improvements of methods of teaching. Each meeting of the class will begin with a lecture lasting one hour, to which any number of teachers up to 40 can be admitted. Subsequently a series of practical laboratory exercises will be worked by teachers on the above subject, to which the first 20 applicants for places in the class will be admitted. Applications should be made by letter to Prof. Fleming.

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A Proposed New Alpine Railway.—The Berlin correspondent of the *Daily News* says that the building of a new railway from Germany to Italy is in contemplation. The new line, which would doubtless become a dangerous competitor to the St. Gothard Railway, is to be called the Vintschgau Railway, and is to start from Landeck, on the famous Arlberg line, and to continue through the Vintschgau Valley, by Reschenscheideck, Meran, Trafoi, and Bormio, to Milan. Apart from the benefit which would accrue to the German export trade from what would be the shortest route from North Germany to Italy, the railway would be one of the finest Alpine lines in the world, as it would lead through the Ortler Mountain groups, and traverse the famous Stilfeserjoch, the highest road in Europe, through a tunnel 7,500 m. long, whilst the St. Gothard tunnel is over 14,500 m. The Chamber of Commerce of Augsburg has submitted to the Chancellor a petition for a subvention for the railway, which is to be built by Austria, as was done in the case of the St. Gothard line. It is interesting to hear that in the opinion of experts the water power available in the regions to be traversed is so considerable that the railway could be an electrical one. Access to the Engadine would of course also be greatly facilitated.

Electric Bleaching of Sugar.—The following is a *résumé* from Mr. Carl Hering's digest of the article by Mr. Peters which appeared recently in the *Zeitschrift für Elektrochemie* describing experiments made to compare the action of ozone, that of electric currents, and that of both combined, in the purification and decolorisation of liquids containing sugar. After a brief reference to the various processes, the published descriptions of which are referred to, he describes his experiments, in which some dark-coloured syrup was subjected to each of these three processes. The ozone produced electrically passed through the liquid in bubbles. In the treatment by the current the cathode was carbon and the anode zinc in one case and aluminium in another; in both cases the liquid was thoroughly stirred during the process. The results are given in detail, and they show very clearly that the action of both combined is very much better than when either is used separately; the decolorisation is much more thorough; the inorganic salts are separated out to a much greater extent, and the organic impurities are easier and more thoroughly oxidised, passing over into the slime, which is easily separated; the taste of the syrup becomes purer; no mould or fermentation could be noticed after one to three weeks, but it was noticed in the untreated syrup.

Telegraphy to the Goodwins.—The following typical note is from the *Daily Chronicle*: "Arrangements are being made at the South Foreland lighthouse and on board the South Goodwin lightship for a series of experiments in wireless telegraphy. The arrangements are being made under the personal direction of M. Marconi, who is accompanied by other experts. If the experiments are considered satisfactory, as there is reason to believe they will, it is stated that the wireless system will be adopted forthwith as a means of communication between the South Foreland lighthouse and the South Sands Head lightship. The position on the Goodwins is a very important one in regard to shipping disasters. The points of communication are only about three miles apart. The present experiments are the outcome of those which took place some time ago at Fort Burgoyne, Dover. It is stated that experiments between England and France are also proposed." We shall be glad to note a change in the type of the Marconi note from the indefinite proposal to the definite accomplished fact. A statement that signals have been transmitted regularly and whenever required between two points for three months on commercial lines would be more to the purpose than these continued temporary tests. We may also add that the experiments between England and France were proposed in the summer.

Conference of Science Teachers.—There is being held this week at the South-Western Polytechnic, Manresa-road, Chelsea, a conference on the methods and apparatus used in the teaching of practical science in schools. This was organised by the County Council Board in connection with the holiday courses of the College of Preceptors. The first meeting was held yesterday at 12 o'clock, the subject being the teaching of elementary experimental physics in schools. Papers were read by Mr. Sanderson, of Oundle School, and Mr. Frank C. Weedon, of Alleyn's School, Dulwich. Dr. Garnett presided. The second meeting, held in the afternoon, was devoted to the teaching of elementary experimental chemistry. Prof. H. E. Armstrong, F.R.S., was in the chair. The third meeting will be held to-day at noon, with Prof. Hudson Beare in the chair. The subject will be the teaching of elementary mechanics in schools. Papers will be read by Mr. S. H. Wells, principal of the Battersea Polytechnic, and Mr. Sidney Whalley, of the Simon Langton Schools, Canterbury. Mr. C. T. Millis, principal of the Borough Polytechnic, will open the discussion. The last meeting will take place to-day at 2.30 p.m., on the teaching of elementary experimental physics in schools. Papers will be read by Dr. T. Buchanan, of the Gordon College, Aberdeen, on "Electricity and Magnetism," and by Dr. J. F. Kerr, Glasgow, on "Heat," to be followed by a discussion. Prof. Ewing, F.R.S., professor of engineering in the University of Cambridge, will preside. An exhibition of apparatus has been arranged so that those attending the conference can exchange views on the best type to be used.

A Mammoth Power Station.—The electric power station for the Metropolitan Street Railway Company, New York, when completed, will deserve the distinction of being the largest in the world. The total capacity of this mammoth plant will be 70,000 h.p., and it will supply the entire system owned by the company. Probably the most striking object at the power-house is the great smoke-stack situated between the boiler and engine rooms, and which ranks as one of the largest structures of its kind in existence. It is 353ft. high, the base being 55ft. square, and the uniform internal diameter is 22ft., the outside diameter varying from 38ft. 10in. to 26ft. 10in. There are 3,400,000 bricks used in the stack, the total weight being 8,540 tons. The building, which measures 270ft. by 201ft., is divided into two parts, the engine and boiler houses. There will be 87 boilers arranged in two parallel lines on each of the three floors of the boiler-house. The maximum capacity of each boiler will be about 800 h.p., making a total of about 70,000 h.p. The coal storage bin, extending the full length of the house above the boilers, will have a capacity of 9,000 tons. The engine-room will contain 11 cross-compound engines, each of 6,600 i.h.p. The two high-pressure cylinders will be 46in. in diameter and the two low-pressure 86in., the common stroke being 60in. Each engine will, says the *Engineer* of New York, be direct connected to a three-phase alternating-current generator, which will operate at 6,000 volts. The current will be transmitted to eight sub-stations, where it will be converted by means of static or rotary transformers to a pressure of 550 volts.

The National Telephone Company's Bills.—The National Telephone Company, as has been stated in our columns, has three Bills to come before the Houses of

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Parliament this session. The third of these is to provide a court of appeal to hear cases in which local authorities refuse to grant permission to lay telephone lines under the streets or seek to impose exorbitant terms for the permission. The Bill in question proposes to enact that, "where any local authority having power to give or withhold consent to the exercise by the company of the powers conferred on the Postmaster-General, which the company are authorised by license to exercise, shall fail within 21 days to give their consent, after being required to do so by the company, or shall attach to their consent any terms, conditions, or stipulations to which the company objects, or shall withdraw a consent, a difference shall be deemed to have arisen between the company and the local authority, and such difference shall be determined by the Railway and Canal Commissioners. The Commissioners, after hearing all parties concerned, may give their consent either conditionally or subject to such pecuniary or other terms as they may think fit, and that consent shall for all purposes be of the same effect as if it were given under the provisions of the Telegraph Act, 1892." The Bill further provides that the proceedings before the Commissioners shall be conducted in the same manner as any other proceedings under the Acts relating to them. The proposals of this Bill appear to us to be most reasonable if only the main points at issue could be advantageously settled in favour of repurchase by the Government at a definite date of the National Telephone Company's works.

Electricity as an Exact Science.—We notice that Mr. Howard B. Little has commenced a series of articles under the above title in the first issue of *Knowledge* for the New Year. In this, the introduction to the series, Mr. Little deals with the history, or, rather, the ancient history, of the subject. Thus, he refers to the oft-quoted statement by Baptista Porta in his book, "The Wonders of the Magnet" (circa. 1559): "I do not fear but that with a far-absent friend I can always communicate, by means of two compass needles, circumscribed with an alphabet." Another writer Mr. Little has unearthed thus stated his conviction: "Forasmuch as this is so wonderful a secret, I have hitherto hesitated about divulging it, and did so disguise my meaning in the first issue of my book as only to be understood by learned physicians and chemists. But now the time is come when I will communicate it for the benefit of lovers of science generally." One cannot but admire the apt use of that "generally." The writer, evidently himself a lover of scientific truth, goes on to describe the "sympathetic needles." It is curious to note that many writers in the sixteenth and seventeenth centuries speak of these needles as though their use was well established, while others laugh at the growth of the "conceit." One could so easily draw modern parallels. It must be remembered, says Mr. Little, that all this was taking place at a time when priests were in the habit of standing in circles around three-legged stools, while one of their number (presumably he who had the greatest command of language) anathematised the stool, till a ring, previously placed upon it, began to roll around it, stopping to indicate certain letters of the circumscribed alphabet, and so interpreting messages from a world otherwise unknown. We await the continuation of the series of these articles with interest.

Cardiff Electric Lighting.—If adverse criticisms in the Press tended always to make electric light undertakings a success, the Cardiff electric lighting works would stand easily first in the United Kingdom. From the first time it was proposed to erect these works until now, every suggestion made by the Cardiff engineers has been criticised more or less adversely in the local papers. We have before us now a long article which appeared during last week which is headed "Mistakes of the Past, How they affect the Present, Antiquated Lamps in Use," etc. In this article fault is found with the position and general design of the works, with the use of rectifiers, with the use of indiarubber on the cables, with the arrangement of the cables, with the design of the arc lamp lanterns, and with the transformers. The author goes on to amplify his condemnation in certain cases, but the technical reader will find that in so doing he has only exemplified his want of knowledge of the subject. It is a great pity that writers of such articles should not send them in first to the borough electrical engineer for comment. We are afraid that in this case the article would have rested in the engineer's waste-paper basket. The author in question finishes up with a consideration as to the use of electricity as a motive power. He says that, although Cardiff may be said to be in a position to give a regular and satisfactory supply of electric power for small motors, it could not guarantee an uninterrupted supply. He adds that no electricity works in the United Kingdom or out of it could do that, for he says as long as one is dependent on running machinery of a delicate and intricate nature an absolute guarantee is obviously beside the question.

Pantomimes. — Few of those who witness the marvellous blending of colours displayed in the pantomimes have any idea how numerous are the hands which nowadays find employment through the progress which electricity has made in the last few years. For instance, at the Adelphi Theatre, in the production of "Dick Whittington," there is a staff of 35 under the supervision of the electrician, Mr. Fred Smith, all employed in connection with the electric lighting. The electric installation of this theatre was extended during the last year at a cost of several thousand pounds. Now the lights in the front of the house and in all the exits are connected to a different circuit entirely from those behind the stage and in the auditorium. This is in accordance with a regulation now wisely enforced by the London County Council. There are altogether about 2,000 incandescent and 20 arc lamps (all hand fed) on the stage alone. The switchboard, a comparatively small one, is conveniently placed on a small balcony at the side of the stage. The Stuarts type of resistances is used. They are worked by large iron levers, the handles of which are painted red, white, and blue according to the colour changes which they control, and are therefore easily worked. All the electric appliances—or property, as we should call it—used in the present pantomime are connected with this board, although that fact is not apparent from the auditorium. Many more besides the youthful members of the audience may wonder where the well-concealed connections are placed which allow the principal fairy to move her wreath of lights so freely and apparently in every direction. To the same category belong the garlands representing orange-flowers and made up of a number of incandescent lights, which have the appearance of being carelessly strewn about the stairs composing the centre of the picture, as well as a cluster of forget-me-nots with blue blossoms, and so forth. As many as 300 lamps, ranging from 1 c.p. to 8 c.p., are fixed in the latter contrivance only.

Incandescent Lamps and Welsbachs. — Mr. Edward Backus, superintendent of light at Somerville, Mass., has recently made the following interesting and curious report, which we take from our New York namesake: "I have been requested by his honour the Mayor to make a test of the Welsbach and 32-c.p. incandescent lamps to ascertain which was best adapted to street-lighting. Now, the test of these lights is not which gives us the greatest candle-power, but which gives

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us the best-lighted streets. We know the Welsbach claim a light of 64 or more candle-power and the incandescent of 32, so that a photometric test for candle-power would result largely in favour of the Welsbach This is not the test that would demonstrate the relative advantage of one light for another for street service. It is a well-known scientific fact that what is known as the red ray in light has much greater penetrating quality than any other ray. The incandescent is very rich in this, while the Welsbach has a small percentage of the same, and although the Welsbach gives apparently a very bright light, its penetrating qualities are comparatively poor. One test which I have applied, and a very simple one, which anyone can try, is to take an ordinary sheet of white paper with a line drawn across it in ink, and cover the same with three or four sheets of thin brown paper and try the distance away from a Welsbach light this line can be distinguished when looking through a tube, and then apply the same test to a 32 lamp. The result of this test shows four incandescent lamps, 57, 45, 60, and 63, making an average of 56½ft. for each light. Two of the Welsbachs, burning Cambridge gas, showed at 51ft. and 42ft., and two, burning Charlestown gas, showed at 42ft. and 57ft., making an average of 43ft. Another test tried was to stand equi-distant from each kind of light and hold a pencil upright on a level surface. If both lights were equal, the two shadows would be of equal density. In the actual test the shadows appeared the same at a point 3ft. nearer the Welsbach than the incandescent, and, from the tests shown, the 32-c.p. incandescent has the greater penetrating power, and, in my opinion, is best adapted for lighting our streets."

Sparking at Commutators.—A recent article by Mr. Dick in the *Elektrotechnische Zeitschrift* is abstracted in the following extract from Mr. Carl Hering's digest in the *Electrical World*. In the article in question the author develops a number of formulæ to be used in making certain calculations in connection with dynamos. He had noticed in constructing dynamos that, under the assumption that there is a sufficiently strong field at the forward edge of the pole-piece, there will be sparkless collection by the brushes only when the latter were replaced by brushes of different material, as in replacing copper by carbon, and even the reverse. This led him to investigate the relations and dimensions in a machine, and the article gives the results of these investigations. It has been supposed that a relatively strong field is required for commutating the current in the short-circuited coil; he gives a formula by which this field may be calculated, and this shows that in comparison to the main field it is, even for toothed armatures, very small. Sparking and armature reaction, he shows, have no direct connection with each other. Among other things, he shows that the short-circuited coil must move in a field which has the same strength as that which is produced by the ampere windings in the short-circuited coil. Also that for sparkless collection there must be a certain very definite resistance in the circuit of the short-circuited coil; formulæ are given for calculating this. He then discusses the connection between the formation of sparks and the armature reaction. Formulæ are deduced for calculating the dimensions of carbon brushes. A summary of the formulæ is then given, and their application to specific cases is illustrated by examples. In an appendix he states that, in spite of sparkless collection of the brushes and the correct dimensioning of the contact surface, there may be bad heating of the commutator; the limits of continuous-current machines may therefore also depend on the heating of the commutator; the use of carbon brushes for producing a certain relation of resistances is allowable only to a certain degree. The effect of the length of the surface of contact on the characteristic of the machine is briefly discussed; the armature reaction is shown to be dependent on the width of the brush.

Electric Railways.—The *Street Railway Journal* of New York has in its issue of December last a very well-written article on the elevated railway problem as existing in America. These elevated railway lines, of which the Liverpool Overhead is the only example in England, have in the past had great support in the United States. Before the introduction of the electric tramways the elevated railways of New York were in a good financial condition, but the competition now has much reduced their profits. In the article in question six lines are described and many statistics as to the numbers of the passengers carried, and the scheduled speeds are collected together. We find from these that with steam lines the average speed with stops is about 13 miles per hour, and this will evidently have to be increased if the railways are to extend their gross revenues. The author of the article then proceeds to investigate how this increase in speed with the same number of stopping places is to be obtained. As a commencement, he states the present conditions of the Manhattan line to be as follows: The standard Manhattan coach weighs 29,088lb., has seats for 48, and frequently carries 100 passengers. It is mounted on eight 30in. wheels. From the above it appears that the total weight of a five-car heavily-loaded Manhattan train is not far from 130 tons, of which over 100 tons are behind the locomotive. The weight on the drivers is but 12 per cent. of the total train weight, and with 25 per cent. adhesion, the maximum drawbar pull possible for the locomotive to exert is 7,875lb. Particulars are also given of the Metropolitan Elevated Railway Company, of Chicago, whose electric locomotive car weighs 53,200lb. complete with motors, or 40,000lb. exclusive of motors. It is, of course, a standard passenger coach with full seating capacity, about one-half of each platform only being taken up with the cab and necessary controlling apparatus. The trail cars weigh about 33,000lb. The seating and standing capacity of both motor and rail cars is approximately 90 passengers. The average four-car heavily-loaded train will weigh about 100 tons, of which 32·5 tons approximately are on the four wheels of the locomotive's one-motor truck, and 67·5 tons are in the trail cars. From 30 to 35 per cent. of the entire train weight is available for traction under these conditions, and the maximum drawbar pull possible to exert without slippage of wheels is, with 25 per cent. adhesion, 16,250lb. He then refers to the South Side Elevated Railway, of Chicago, where the Sprague multiple unit system is used. At the present time this company is using a four-car train of which only one car is furnished with motors. When, however, higher acceleration is required, every car will be fitted with motors. In this way the whole weight carried will be valuable for giving the required adhesion when accelerating. Further in the article a comprehensive table is given showing the acceleration obtained on the present lines and on a test line equipped by the General Electric Company This shows that in special cases the electric train attained a speed of 30 miles per hour within 10 seconds of being started, whereas on the steam lines the speed in the same time was nearly 12 miles per hour. Acceleration curves on these lines are given which are exceedingly useful for purposes of reference, and the article concludes with an estimate of the financial results which would be obtained by introducing electric traction on other elevated lines.

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THE PRACTICAL TESTING OF ELECTRICITY METERS FOR CENTRAL STATIONS.

BY C. A. L. PRUSMANN, A.I.E.E., ASSISTANT ELECTRICAL ENGINEER, BRADFORD.

INTRODUCTION.

In this series of articles it is proposed to deal somewhat exhaustively with the process and methods of testing electricity meters, an operation which, as every central-station engineer is aware, is absolutely necessary with the present delicate construction of these registering appliances. The mere fact that transit alone may entirely alter the calibration of a meter is sufficient primary cause for subjecting it to a thorough test on arrival at its destination, while the inherent defects of many types, which develop after being on circuit in the premises of the consumer, necessitate constant watchfulness, and not infrequent recalibration or removal. Each type of meter, moreover, not only has its own peculiar points of weakness, but is more particularly adapted than the others to certain special circuits. It is still further necessary, therefore, to take these two circumstances in their special relationship to each other—that is to say, to consider the effect of the "load" upon the calibration of the meter, and the efficiency of registration of the meter in connection with the various uses of the current. All these points of consideration and their many side issues can, of course, only be known after many years of practical experience in the testing-room, and even the meter-makers are in ignorance of many of the weak points, as they, of course, have only to deal with the matters which arise during manufacture.

The subject, as dealt with in these articles, will be considered in the following order:

The Equipment of the Meter-Room.—(1) General arrangement; (2) handling; (3) departmental book-keeping; (4) connections and terminals; (5) necessary instruments and apparatus, including methods of setting up and using; (6) staff.

Different Types of Modern Meters.

Testing.

There are at the present time 79 municipal electricity supply undertakings in the United Kingdom, 85 more are applying for provisional orders, and there are also 100 electricity supply companies. When it is considered that the public supply of electricity has practically not existed more than 10 years, and that most types of meters at present in use have been evolved during the past five years, it is clear that only the larger undertakings can have had any wide experience as to the behaviour of meters. This is borne out by the many enquiries received by the author from time to time upon the subject from those who are in charge of this department in many of the smaller towns. To all such, the matter which is to follow is dedicated.

THE EQUIPMENT OF THE METER-ROOM.

In this section it is proposed to deal with the meter-room as it should be found to exist in every well-appointed and well-managed central station. It will perhaps appear to some of our readers that the management and apparatus herein described is somewhat elaborate and complex, and especially so when considered in relation to the stations of the smaller provincial towns. We are anxious to justify ourselves in this respect in advance. It must be borne in mind that upon the accurate and reliable testing of meters, as at least one factor, will depend to a large extent the initial success of the station and its development as a business enterprise. Consumers are particularly sensitive in regard to the reliability of meters, and on that ground alone every effort should be made to set up in his premises the most perfect meter possible for all practical purposes. Nothing can be considered trivial or useless, however apparently insignificant, which in any way contributes to this most desirable result.

General Arrangement of the Meter-Room.—The first important point in connection with the expeditious and satisfactory testing of meters is undoubtedly the general arrangement of the meter-room. This is a matter which is often entirely overlooked or neglected, but, as will be seen from the following remarks, it really forms the basis of a proper method and system. In the first place, we may assume, as a matter of course, that some special room is set apart for the purpose. The dimensions and situation must depend largely upon local circumstances, we allow, yet such a room should in all cases be of ample size, and also specially fitted up for meter testing. For it will generally be found that it is a wise plan to store meters in considerable numbers. Apart from the demand on the stock for meters for new consumers, a considerable demand arises out of the necessity for changing and replacing on the circuit meters which have been found defective from a variety of causes. Special stress is laid upon this point because so many instances may be seen in our central stations in which any hole or corner has been considered good enough for a meter-room. Proper testing, storing, and handling are, under such circumstances, impossible, and it need scarcely be wondered at if those who have the responsibility of handling and testing meters in such places should drop into a careless or indifferent performance of their duty. By all means, therefore, let the meter-room be large, and where possible distinctly divided into two portions—viz., the storeroom and the testing-room. The storeroom should be well provided with shelves, which should be of considerable strength, as the weight to which they are sometimes subjected is very great. The shelves, moreover, should be so arranged as to enable meters to be stored without confusion under the following heads: (1) new meters awaiting testing; (2) meters passed and ready for the circuit; (3) meters brought from circuit and awaiting examination; (4) defective meters.

The storeroom, when possible, should be provided with two doors, one through which the storekeeper can carry the meters without having to enter the test-room, and the second entering direct into the test-room. It is most important that the test-room proper should be kept as private as possible, and the above arrangement answers the purpose admirably. A word here may be added as to the lighting of the storeroom. Very possibly artificial light may have to be resorted to, and in this case it is as well to have plenty of it. The fact of the room being "only a storeroom for meters" is often an excuse for a miserably poor light. Serious errors in the meter books arise from the numbers and sizes of meters being misread, and all precautions should be taken to reduce the chances of error in this direction to a minimum.

We now come to the question of the general arrangement of the room in which the actual testing is to be done. This room requires describing at some length. The room should be lofty, and, where possible, situated on the ground floor, the effects of vibration being felt there less than on floors above the ground level. It is of primary importance that the circuits, apparatus, and general arrangement of the room are such as to allow of expeditious and accurate testing being carried out. At the present day most central stations are connecting installations to their supply mains at a very rapid rate, and it often happens that the calls on the meter department are very heavy for short periods. At such times as these a well arranged and equipped test-room is seen to advantage, for with proper conveniences it is surprising how much time and expense may be saved, in addition to securing reliable tests. Here, again, a good light is more than ever essential, both as regards daylight and artificial light. A badly-lighted test-room ought not to exist anywhere. The artificial lighting should be so arranged as to give a good general illumination. Ordinary flexible pendants, suspended from the ceiling, the lamps being fitted with white opal shades, prove to be the most satisfactory. Extra counterweight pendants should be fixed where particularly good lights may be required; in positions, for instance, where there are instruments having finely-divided scales, and where fine readings have to be taken. The eyes, however, should be protected from any glare, and frosted lamps will be found to subserve that purpose. A further very useful arrangement—in fact, an indispensable one—is to have wall plugs fixed at different points in the room, from which portable lamps may be taken. These will often be required for examining meters when connected for testing, etc., or for the examination of defective meters. The room should be fitted with heating

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apparatus, preferably hot-water pipes or electric radiators, and the temperature as far as practicable kept constant at an average of from 15deg. to 17deg. C. The room must also be made as fireproof as possible, as it is often necessary to leave current on the meters during the night, when no one is in attendance. Too much

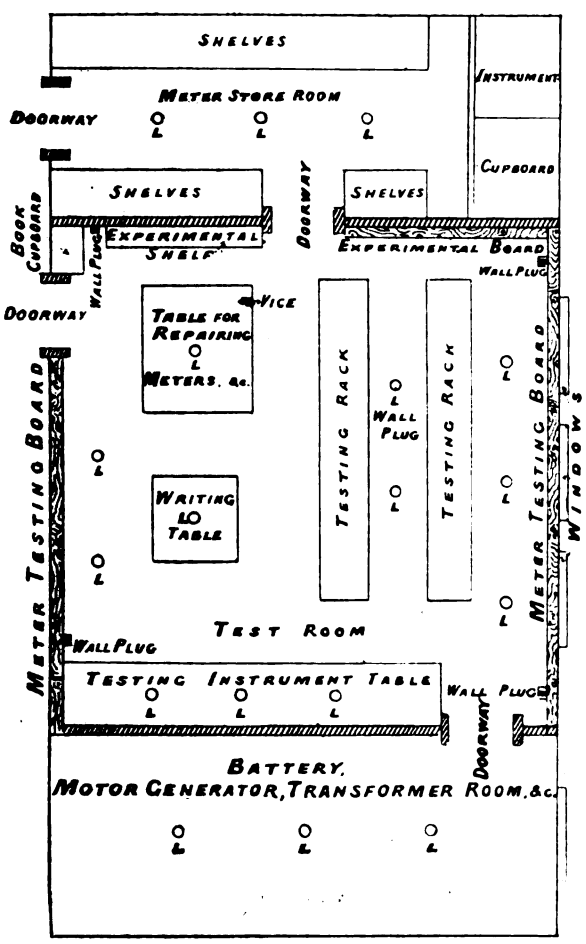

FIG. 1.

importance cannot be attached to this point. Wood should be excluded wherever possible, and special attention must be given to the positions chosen for fixing resistances and other apparatus which are liable to become heated by the passage of the current. Where, however, resistances cannot be fixed except on woodwork, they should always be provided with good slate bases, or screwed on to stout asbestos sheet. The resistance frames, moreover, should be secured to the woodwork only at the corners, thus keeping by means of packing the body of the resistance some inches away from the woodwork.

Arrangement of Tables, etc., for Testing.—With regard to the arrangement of tables and testing racks, it will generally be found sufficient to make provision for four testing circuits, as more than these are seldom required. With this number both ampere-hour and watt-hour meters can be dealt with conveniently. A word or two here may not be out of place as to what is meant exactly by the term "testing circuit" as used above. In all cases of testing meters, excepting that, of course, in which only a single meter is concerned, it becomes absolutely necessary that they should be connected up in series with one another. For the present both ampere-hour and watt-hour meters may be considered as dealt with in this manner, as far as the arrangement of testing tables is concerned. The question then becomes, what is the best arrangement for readily and expeditiously connecting meters in series, at the same time arranging them in as compact a space as possible, consistent with proper convenience for watching the several points which require attention. In some types of meter it will be found most convenient to stand them on a series of special shelves, whereas in others the maximum of advantage is secured by having them temporarily fixed to boards on a vertical wall. Provision must therefore be made for both these classes of meters. If, therefore, two circuits are allowed for each class, we shall have an arrangement which will satisfactorily answer all ordinary conditions of testing. A separate circuit may, however, be included in the test-room for the purposes of experimental work. We will now turn to consider simply the space occupied by the meters under test, exclusive of all instruments, switches, etc. Assuming the shape and relative positions of the storeroom and test-room to be as in Fig. 1, a useful arrangement of testing circuits is as follows:

The arrangements set forth in Fig. 1 apply only where the meter-room is of the particular shape as shown. It will of course be readily seen that the general arrangements of shelves, tables, etc., must depend upon what the room itself is like, but the arrangements given in the figure will be suggestive of what is generally required for the purpose of meter-testing. Turning to Fig. 1, it will be seen that entry is made into the test-room by means of the door shown at the top left-hand corner. As far as possible the door must be kept closed, and in no case must it be used by the storekeeper. All new meters should be taken into the storeroom through the door shown leading into it direct from the passage. On the same side as the test-room door, and extending the whole length of the room, must be fixed a deal board, some 1ft. 3in. broad and 1½in. thick. The height from the floor to the top of this board should be about 4ft. 3in. To this board the meters are screwed for testing, and some 4in. above it another and a narrower one must be fixed, having two grooves cut in it parallel with one another. In these grooves two wires are run along the whole length of the room, having at intervals of 2ft. terminals connected to them, from which are taken the connections leading to the "shunts" of the different meters. Further particulars will be given relating to these terminals in a later section. Continuing round the room in the same direction, we come to the second side. Here a good substantial table must be provided projecting about 1ft. 9in. from the wall, and some

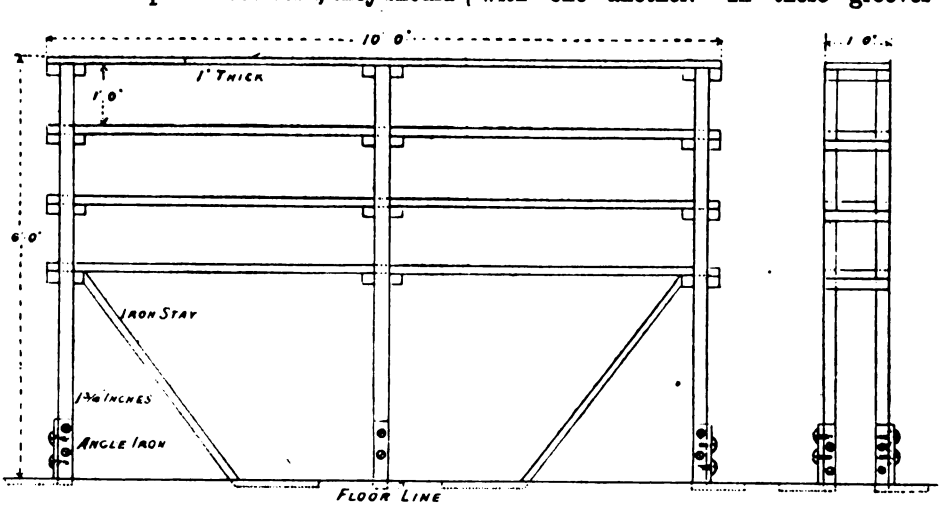

FIG. 2.—Meter-Testing Rack.

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3ft. 3in. high from the floor, and extending the entire length of the room, with the exception of the space required for a door (as shown in the figure) leading into the room set aside for batteries, motor-generator, or transformers. If a small room is not available for this purpose, a portion of the test-room itself must be boarded off. It need not, however, be of any very large size, and in many stations no necessity for a separate room arises, as special plant is not put down for meter-testing purposes. The table previously referred to is for the fixing of the testing instruments, such as balances, dynamometers, etc. The wall above the table is used for fixing all switch gear, fuses, voltmeters, ammeters, etc. The third side of the room should be simply a counterpart of the first. The fourth side, in the centre of which is the door leading into the storeroom, should be set aside for experimental work, and for the testing of meters on which special or extended tests are to be carried out. On the right-hand side of the door should be similar arrangements to those on sides one and three, and on the left-hand side a shelf as on side two. This leaves us with the centre of the room to deal with. The right-hand half of the room should be provided with special meter-testing racks, which consist of a number of shelves fixed one above the other 1ft. apart. Four tiers of shelves are in most cases ample, the top tier some 6ft. and the bottom one 3ft. from the floor. It is of the utmost importance these racks are securely bolted to the floor to avoid all risk of a collapse. Laden with a full complement of meters, a collapse would be most disastrous. It will, therefore, be necessary to take all precautions against a mishap of this kind. Fig. 2 shows clearly the general arrangement of one of these racks. It is secured to the floor by means of stout angle iron screwed securely to the upright supports and to the floor. The angle iron should be let into the floor to prevent any stumbling over it. It may be found necessary to further secure these racks by staying them from the top on to the walls of the room. A four-tier rack, 10ft. long, will easily accommodate some 40 to 60 average size meters at one time. Two of these meter-testing racks should be provided.

Referring again to Fig. 1, it will be seen that a table is fixed on the left-hand side of the meter-room and near the door. This table is used for the overhauling of meters, filling with mercury, and work of this nature. It should not be too high from the floor, and must be fitted with a good vice, and provided with drawers for the reception of all necessary tools, etc. A second and smaller table is fixed near the instrument table, and also fitted with drawers. This will be found very useful for working out meter tests, and entering the meter and general books belonging to the department. If the heating apparatus consists of hot-water pipes, these should be run along the sides of the room; or if by electric radiators, they should be fixed as much as possible out of the way, and where the flexible wires supplying them with current are least likely to get damaged. All possible steps must be taken to ensure good ventilation, at the same time, of course, carefully avoiding draughts. Apart from the unpleasantness caused by draughts to the meter-room staff, some of the instruments often used are liable to be affected. A cupboard set aside for the departmental books is absolutely essential, and if there is room for another it would be found most useful for a variety of purposes. A suitable number of chairs and stools complete the general equipment of the meter-room. All matters relating to connections, terminals, instruments, etc., are left for a subsequent section. The concluding piece of advice is not on any account to cramp the test-room. This, unfortunately, happens only too often, with the result that endless trouble arises from short-circuits, instruments and meters getting upset, and unreliable tests.

(To be continued.)

ACCUMULATOR-REGULATING DEVICES.

THE HEATH AND FIELD SYSTEM.

The question of the best arrangement of contacts and connecting bars for accumulator regulation has been often discussed, and many firms have now settled on standard designs. The large number of regulating cells required, especially where high-voltage lamps are used, necessitates a large amount of cable to make the connections from the individual cells. Certain of our consulting engineers have endeavoured to reduce the cost of these cables by placing the regulator itself in an acid-proof case in the accumulator-room, and then working it from the main switchboard by mechanical gear. The chief difficulty in this case is due to back-lash in the mechanical gear, which renders it almost

FIG. 1A.—Front View of the Heath and Field Accumulator Regulator.

impossible to leave the contact bars always fairly on the contact pieces. If this is not done, heating ensues. By this system only two conductors are required from the regulator to the main switchboard.

Messrs. L. W. Heath and J. W. Field have worked out another method of reducing the cost of the copper connections which is preferable to the above. It could also be used in conjunction with a mechanical transmission if the distance from the accumulator-room to the switchboard is great, and then would save a large proportion of the local connections to batteries. The principle of the

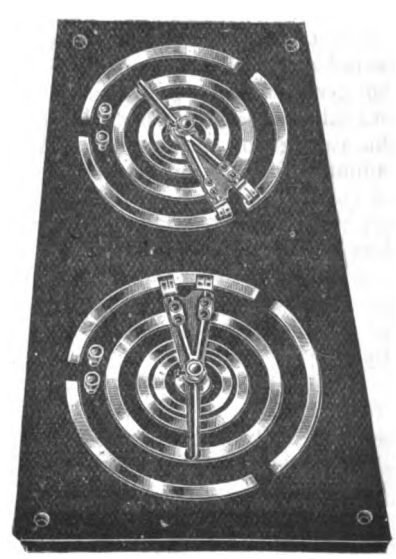

FIG. 1B.—Back View.

apparatus consists in the use of one group of a few cells for small adjustments in voltage, and a number of other groups of cells each containing the same number for large alterations. The change, however, can never be made by greater steps than two volts. The actual mechanical design of the switch is shown by Figs. 1A and 1B, but the diagrammatic illustrations which follow show more clearly how it works. These are a design for 20 regulating cells. The apparatus consists of two sets of contacts on the two faces of the slate (Fig. 1), being an ordinary type of battery switch with four contacts only. This is placed on the front of the slate, while at the back there is fixed a battery switch (Fig. 3) which has five

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contacts. This switch has a double arm, carrying two contact brushes, x and y. The spindle of first switch is geared with that of the second by a pinion and spur wheel (Fig. 4), so that one complete revolution of the first corresponds to a motion of the second over one segment of its face. The small roller, M, running on a dummy bearing ring, relieves the spindle of the regulator from any undue bending moment produced by the pressure of the brushes on the contacts.

The progressive action of the arrangement when reducing the number of cells in circuit can be seen in Figs. 4, 5, and 6, in which the double contact arms on the under switch gear are replaced by sliders, also marked x and y. From these it will be seen that as the connections are changed from one group to the next, the three regulation cells are placed in series with the incoming terminal cell of

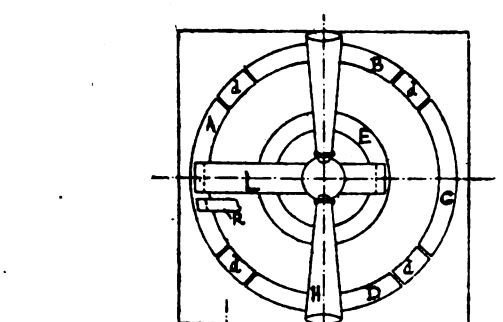

FIG. 1.

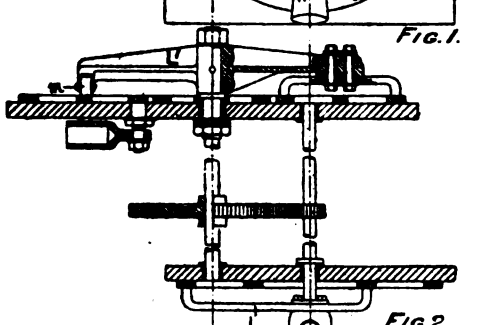

FIG. 2.

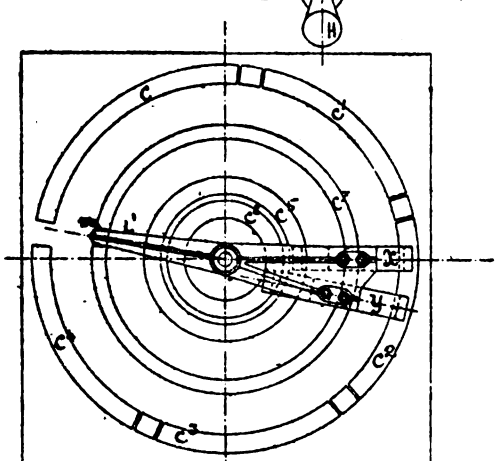

FIG. 3.

the battery. The next three steps cut these three regulating cells out, and then the contact with the main battery is again slipped back four cells. The arrows in the figures represent the simultaneous movement of the two arms of the regulator.

In the case chosen for illustration, the regulator, with nine contacts in all (counting back and front faces), will give $5 \times 4 = 20$ different pressures on the circuit it regulates, and its action is adjusted by means of the double "stepping-over" arrangement of the back brushes, to be free from all discontinuity of main current during action; further, it will be seen that while either of the back brushes is changing contacts it carries no current, so that the back movement, which is comparatively slow, is never subject to any sparking whatever. The arm on the front face, when bridging the gap between consecutive segments, is provided with a low resistance in the usual way. With this device the number of cables required to be run to the battery-house from the switchboard will, in general, be considerably less than half the number necessary with an ordinary form of switch. Thus 20 steps require only nine cables, while 36 steps would require 13. The consequent saving in the expense of cables can, in ordinary conditions, easily exceed £100, as shown in the case now taken of a 36-way switch, to carry up to 300 amperes.

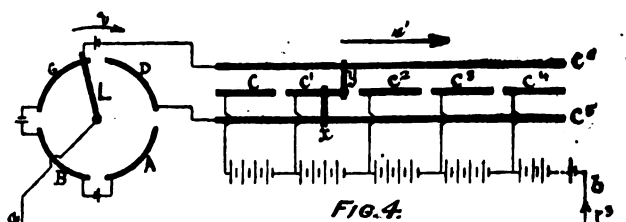

FIG. 4.

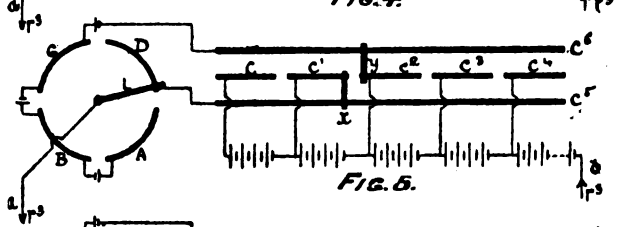

FIG. 5.

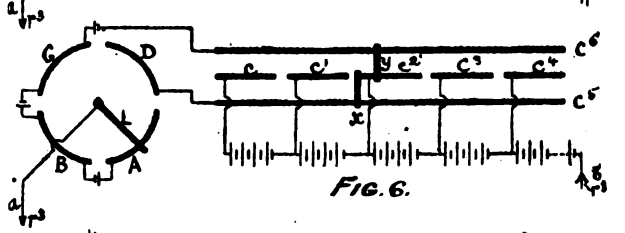

FIG. 6.

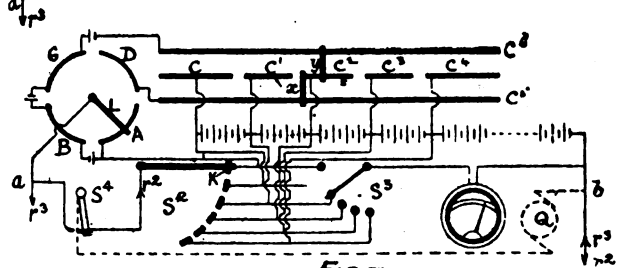

FIG. 7.

This with the ordinary type of switch requires 36 cables, as against 13. Therefore a saving of 23 cables to carry, say, 300 amperes is effected. These should be $^{37}/_{12}$ of, say, an average length of 20 yards. This gives a net saving of £125 in the cost of the cable, or about £150 including the saving on the fixing of the cables, etc. A segment dial, painted with a number representing the actual cells in circuit, or the pressure given by them, indicates the position of the switch with reference to its range at any time, this range, in the case of the instrument shown above, being five revolutions of the handle of the front face.

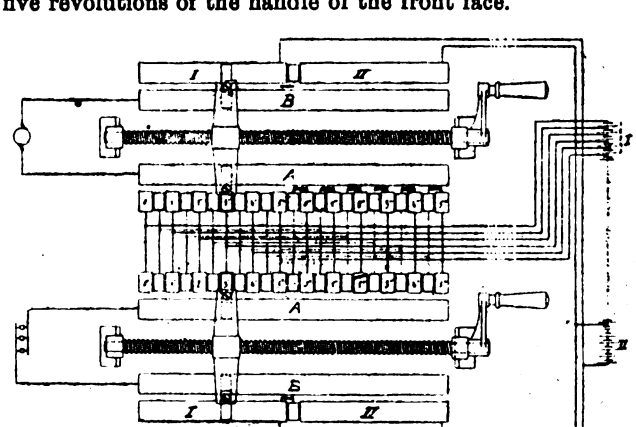

FIG. 8.—Diagram of Connections of the Erlacher-Besso Accumulator Regulator.

The chief advantages attending the use of this apparatus are: (1) less than half the ordinary number of cables is required, which cables often run into a large figure; (2) small amount of switchboard space occupied, a matter of importance in many central stations; (3) the battery is kept more uniformly charged than with the usual regulators.

In the case of quite a small regulator, recently supplied, we are informed that the saving effected in the cost of the connecting cables was £80. Messrs. Verity, Limited, are

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at present manufacturing and supplying the apparatus for the patentees.

To show how closely working in the same direction can go without collaboration, we print herewith a diagram (Fig. 8) of an accumulator switch invented by Messrs. G. J. Erlacher and M. A. Besso, of Winterthur. From this it will be seen that these gentlemen have developed a very similar switch to that described above. We do not, however, think their arrangements so good as those of Messrs. Heath and Field.

NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

[*Copyright.*]

CXXXV.

No "cut-and-dried" method—neither that of constant current, of constant potential, or of constant power—can be recommended generally for charging secondary cells. The best system will be a complex one adapted to suit given conditions; it will vary with every type of cell. With stationary batteries there is seldom any difficulty; the main points to be regarded are simplicity and convenience, economy of power, and due care not to discharge before the completion of charge, and to be well within the limits of safe current density. It is in the case of traction batteries, and where economy of time is specially necessary, that skilled investigation and superintendence, to devise and carry into effect a special system, become of importance. The system that might be eminently satisfactory with one type of cell might be ruinous to another. No attention need be paid to maximum rates of charge as heretofore specified by makers, for these are based upon the assumption that charging is to be effected under constant current; and whilst they may be greatly exceeded with perfect safety during the initial period of charging, they may in the final period be decidedly detrimental to the life of the battery. The charging should be divided into several stages, according to the rise of the counter E.M.F. (e); and the maximum safe current density for each of these periods should be cautiously approached. These safe current densities will vary very considerably with different types of cell. With these data obtained, the time occupied in charging will vary according to the capacity per square inch of peroxide surface: if the time requires to be further diminished, this specific capacity must be diminished—*i.e.*, the area of active surface must be increased. The new system may be defined as that of charging by a series of constant currents, each being less than the preceding one; the power rising in each stage, but diminishing from stage to stage; the rise of P.D. being less than in the system of charging under constant current (Fig. 1); and the fall of current being less than in charging under constant potential (Fig. 2). The rise of P.D. and the increased evolution of gases are signs that the charging should be slackened and a new stage entered upon.

CXXXVI.

The hydrometer—as was specially insisted upon by Mr. Preece 12 years ago—may give valuable information as to the condition of a cell in regard to charge. The ordinary hydrometer, however, is useless for the purpose now in view; the instrument adapted for accumulator tests should have its range limited by the maximum and minimum specific gravities to be measured, it should have a very open scale, and the readings—water being taken as 1,000deg.—should be readily and accurately observable. It is not sufficient to be able to note roughly a rise or fall of 10 of these degrees; we require, if possible, to note a difference of 1deg. An instrument of this delicacy has not, I think, yet been devised; and the instruments in ordinary use can give only very rough indications.

Let Sp. G. = the density of the electrolyte in a given accumulator when fully charged;
sp. g. = the initial density of the acid before charging;
and δ = the number of degrees rise in density after charging for one hour;

then the total time requisite to effect the charge will be

$$T = \frac{\text{Sp. G.} - \text{sp. g.}}{\delta} \text{ hours.}$$

The remaining time requisite will, of course, be $t = T - 1$ hours, if the rise in density is from sp. g. to sp. $g + \delta$. But if the density of the acid prior to the determination of δ be other than (sp. g.)—viz., *sp. g.*—then the remaining time requisite to complete the charge will be

$$t = \frac{\text{Sp. G.} - \textit{sp. g.}}{\delta} \text{ hours.}$$

or, allowing for the charge which may be needed to determine δ, the remaining time required is $t - 1$ hours.

Example 1: *Problem.*—The initial sp. g. of the electrolyte being 1,170, an accumulator is charged with a certain current for one hour, after which the density has become 1,175. It is known that the acid "turns milky," or that the accumulator is fully charged, when the sp. g. has reached 1,210. What is the total time required to fully charge the cell after complete discharge?

$$T = \frac{1,210 - 1,170}{5} = 8 \text{ hours.} \qquad (\textit{Ans.})$$

Example 2: *Problem.*—The sp. g. of the same electrolyte in the same accumulator, after it has been partly charged or discharged, is found by the hydrometer to be 1,180. An hour's charge, with the same current as before, brings up the density to 1,185. What time would be required with this current to charge the cell if it were completely discharged, and what time is now required to complete the charge of the battery?

The time for the total charge is T, as given above. The time required to complete the charge, *sp. g.* being 1,180, is

$$t = \frac{1,210 - 1,180}{5} = 6 \text{ hours} \qquad (\textit{Ans.})$$

Or, allowing for the rise of 5deg. in the density during the one hour's charge which may be necessary to determine this value of δ, the remaining time requisite to complete the charge is

$$t - 1 = \frac{1,210 - 1,185}{5} = 5 \text{ hours.}$$

Example 3: *Problem.*—Applying the formula to the cell referred to under Section CXXVII., where the initial and final percentages of H_2SO_4 in the electrolyte are $N = 35$ and $n = 20$, what would be the time of charging with a current producing in one hour a rise in density of 15deg.?

The specific gravities corresponding to the given percentages of mono-hydrated sulphuric acid are 1,263 and 1,144.

And $$T = \frac{1,263 - 1,144}{15} = 8 \text{ hours.} \qquad (\textit{Ans.})$$

But if the weight of electrolyte be duly proportioned to the capacity of the cell, according to the formula given under Section CVI.—viz.,

$$W = A + Aq + aq + \frac{Aq + aq}{\frac{100\ A}{n} - (A + Aq)} \times A + Aq,$$

there is no necessity to charge during one hour in order to obtain the value δ; the percentage of the total charge which has been expended, or the residual charge contained in the accumulator, can be calculated directly from a single hydrometer measurement.

Thus, with any fixed values for the initial and final specific gravities of the electrolyte,

(Sp. G. – sp. g.) $k = 100$ per cent. of the total charge

(the constant $k = \frac{100}{\text{Sp. G.} - \text{sp. g.}}$ in any given case).

Let *sp. g.* be the density of the electrolyte at any time, as determined by the hydrometer.

Then the percentage of the total charge expended, deficient, or to be supplied is

$$(\text{Sp. G.} - \textit{sp. g}) \, k.$$

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Or the residual percentage of the total charge in the accumulator is

$$100 - (\text{Sp. G.} - sp.\ g.)\ k.$$

Example 4: *Problem.*—The density (*sp. g.*) of the electrolyte, in the case of the cell mentioned in the last problem, is found by the hydrometer to be 1,204. What percentage of the total charge is deficient?

$$\text{In this case } k = \frac{100}{1{,}263 - 1{,}144} = \cdot 84 \text{ (nearly).}$$

$$\text{And} \quad (1{,}263 - 1{,}204) \times \cdot 84 = 50 \text{ per cent.} \quad (Ans.)$$

Example 5: *Problem.*—In the same accumulator, the density (*sp. g.*) of the acid is found to be 1,234. What is the residual charge as a percentage of the total charge?

$$100 - \overline{(1{,}263 - 1{,}234)}\ k = 75 \text{ per cent. (nearly).} \quad (Ans.)$$

LII. (*bis*).

The following corrected and extended list of values corresponding to the watt-hour and to the kilocalorie is substituted for the tables given under Sections XXXII. and LII.:

1 watt-hour (·5263 ampere for one hour under mean E.M.F. of 1·9 volt) =
- 36,000 meg-ergs.
- 3,600 joules.
- 367 kilogrammetres.*
- 2,655 foot-pounds.*
- 1·1852 foot-ton*.
- 857 gramme-Centigrade calories.
- ·857 kilocalories.
- ·001335 horse-power hour.
- The watt-hour is generally taken as $\frac{1}{746}$ = ·00134 horse-power hour.

1 kilocalorie (the heat that will raise 1 kilogramme of water from 4deg. to 5deg. C.
- 1·16 watt-hour.
- 42,000 meg-ergs.
- 4,200 joules.
- 428 kilogrammetres.*
- 3,097 foot-pounds.*
- 1·3826 foot-tons.*
- ·001557 horse-power hour.*
- 3·96 British units of heat (1lb. of water raised 1deg. F.).

HIGH-SPEED ENGINES.

At the ordinary meeting of the Institution of Civil Engineers on Tuesday, the 10th inst., Mr. W. H. Preece, C.B., F.R.S., the president, in the chair, the paper read was on "High-Speed Engines," by Mr. J. H. Dales, A.I.C.E.

In applying provisions for eliminating knock in double-acting engines, the author had found that the ordinary rates of rotation could, with practical immunity from overheating, and an absolute freedom from seizure of bearings, be exceeded to the extent of 30 per cent. to 50 per cent. This had been effected by providing a close-up, and at the same time expansible, adjustment of bearing brasses, and so reducing the production of heat to only that caused by the rotation of a shaft as distinguished from the usual cause of seizure—namely, the expansive force of the metal of both journal and brasses.

At moderate rates of rotation, say 300 revolutions per minute, an audible knock took place with a $\frac{1}{100}$in. clearance in the bearings of double-acting engines, and a rise of temperature of 20deg. or 30deg. F., which almost always took place in practice, would expand the bearings more than that amount of clearance, and therefore an engine, if fitted with fixed brasses, was always liable, with little or no warning, to become overheated, and to seize in its bearings. The provisions which were made for avoiding the usual consequences of heating were very simple, and consisted of a small ram of the hydraulic-pressure type, which was made to bear on the adjustable brass of a bearing. On the alternative stroke of an engine, when the working pressure was not on the adjustable brass, the ram was forced through its packing by a spring of sufficient strength to overcome the friction and the inertia of the ram and parts, and in such manner placed the adjustable brass close on its journal. This action caused a slight clearance in the ram cylinder, which was instantly filled by liquid from a reservoir which entered by a back-pressure valve. The shock of the working stroke of the engine acting upon the liquid inside the ram cylinder instantly shut the back-pressure valve and confined the liquid as a packing at the back of the ram, and so maintained the adjustment of the brass which had been made by the spring. Similar fittings were provided on all the reciprocating bearings of an engine which were usually subject to knock.

It had been found that all surfaces of close-up bearings which were not continuous had to be lubricated separately, as there was not sufficient oil left from the first to supply a second after part had been lost in the joint space. White metal had been found practically necessary at very high rates of rotation, and the risks of its melting out had been guarded against by such a backing of other metal as would not allow of sufficient clearance occurring in such an event as would cause the pistons to knock in the cylinder ends.

The value of close governing had been very much underrated, and economies had been sought in reducing the coal bill by various expensive expedients in other ways than by increasing the output and quality of work, as it could be done by good governing. It could be shown that by running to within 1 or 1½ per cent. total variation in the speed of an engine, an increase over ordinary results in the quantity of work could be produced which in many cases amounted in value to more than the whole of the coal bill. The possibilities of close governing by the various types of governor in common use had been investigated, and it had been found that dead-weight loaded governors of the ordinary type, even when compensated for change of position, could not be moved by any less variation of speed than about 2 per cent. from the normal, or a total variation of 4 per cent., taking no account of any work to be performed in the way of moving throttle or expansion apparatus. Spring-load governors with angular arms pivoted, as in the former case, on plain pins, could be moved with a variation of 1½ per cent. from the normal, or a total of 3 per cent., taking no account of the performance of any governing functions. Spring-load governors, fitted in all joints with ball bearings and designed with small relative inertia and high speed, had been made to work auxiliary apparatus with as little variation of speed as 1½ per cent. total, and had governed engines within those limits.

Perfect governing could be obtained when (1) the direction of the strains of centrifugal force were not diverted; (2) such strains were directly radial; (3) the friction and inertia of the centrifugal generating parts were reduced to a minimum; (4) the mechanical relations of the governing parts were constant; (5) the inertia of the centrifugal generating parts, whilst very small relatively to the centrifugal forces, were as far as possible in excess of the driven parts of the governing apparatus. These points were embodied in a flywheel governor dealt with, in which the load springs were arranged radially, as also were the spring boxes and guides belonging thereto, so that the centrifugal forces caused no cross strains. The springs formed a large part of the centrifugal weights, and had a peculiar effect upon themselves, which was illustrated by a diagram. The motion of the governor in performing its functions was transmitted to the expansion eccentric by means of a spur wheel mounted on a sleeve which was solid with the eccentric, and was actuated by means of rack teeth formed in the spring-box slides, giving a practically constant mechanical effect in the action between the governor and the expansion eccentric. The inertia of the governor was in excess of the driven parts as about 3 to 1, while the centrifugal weights were about 2 per cent. of the total spring load. The total average centrifugal force of the governor was about 3,000lb, and the only cross strains on the spring-box slides were those brought about by driving the cut-off eccentric, and those strains were relatively very small, as the cut-off valve was worked by a rocking shaft and twisting spindle in order to avoid the friction of a pulling spindle and the effects of the steam pressure on the same. The arrangement could be adjusted so as to govern an engine to 1 per cent. total variation throughout

* g being taken as 981 C.G.S. units (32·185ft. per sec.).

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the whole steam range of the expansion gear, which was about $\frac{5}{8}$ cut-off from zero, and without racing. The expansion motion was reversible with the same set of parts.

In regard to the possibilities of fine governing, the principles of a cut-off governor were much more favourable than those of a throttle governor in any engine having any cut-off and a reciprocating action. The cut-off admitted of no accumulation of pressure during the closed time of the working stroke, as in the case of a throttle governor, and, therefore, no action of a governor working a cut-off was required stroke by stroke, as in the case of any attempt at fine governing by a throttle. In the case of the cut-off, a simple change of position of the governor was alone needed to alter the steam supply; while in the case of the throttle, not only was a change of position necessary, but a constant approximate cut-off action which had to be produced by a constant fluctuation of the speed of the engine, and which defeats the very effect of regular running which it is desired to produce. A throttle would be perfectly suitable to govern a true rotary engine, that was, one of constant torque, but its principles were opposed to perfect governing of any engine having any cut-off.

The adjustment provisions dealt with increased the power value of an engine and its steam economies, and rendered it more reliable than ordinary fixed bearings at low speeds, while dead close governing increased the quantity and quality of work produced often to an extent of equal value to the whole of the coal bill. High power in small engines effected a saving in first cost, attention, maintenance, space, and buildings; and high speed in the case of electric lighting considerably reduced the ordinary cost of dynamos. Also, under full load, strain economies could be had in small engines equal to those which were obtained from large engines, despite the fact that the clearances of small engines were necessarily greater proportionately than those of large or, rather, long-stroke engines. This was accounted for by the relatively small cylinder losses in engines running at a high rate of reciprocation.

INSTITUTION OF ELECTRICAL ENGINEERS.

Telegraphy by Magnetic Induction.

BY S. EVERSHED, ASSOCIATE.

Although many practical trials of telegraphy by means of the mutual induction between two distant circuits have been made during the past 10 years, this form of wireless telegraphy has of late been rather overshadowed by the more brilliant possibilities of telegraphy by means of Hertzian waves of high frequency, and the low-frequency electromagnetic system has hardly received the attention it deserves. It is probably not capable of such general application as Hertzian telegraphy, but it has a distinct advantage in employing electromagnetic waves of low frequency, the laws of which are simple and well understood, and the necessary apparatus for transmitting and receiving will not be too remote in type from dynamos and motors to enable us to readily understand the principles on which their design and working should be based. Moreover, with one limitation, to which reference will afterwards be made, our knowledge of the laws of magnetic induction is sufficient to enable us to determine precisely what conditions are requisite for communication with a place at any distance.

The author's attention was directed to the subject some years ago in connection with communication between light-vessels and the shore, and his magnetic induction telegraph was, as is pretty generally known, tried between the North Sand Head light-vessel and Dumpton Gap, and proved a total failure, owing to the almost complete absorption of the electromagnetic waves by the media through which they were required to pass. During the time these trials were in preparation, exhaustive experiments were carried out at Woodfield Works by the author, in conjunction with Mr. Oswald Cox, and the main principles of telegraphy by magnetic induction were investigated, and one or two fundamental formulæ worked out. It will not be inappropriate at the present time, when wireless telegraphy is coming into prominence, to put the conditions then arrived at before the members of the Institution as briefly as possible.

When we desire to convey energy through space from one place to another by electromagnetic waves, we must provide a primary circuit at one place to emit the induction waves, and a secondary circuit at the other place to receive them. Every time a current is varied in any way in the primary a certain fraction of the energy linked with this circuit will appear in the secondary, to run down there into heat (as $C^2 R$), unless there is a motor or other translational device included in the secondary. By maintaining an alternate current in the primary a continuous supply of energy is available in the secondary, and a suitable indicator in the secondary—that is to say, a motor adapted to convert part of the received electrical energy into energy of motion, either visible or audible—will enable the receipt of the energy to be detected. Break up the primary current into dots and dashes and you have a working telegraph.

Of course, there are other means of indication which are not in any ordinary sense motors. For example, electrolytic effects may give a direct indication of the secondary current, or a coherer may be used to give indirect indication by closing a local circuit. But the principles underlying the application of magnetic induction to wireless telegraphy will be better understood if we assume the indicating device to convert some part of the received energy into motion. It may be motion only capable of bringing two contacts together to close a local circuit, or capable of making audible sound waves in the air, or it may be directly visible; but, in any case, something is made to move; and the moving body being, presumably, attached to some support, either by pivots or an elastic suspension, cannot be moved without the expenditure of energy to overcome the mechanical friction of the pivots or the molecular friction of the suspension. If sound waves are set up there is a further expenditure of energy.

The secondary current being of course an alternating one, it is probable that the motion imparted to the indicating device will be oscillatory also. The ordinary Bell telephone will occur to everyone as typical of such an indicating device. The friction—resistance to motion—may follow any law with regard to velocity, it may even be constant (independent of velocity), but in every case examined by the author the frictional resistance has proved to be simply proportional to the velocity—at all events at such frequencies as are likely to be used in practice. In what follows it will be assumed that when moving with velocity, v, the moving body requires a force equal to $r\,v$ to overcome friction, r being a constant for any particular moving system. Calling the amplitude of oscillation a, and if $p = 2\,\pi\,F$, the mean power required to oscillate the moving part will be $= \frac{1}{2}\,r\,a^2\,p^2$, and at its maximum value the power spent in overcoming friction will be $r\,a^2\,p^2$; the oscillation being a simple sine function. Having got an indicator, the first step towards its application to an induction telegraph must be to determine the value of the coefficient r, and to decide upon a value for the amplitude a which will give indications of the necessary magnitude. These two data will enable primary and secondary circuits to be designed to give the required secondary power with any given primary power.

The Inductive Circuits.

There are two practicable ways of building such circuits. The first consists of running a pole line of sufficient length at each end of, and at right angles to, the imaginary line joining the two points between which communication is to be established. Each pole line being earthed at both ends, the circuits complete themselves through the earth and form two circuits in parallel vertical planes. This is the system devised by Mr. W. H. Preece. It was in practical use long before any other system of wireless telegraphy was heard of, and, indeed, it is very largely due to Mr. Preece's early and continuous work in this connection that we have any wireless telegraphy to discuss to-day. The efficiency of this system, taking cost of materials as a measure of efficiency, depends on the average depth at which the current travels in returning through the earth

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from one earth pole to the other. Many experiments have been made by the Post Office authorities to determine the mean depth of the return path, but the author understands that the results do not indicate any definite law governing the relation between length of pole line and depth of return. In these circumstances it becomes impossible to accurately forecast what any proposed pair of lines will do. Moreover, leakage from one circuit to the other complicates matters.

The other method of forming the primary and secondary circuits consists in running a pole line completely round the boundary of a sufficient area of ground at each station. This in effect turns Mr. Preece's two vertical circuits into two horizontal circuits, and there is the immediate loss of one-half the mutual induction between them—an effect only compensated for if the area of the horizontal circuits can be increased. If the areas of the primary and secondary circuits are A_p and A_s respectively, and the distance between them is D (D being large compared with the diameters of the circuits), then the total induction threading the secondary,

$$B = \frac{2 A_p A_s C}{D^3} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

when the circuits are in parallel planes normal to the line joining their centres; while in the case of the two circuits lying in the same plane

$$B = \frac{A_p A_s C}{D^3} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Another point to bear in mind when comparing the vertical and horizontal systems is that in the former a pole line is only used over half the whole length of circuit, the remainder being made up by the earth return. In the latter the pole line extends right round the circuit, and is on that account likely to prove more costly.

However, horizontal circuits possess compensating advantages which may easily outweigh their drawbacks, and in the following formulæ for determining the volume of copper in the lines, areas of circuits, and primary power required for signalling over any given distance, the circuits are supposed to be laid in a horizontal plane.

The expressions given in (1) and (2) show that circular circuits will give the maximum effect for a given length of pole line. But this is an ideal form which could hardly be contemplated in practice, and it will therefore be assumed that each circuit forms the boundary of a square area. Since each circuit will have to serve for both transmitting and receiving, it is clear that they must, if possible, be identical in size and shape.

Let

V_p, N_p, R_p be the total volume of wire, number of turns, and resistance of the primary circuit.

V_s, N_s, R_s the corresponding values for the secondary circuit.

a sectional area of line wire.

ρ specific resistance of line wire.

s length of side of square circuit.

D distance from centre of primary to centre of secondary.

C_p value of primary current.

W_p value of power spent in primary.

W_s total electrical power in secondary.

B total magnetic induction threading secondary.

E_s impressed E.M.F. in secondary.

C_s current in secondary.

M mechanical power of indicator or motor in secondary.

All the cyclic quantities are assumed to be simple sine functions, and the letters denoting them stand for their maximum (crest of wave) values.

The whole of the power required in the primary circuit is assumed to be that wasted in heating the wires. To be strictly accurate, the power radiated into space, of which a minute fraction appears in the secondary, should be added; but at the low frequencies suitable for working the whole radiated power is very small compared with $C^2_p R_p$.

To get the greatest possible conversion into mechanical energy in the secondary, E_s must be in step with C_s, and the condition for maximum activity of a motor must be fulfilled. As is well known, this condition requires the back E.M.F. of the motor to be equal to one-half the impressed E.M.F. The highest possible value for the mechanical power of the secondary indicator is, therefore,

$$M = \tfrac{1}{2} E_s C_s.$$

But $$C_s = \frac{E_s}{2 R_s}\ ;\ \text{so that } M = \frac{E^2}{4 R_s}.$$

Now $$E_s = p B = \frac{p s^4 N_s N_p C_p}{D^3}\ ;\ \text{and since } C_p = \sqrt{\frac{W_p}{R_p}}$$

$$R_p = \frac{4 \rho s N_p}{a},\ \text{and } a = \frac{V_p}{4 s N_p},\ \text{we have:}$$

$$E_s^2 = \frac{p^2 s^6 N_s^2 W_p V_p}{16 D^6 \rho} \quad . \quad . \quad . \quad (3)$$

also $$R_s = \frac{16 \rho s^3 N_s^2}{V_s}\ ;$$

so that, finally,

$$M = \frac{E_s^2}{4 R_s} = \frac{p^2 s^4 W_p V_p V_s}{16^2 D^6 \rho^2} \quad . \quad . \quad . \quad (4)$$

Here we have an expression for the power turned into audible, visible, or in any other way discoverable motion by an indicator considered as a motor—a motor which is only required to overcome its own mechanical friction, and working under the ideal conditions of maximum activity, negligible electrical resistance and self-inductance, E.M.F. and current in step, and, lastly, *absence of any medium which can absorb* or distort the magnetic waves on their road between the two circuits.

As might have been anticipated, the mechanical power does not depend in any way on the number of turns of wire into which V_p and V_s may be divided. The number of turns in primary and secondary will depend only on the E.M.F. of primary generator, and E.M.F. for which the motor is designed; these are questions entirely distinct from the mechanical work to be done, just as the bearing friction in an ordinary motor is quite independent of the volts and amperes of the machine. Formula (4) also indicates that the least volume of wire will be used if we make $V_p = V_s$; and in that case, if we put V_t for the total volume of wire used in the construction of the two circuits, (4) becomes

$$M = \frac{p^2 s^4 W_p V_t^2}{32^2 D^6 \rho^2} \quad . \quad . \quad . \quad . \quad (4^a)$$

At this point it will be useful, by working out an example, to give an idea of the mechanical power which can be delivered at a distance of several miles by the expenditure of a reasonable amount of power in the primary circuit, and by means of a practicable weight of wire.

Suppose we put 1,000 kg. (about one ton) of copper wire into circuits 1,000m. square and 10 km. apart. Let the frequency be 100 ⌒⌒, and the mean power spent in the primary circuit be 100 watts. That is to say,

$$p = 628,\ s = 10^5 \text{ cm.},\ W_p = 200 \times 10^7 \text{ ergs per second,}$$

$$V_t = \frac{10^6}{8{\cdot}9} = 1{\cdot}1 \times 10^5 \text{ c.c.},\ \rho = 1{\cdot}7 \times 10^3 \text{ C.G.S. units,}$$

and $D = 10^6$ cm.

If these values are put into (4^a), we get

$$M = 0{\cdot}34 \text{ erg per second.}$$

Now, as will presently appear, it is quite easy to obtain indicating instruments which will work with less than one-third of an erg per second; but it must not be forgotten that the value just given for the mechanical power available is under ideal conditions that can only be approached—never reached.

Transmitting Devices.

It is not necessary to discuss in any detail the apparatus required for producing the alternate or interrupted current in the primary circuit. An interrupted current may be derived from batteries by means of a rotary contact wheel driven by clockwork or by an electromotor. For tele-

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graphing over great distances the primary power must be considerable, and it will probably prove more economical and convenient to have a small alternator driven by an oil or gas engine. No particular difficulty is likely to be met with in designing a compact plant for the purpose.

Receiving Devices.

In every instance, so far as the author is aware, in which communication has been carried on by magnetic induction or by earth leakage, the ordinary Bell telephone has been used as a "sounder." It is well adapted for the purpose, as it enables exceedingly minute currents to be detected. This sensitiveness does not arise so much from the efficiency of the telephone as a current detector as from the marvellous delicacy of the human ear, which is able to distinguish sound waves produced by motions so exceedingly small as to be absolutely invisible, even when magnified many times. In the course of the investigation already referred to the author made careful measurements of the magnetic and electrical quantities involved in the telephone, but up to the present he has been unable to devise adequate means for measuring what fraction of the electrical power supplied is converted into mechanical power. This conversion can be estimated for any given amplitude of the diaphragm from a knowledge of the change in induction threading the coils for different displacements of the diaphragm, obtaining in this way the back E.M.F. But the difficulty remains of determining the amplitude when an alternate current is flowing in the coils.

However, in the case of the telephone it is not essential to know the mechanical power in order to ascertain the conditions for working to a given distance. By measuring the alternate current required to produce readable signals, it is possible to deduce with fair accuracy the distance over which Morse code signals can be sent. The author has measured the current flowing in a Post Office pattern Gower-Bell telephone while receiving Morse signals readable by a skilled operator in a quiet room—"readable" implying that the message could be read without difficulty. Two operators were found to agree very closely in their estimate, and it appeared that the current for readable signalling was nearly twice the minimum current which produced an audible sound. The current was determined by connecting the telephone to a circular ring of wire through which a measured induction was alternating. The resistance and self-induction of the telephone were separately determined, and the whole impedance was sufficiently large to enable the current to be estimated without reference to the back E.M.F. of the vibrating diaphragm. The mean of several observations gave for the maximum (crest of wave) value of the readable current

$$C = \frac{2{\cdot}9}{10^6} \text{ amperes.}$$

A current of one-half the above value makes a just audible sound.

When a telephone of this type is used as receiver on the secondary of an induction telegraph, the only condition to be fulfilled to get the best effect is that the resistance of the secondary circuit should equal that of the telephone. This is only another way of saying that the telephone is a very badly designed motor, with such an enormous combined resistance and inductive drop that the current is quite independent of its back E.M.F. A large component of the current—namely, that required to force the vibrations—is, of course, in step with the diaphragm, and therefore in quadrature with the back E.M.F.; in short, an idle* current in the sense that it does no mechanical work.

Suppose this particular telephone is connected to the secondary of the two circuits which are given above as an example. To get maximum current we must either wind the telephone to equal the line resistance, or divide V_s into a sufficient number of turns to bring R_s up to the resistance of the telephone. The resulting ampere-turns in the telephone coils is the same in either case, and it will be simpler to choose the latter alternative, although in practice the telephone would, of course, be wound to suit the line. Using the same notation as before, and calling x the impedance of the telephone coils at frequency F, we have first to make

$$\frac{16\,\rho\,s^2\,N_s^{\,2}}{V_s} = x;$$

that is,

$$N_s = \frac{\sqrt{V_s\,x}}{4\,p\,\sqrt{\rho}}.$$

Now

$$C_s = \frac{E_s}{2\,x} = \frac{p\,s^3\,N_s}{8\,D^3\,x}\,\frac{\sqrt{W_p\,V_p}}{\sqrt{\rho}}$$

and, substituting the value just found for N_s, we find

$$C_s = \frac{p\,s^2\,V_t}{128\,D^3\,\rho}\,\sqrt{\frac{W_p}{x}} \quad . \quad . \quad . \quad (5)$$

Working out the value of C_s from the data already given, the frequency being now 400 ⌒ per second—the rate adopted by the Post Office after many trials at different speeds—and the impedance of the telephone $x = 220$ "ohms" at 400 ⌒, we find

$$C_s = \frac{12}{10^6} \text{ amperes;}$$

that is to say, a little more than four times (4·1) the minimum for readable signals, so that the weight of copper in the lines might be cut down to a quarter of a ton, or the distance increased by multiplying by $\sqrt[3]{4{\cdot}1}$, making the distance between the centres of primary and secondary circuits 16 km. (10 miles).

It is clear, therefore, that, in the absence of wave absorption, an ordinary telephone without any modification will enable induction telegraphy to be carried on at considerable distances. In the absence of any measurements of the absorption of electromagnetic waves by the earth, it is, of course, impossible to predict to what distance it will be possible to signal by means of a system working at 400 periods per second, but the author is inclined to think that at this speed absorption will rapidly damp out the waves as the distance increases.

The telephone may easily be improved for signalling purposes. When articulation is not required, the pitch of the diaphragm may be lowered with advantage. During the working out of the apparatus for the lightship telegraph, Mr. Cox devised several forms of telephone sounders in which the coil was rigidly attached to the diaphragm, and adapted to move in a powerful magnetic field. One or two instruments of this type were made, and worked well. Time, however, did not allow of our bringing any of them to perfection. But in whatever way the telephone may be improved as a motor, the most serious difficulty will always remain. To get an easily audible note it is necessary to work at a fairly high frequency. At 100 periods per second one can just hear a low hum in a telephone, but it is not until the frequency reaches 200 or 300 that dots and dashes become at all distinct. At 400 periods the note is sufficiently piercing to enable an operator to read a message without any serious strain.

Whatever form the telephone as a "sounder" may ultimately take, its suitability for induction telegraphy must depend on the degree of absorption met with in practice. If absorption is serious, audible indications must be abandoned, and an indicator working at a very low frequency will become necessary. What form such an indicator should take for Morse code signalling is by no means clear, but a simple form of vibratory indicator devised by the author in 1892 for use in connection with the light-vessel experiments may be described, as it illustrates very clearly the principles involved in all vibratory indicators of minute alternate currents, and possibly contains the germ of a practicable "speaking" instrument.

The essential parts of the author's indicator are shown in Fig. 1. A rectangular loop of fine wire, *a*, *b*, *c*, *d*, is fixed in an insulating block in a position which allows its end, *b-c*, to move freely in the air-gap of a magnet, N S. When the rectangle is traversed by an alternate current it

* The author regrets to see that Dr. Thompson sanctions the inappropriate phrase "wattless current" for a current in quadrature with the E.M.F. Such currents are, alas! only too watt*ful*—they are never watt*less*. But they are distinctly idle, in that they never do any useful work.

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vibrates up and down about its fixed ends, *a-d*, and if the rectangle is tuned so that its free period of vibration is equal to the periodic time of the current it becomes an exceedingly sensitive alternate-current voltmeter, the amplitude being strictly proportional to the impressed E.M.F. on the terminals of the rectangle.

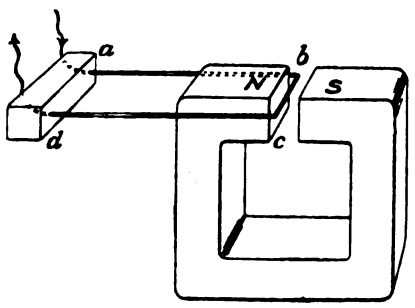

FIG. 1.—Vibrating Rectangle, with Magnet.

By combining the mechanical equation of motion with the equation of the electrical quantities concerned, the following simple equation is arrived at for the amplitude in terms of the molecular and other frictional resistances to motion, the condition of synchronism or resonance being assumed.

Let a = amplitude at end *b-c*;
r = force required at end *b-c* to overcome frictional resistances at unit velocity;
R = electrical resistance of circuit, including rectangle;
L = self-induction of circuit, including rectangle;
E = impressed E.M.F.;
h = H l = field in air-gap × length *b-c*.

Then
$$a = \frac{E\,h}{p\,\sqrt{(h^2+R\,r)^2+r^2\,p^2\,L^2}} \quad . \quad . \quad . \quad (6)$$

Also, if i and v are instantaneous values of the current in and velocity at end of rectangle,

$$h\,i = r\,v,$$

and the maximum velocity is $p\,a$; so that, if C is the maximum value of current,

$$C = \frac{r\,p\,a}{h}.$$

Also, the maximum back E.M.F. $-$ V $= p\,a\,h$; hence maximum power is

$$V\,C = r\,a^2\,p^2 \quad . \quad . \quad . \quad . \quad . \quad (7)$$

By differentiating (6) it is seen that a will have the greatest possible value when the field is adjusted until

$$h^2 = r\,\sqrt{R^2 \times p^2\,L^2}.$$

Writing R^1 for $\sqrt{R^2+p^2\,L^2}$, we have for the value of amplitude under most favourable conditions,

$$a = \frac{E}{p\,\sqrt{2\,r\,(R+R^1)}} \quad . \quad . \quad . \quad . \quad (8)$$

The condition for maximum amplitude is clearly that for maximum activity also, and accordingly we find that when $L=0$ and $h^2 = R\,r$, the back E.M.F. is equal to half the impressed E.M.F.

So much for the theory of this simple alternate-current synchronous motor. It is gratifying to add that its actual behaviour is, within the limits of observational error, strictly in accordance with theory.

By adding a fixed contact screw adjacent to the free end of the rectangle, a local circuit will be closed whenever the vibrations are sufficient to make the rectangle touch the contact screw. Another and better arrangement is to have two rectangles connected to two separate secondary circuits in such a direction that they oscillate in opposite phase. The two rectangles being made, the poles of a local circuit can be made to act as a relay on coming into contact with each other. Two relays of this type were made by the author's firm in 1896 for use in the light-vessel trials, and a few months ago they were attached to the wireless telegraph erected by the Post Office for communicating between Lavernock and Flat Holm, in the Bristol Channel. They are in daily use as relays for closing a call-bell circuit. The primary current is derived from a small alternator with a very heavy flywheel on the armature shaft. The machine being driven by hand to a speed above the synchronising frequency, the exciting current is switched on, and the alternator allowed to come gradually to rest—passing slowly through the synchronising speed, so that the two rectangles of the distant relay have time to come to their maximum amplitude.

The rectangles in these two relays are made of iridio-platinum wire three mils in diameter. They are each 4cm. in length, 2cm. in breadth, and their frequency is 16 periods per second. The twin-rectangle relay has one great advantage over the single pattern, shown in Fig. 1. When the twin rectangles are properly tuned to unison, it is almost impossible to bring them into contact by shaking the instrument. Even when the contact points of the rectangles are separated by only 0·002in., it is difficult to make contact by shaking the relay. They may be oscillating over a large scale, appearing to overlap each other, but oscillating in unison and in the same phase, as the rectangles do when shaken, they do not come into contact. These relays were designed for use on board a light-vessel, and entire freedom from accidental contact due to shaking was, of course, essential.

Measurements of the value of the frictional resistances of rectangles made of copper, platinum, and iridio-platinum were made, and showed very little difference between them. The value of r was determined by means of a vibrator like Fig. 1, having its field produced by an electromagnet, so that h could be varied. The process consisted in observing the amplitude at synchronism for different values of h, and plotting the curve connecting them. There being no self-induction in the circuit, the amplitude follows the law,

$$a = \frac{E\,h}{p\,(h^2+R\,r)}.$$

The impressed E.M.F. was provided by a secondary circuit of a single turn, in which the total induction, B, could be measured. That is to say, $E = p\,B$; so that

$$a = \frac{B\,h}{h^2+R\,r} \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

Having plotted the observed values of a and h, a curve is determined by means of equation (9) to fit the observed points as closely as possible. One of the curves is given

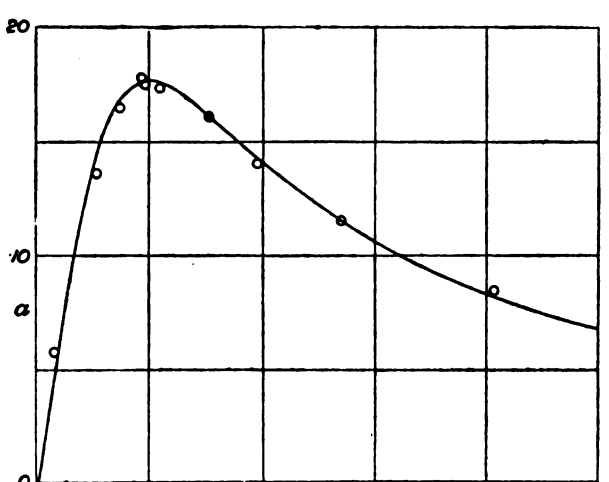

FIG. 2.—Curve connecting a and h for Inidio-Platinum Rectangle; a in centimetres, h in C.G.S. lines.

in Fig. 2. It shows the relation between a and h for a rectangle of iridio-platinum wire 3·3 mils diameter and 2·9cm. long, having a frequency of 25 periods per second. The curve is drawn from the equation,

$$a = \frac{1{,}770\,h}{h^2+25\times10^6}\ \text{cm.};$$

so that
$$R\,r = 25\times10^6\ \text{C.G.S. units.}$$

Now $R = 4{\cdot}28$ ohms $= 4{\cdot}28\times10^9$ C.G.S. units; hence

$$r = \frac{25}{4{\cdot}28\times10^3} = \frac{5{\cdot}85}{1{,}000}\ \text{dynes.}$$

(To be continued.)

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AWAKE AND ARISE!

Perhaps one of the most ominous signs of the times will be found in one of the clauses inserted in a large number of the provisional orders for which sanction is sought during the next session. We have before us the *London Gazette* for the past two months, and venture to say that the electrical industry—nor must we stop here, but must include all commercial enterprises—will have a rude awakening in the future if attention and action is not immediately given to the present. The clause may have crept into some previous provisional orders. We do not remember it, nor have we heard of it. First, however, let it be read. Taking up the *Gazette* for Nov. 11, 1898, on pp. 6,605-6 is the advertisement relating to the Ilkeston electric supply. Clause 4 reads as follows:

> "4. To authorise the corporation to *manufacture*, purchase, hire, *sell*, and let meters, lamps, accumulators, dynamos, fittings, plant, machinery, and other matters or things required for the purposes of the order, and to *acquire*, *work*, and use patent rights for the producing, storing, controlling, distributiug, measuring, and using, or otherwise relating to the supply of electricity." [The italics are ours.]

A similar clause appears in the order for Keighley, pp. 6,607-8, of Nov. 11, 1898; in that for Mirfield, pp. 6,611-2, same date; also that for Mexborough, pp. 6,612-3, same date; and, indeed, in some seventy (more or less) notices appearing in the *Gazette* from the beginning of November onwards through the time during which such notices appear. The question involves a principle which to discuss completely would need far more room than we can devote to it, so that much must be left to the reader's own knowledge of commercial matters. This clause, if carried, will enable municipal authorities to open factories and to compete against individual enterprise. It enables the authority to use collective credit and capital to compete against individual credit and capital. It enables the authorities to undersell against the very individuals who partly find the credit and capital wherewith to consummate their own ruin. The argument will be brought forward that, of course, the municipalities do not intend to do this or to do that; the clause only deals with things electrical, and that the matter is in the nature of an experiment. This is beside the point, and untrue. Once having obtained sanction to raise capital for manufacturing work on the credit of the ratepayers, who knows where the matter will stop? Not with electrical things, certainly. In fact, the end must necessarily be the absolute extinction of individual enterprise. But we will not pursue this point, rather touch upon what will immediately occur in the concrete than discuss what the end will be. Take the one concrete question of the manufacture of fittings. The fittings, as originally designed, were somewhat crude and inefficient. Now the various manufacturers have evolved fittings excellent in design, certain

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of action, and worthy of the industry. Municipalities are not going to work out things like this, but will probably copy anyhow and from anywhere. Then if their factories are not fully occupied with making their own fittings they will make and sell to outsiders—in fact, the clause is sufficiently elastic to allow them to do anything in the way of trade. Unfortunately—and herein lies the danger—the Legislature has in other directions sanctioned municipal enterprises which are of a distinctly commercial character, and which in our estimation ought never to have been sanctioned. We do not refer to the supply of pure air or of pure water, as we contend the supply of these necessaries comes into a different category. The generation of gas or electricity is in the borderland, the weight of expediency being, perhaps, towards municipalisation. But while we admit the preference to municipalisation of water, we do not admit the principle underlying the right to manufacture water-pipes, ball-cocks, taps, valves, engines, and all the paraphernalia used in the distribution of water. We have reason to believe that the Electrical Section of the London Chamber of Commerce is taking action in this matter, but its influence must be strengthened by that of the whole industry—in fact, by the whole commercial influence of the nation. "Men, be up and doing," must evidently be the motto for the New Year.

FORTHCOMING EVENTS.

FRIDAY, JAN. 13.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Lecture by Dr. Archibald Barr, M.I.C.E, on "The Application of the Science of Mechanics to Engineering Practice."

TUESDAY, JAN. 17.

Institution of Civil Engineers.—At 8 p.m. Papers on "The Effects of Wear upon Steel Rails," by William G. Kirkaldy, A.M.I.C.E., and "On the Microphotography of Steel Rails," by Sir William C. Roberts-Austen, K.C.B., F.R.S., A.I.C.E.

Liverpool Self-Propelled Traffic Association.—Royal Institution, Liverpool, at 8 p.m., "Motor *versus* Horse Haulage: an Account of Nine Months' Experiences," by S. H. Sparkes.

WEDNESDAY, JAN. 18.

Society of Arts.—At 8 p.m., "Canals and Inland Navigation in the United Kingdom," by L. F. Vernon-Harcourt, M.A.

THURSDAY, JAN. 19.

Institution of Civil Engineers.—Students' visit, at 2.30 p.m., to the testing and experimenting works of Messrs. David Kirkaldy and Son, 99, Southwark-street, S.E.

FRIDAY, JAN. 20.

Royal Institution.—At 9 p.m., "Liquid Hydrogen," by Prof. Dewar, M.A., LL.D., F.R.S.

ELECTRICAL SECTION—LONDON CHAMBER OF COMMERCE.

A meeting of this section was held on Friday last, under the presidency of Mr. Sydney F. Morse. The business before the meeting was of the utmost importance, the interest centering round the following two items on the agenda:

Municipalisation.—To consider the threatened municipalisation of electrical undertakings, and what action should be taken in reference thereto.

Municipalities and Electrical Fittings.—To consider the applications now being made by corporations for power to deal in electrical fittings and apparatus, and what action should be taken in reference thereto.

It was exceedingly fortunate that the presence of Sir A. Rollit was accidently arranged, as he gave in a most direct and uncompromising manner the views as held by the municipalities. Unfortunately, Sir A. Rollit was a little late in getting to the meeting, and we venture to think missed the gist of the arguments of the opposition to municipalisation. So far as we gathered, the members accepted the position that it comes within the scope of municipal action to generate and distribute electrical energy, but that it is altogether outside the scope of municipal action to set up factories to manufacture the detailed plant required in the construction of the works and the distribution of the electrical energy. Upon the first of the above questions a sub-committee was formed to consider and report; upon the second the opinion was most emphatic, and against municipal action.

HIGH-VOLTAGE POWER TRANSMISSION.*

BY CHAS. F. SCOTT.

(Continued from page 21.)

RÉSUMÉ AND CONCLUSIONS.

"It is undoubtedly true that the loss is made up of a loss over insulators and a loss between wires, and that the latter is the only loss worth considering.

"The loss between wires is not affected by any atmospheric conditions except precipitation. This statement, of course, must be taken as applying to such a climate as that in which the measurements were taken. The lines were seldom in fogs or clouds, and when they were, or when rain was falling, the moisture was of the purest. Near cities the loss would be undoubtedly much greater than that shown in these curves because of the impurities both in solution in the moisture of the atmosphere and in suspension.

"There will be for a given transmission a certain economical voltage, because while an increased voltage, with a given line wire, will reduce the loss in this wire by decreasing the transmission current it will also increase the loss between the wires.

"It is believed that attention to wave form is very important. The sine wave is undoubtedly the best as giving a stable form, and because of superior results with all kinds of apparatus. A flat wave would, of course, give less loss, but would not be stable, and as the nearest practical approach to a sine wave willl not be perfectly stable, but will still contain some harmonics, it will be of advantage to keep the series reactance of the transformers and generators as low as possible.

"It is believed that 40,000 volts is perfectly conservative and safe as regards loss between wires for any ordinarily good wave form, and in a climate such as that in which the measurements were taken—*i.e.*, where the air and precipitated moisture are practically pure—40,000 volts comes well below the bend in the loss curve, even under the worst weather conditions.

"I can see no advantage of porcelain over glass, unless it be that of superior mechanical strength. The latter is rather a doubtful advantage. The ball from a heavy-calibre rifle or revolver such as are used in the western country will smash any insulator, whether glass or porcelain. Porcelain offers a more tempting mark, being white. As to hygroscopic properties, no difference could be discovered so far as these measurements were concerned. It will make little difference under running conditions whether the insulator be hygroscopic or not, as the small amount of power necessary to keep the surfaces dry will be insignificant. I say under running conditions, because in starting up a 'cold' line there is danger of breakdown if current is put on suddenly at full value, instead of being raised gradually. As far as the resistance to piercing is concerned glass is just as good practically at least as porcelain. It needs no electrical test to pick out a good glass insulator, which is one advantage of glass over porcelain.

"To sum up, glass insulators are cheaper, lighter, more easily tested, and less likely to be shot at than porcelain; on the other hand, they have less mechanical strength.

* Paper read before the American Institute of Electrical Engineers

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"In every case, in my experience, where a breakdown has occurred, it has been on a cross-arm which was 'wind shaked' and 'weather cracked,' the current following the cracks. This leads to a curious result. The mark of the current will be on surface of the arm for 5in. or 6in., then disappear from the surface altogether for some inches, then reappear, etc. On cutting open the arm one sees how the current has followed the best path, dodging in and out. Rain and moisture probably settle towards the cracks, carrying salts from the body and surface of the wood. This forms a path of low resistance, especially in wet weather. For this reason I have in the plant of the Colorado Electric Power Company taken particular pains in treating both pins and cross-arms. The cross-arm treatment is such as fills all cracks and fissures, as a section of the wood shows.

"This report would be incomplete without an acknowledgment of the assistance rendered in the work by the engineering force of the Telluride Power Transmission Company, headed by Mr. P. N. Nunn. Especial credit should be given Mr. A. L. Woodhouse for his faithful work and constant perseverance in the face of great discouragement."

High-Tension Tests at East Pittsburg.

Laboratory tests and measurements on a small scale cannot take the place of tests under the conditions of practical service, such as those at Telluride. There are, however, many important elements which may be determined by laboratory measurements. A high-tension line for testing insulators and making measurements upon the losses between wires was erected at the East Pittsburg factory in the fall of 1897. A number of the tests which have been made are here recorded.

1. A test was made to determine whether the wave form of the charging current to the line was similar to that through a resistance, or whether it was modified by the loss component, the loss occurring only at the higher part of the E.M.F. wave. The current to the high-voltage line, at pressures varying from 30,000 to 60,000 volts, was passed through a coil possessing high self-induction. The E.M.F. upon the coil was measured by a voltmeter. The E.M.F. was also measured when a current of equal strength was passed through the coil, the line being short-circuited and a low E.M.F. applied. It was found that the voltage upon the coil was the same, within a small error of observation, in both cases, showing practically no difference in the wave form of the current under the two conditions. The current was from an armature giving practically a sine wave.

2. The charging current to the line was measured under several different conditions when the current was obtained from a generator giving practically a sine wave. The results of measurements were compared with the currents as calculated by the theoretical formula. The last measurement in the table was made upon the Niagara-Buffalo line, with current from a Niagara generator, which differs slightly from a sine wave.

Comparison of Measured and Calculated Charging Current to Parallel Wires.

Length, One Mile—10,000 Volts.

Size of wire.	Distance between wires.	Frequency.	Measured current.	Calculated current.
	Inches.		Amp.	Amp.
No. 8 B. & S.	21·7	60	·0307	028
8 B. & S.	48·0	60	·0245	·0252
8 B. & S.	79·5	60	·0234	·0238
8 B. & S.	127·5	60	·0225	·0222
No. 8 and ground	120·0	60	·0427	·0412
0·71in. diam.	18 for ⅓ of distance 36 for ⅙ of distance	25	·0176	·0176

3. The fall of potential around the wires was noted by tests made with spark-gaps. The wires 48in. apart were connected to the high-voltage terminals and a spark-gap was placed between two idle wires, also 48in. apart, placed about 21in. below the first wires. A spark-gap consisting of brass terminals, with a ¼in. radius, was placed between the two idle wires. When the gap was $\frac{1}{32}$in. the sparking began when the E.M.F. from the raising transformer was 26,000 volts. A gap of $\frac{1}{32}$in. requires an E.M.F. of 2,200 volts to produce sparking. When the spark-gap was made $\frac{8}{32}$in. (equivalent to 12,000 volts) the sparking began at 103,000 volts from the raising transformer. At intermediate points there is a fair proportionality between the spark-gap and the E.M.F.

In another test a spark-gap was placed between one of the idle wires and the adjacent wire of the live circuit. When the spark-gap was ⅛in. (equivalent to 6,000 volts) the spark passed when the E.M.F. was 17,500 volts, and when the spark was made ¼in. (equivalent to 12,000 volts) the sparking began at 33,000 volts. When the gap was ⅜in. (equivalent to 16,000 volts) sparking began at 41,000 volts. When the gap was ½in. (equivalent to 20,000 volts) sparking occurred at 49,000 volts. The E.M.F. did not differ greatly from a sine wave. These tests have an important bearing in connection with the running of telephone and other circuits adjacent to high-potential wires. It is essential that the wires of a high-potential circuit be spiraled so that each wire sustains the same relation as every other wire to the second circuit, in order that the effects of static induction may be neutralised.

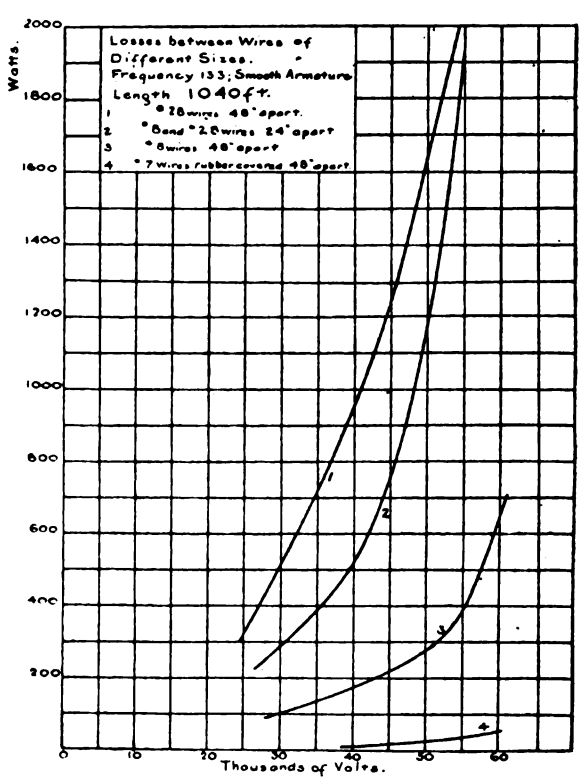

Fig. 13.

4. The effect of the size of wire upon the loss was investigated by running a pair of No. 28 brass wires 0·0126in. in diameter and then replacing it by large rubber-covered wires. The rubber-covered wire was No. 7 B. & S. gauge 0·144in. in diameter; the outside diameter of the rubber covering was 0·3in., and the diameter over the braid was 0·35in. In each case measurements were made upon another circuit, which was unchanged during the different tests, and thus served for comparison. The results of these tests are shown in Fig. 13, which also gives the conditions when one fine wire and one wire of larger size, No. 8 B. & S., constituted the circuit. This comparison shows the very marked increase in loss when the fine wire is used. The loss is greatly decreased when the rubber-covered wire is used. The loss on the rubber-covered wire, however, increased considerably after the voltage had been raised and the rubber had broken down, thus permitting the current to pass freely to the outer surface of the insulation. It is quite probable that the loss would increase as the insulation became defective, until it was nearly equal to that of a wire having the same total diameter.

The measurements on wires of different size given in Fig. 13 are qualitatively correct, although some of the

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readings on which the curves are based were quite small, so that the absolute values may not be exact.

5. The effect of the current in drying the surface of the insulators was illustrated in a test made during a rain. Upon applying 45,000 volts to a circuit the wattmeter indicated 116. After four minutes the deflection had decreased to 72, the current remaining the same. The E.M.F. was then increased to 60,000 volts, the wattmeter deflection increased to 155, and at the end of three minutes it had fallen to 138. The current was one-third greater than at the lower voltage, but remained constant while the wattmeter changed. The rain continued during the test, which shows, therefore, that the condition of the insulator is materially improved by the presence of the current.

6. It was noticed that when there was a breakdown upon the line, and the current passed suddenly between wires over the surface of the cross-arm, that there was a sparking between the terminals of the ammeters in the high-tension circuit across the surface of the instrument. This was further investigated by placing in circuit a coil of low resistance through which one ampere would be sent by about 1⅓ volts at a frequency of 125. A spark-gap was placed in shunt to this coil. A 2in. spark-gap was also placed between the line wires. The voltage of the primary was gradually raised until at 35,000 volts the current passed across the spark-gap between the line wires. A spark also passed across a gap of ⅜in., shunting the small choke coil. This test shows the remarkable suddenness of the rush of current when the short-circuit occurs due to the breaking down of the spark-gap on a high-voltage circuit. This phenomenon was observed by Mr. Mershon in choke coils used in connection with lightning arresters at Telluride.

Running tests were made on four lines in multiple at high voltages. Each line consisted of two wires 1,040ft. in length held by 26 insulators. The insulators were of various types of glass and porcelain, some of the ordinary form and some underhung. For hours at a time 100,000 volts or slightly more were kept upon the line. For about six weeks voltages ranging from 70,000 or 80,000 to 100,000 volts were kept on the lines for about eight hours a day. When there was rain, the line would short-circuit and the voltage had to be reduced. During a driving rain-storm 48,000 volts was kept on the lines, and it may have required a considerably higher voltage to have caused short-circuiting.

7. A high-tension wattmeter similar to the Thomson wattmeter at Telluride was used. To correct the wattmeter for the errors caused by charging current in the shunt resistance, a condenser was placed in parallel to the shunt circuit of the wattmeter. This condenser should be so adjusted that the current through the shunt circuit of the wattmeter is the same that it would be if there were no condenser and the shunt resistance had no capacity. This permits the capacity current in the circuit to be shunted round the wattmeter by the condenser. The condenser in shunt to the wattmeter was capable of adjustment, and by varying its capacity the deflection could be made positive, or zero, or negative when current was delivered to a constant load. The proper adjustment was made by taking a comparatively low voltage, at which the charging current was very high in comparison with the loss, so that the loss was nearly negligible, and adjusting the wattmeter to indicate zero. At higher voltages, when there was a considerable loss, the error with this adjustment would be inappreciable. Certain variations with temperature and humidity were noted which would be explained by a variation in the capacity of the resistance, causing a variation in the charging current to the shunt circuit of the wattmeter. The high resistance for the shunt circuit was wound upon fuller-board plates containing brass stiffening pieces. Tests were made upon individual plates by measuring the capacity between the wire and the supporting strip of brass, and it was found that the capacity and the insulation resistance both varied with the amount of moisture in the fuller-board insulation. In order to prevent variations of this kind, subsequent resistances were wound upon glass plates, which seems to be a very satisfactory form of construction.

(To be continued.)

JAMES BOWMAN LINDSAY, ELECTRICIAN, ASTRONOMER, LINGUIST, 1799-1862.

BY J. J. FAHIE, M.I.E.E.

(Continued from page 22.)

NOTE.—In our issue of Jan. 6, p. 21, col. 1, line 9, for "mud" read "mad"; p. 22, col. 2, line 12 from bottom, read "remarked that when the voltaic pile was at the height of its strength its sparks were seen," etc. The photograph on p. 21 was reproduced by special permission from a portrait in the possession of Sir John Leng, M.P., Dundee.

In 1809, Sir Humphrey Davy for the first time produced at the Royal Institution a *continuous* arc of light from charcoal points with a battery of 2,000 pairs of zinc and copper of 128,000 square inches surface. When the pieces of charcoal were brought within the distance of 1-30in., a bright spark passed between the points, and immediately afterwards more than half of each pencil, the length of which was 1in. and the diameter ⅙in., became ignited to whiteness, and on withdrawing the points from each other a constant discharge took place through the heated air in a space equal at least to 4in., forming an arc of light in the form of a double cone of considerable breadth, and of the most dazzling brilliancy (Roget's *Galvanism*, 1832, p. 11).

In 1809, Children casually refers to the electric light, and in 1815 he fused platinum and iridium wires to a brilliant whiteness with his battery of 20 zinc-copper elements, each zinc exposing 32 square feet of surface (both sides), (*Philosophical Transactions*, 1809 and 1815).

In an article in the *Mechanics' Magazine* for 1834, on the comparative intensity of different lights, we read, "An angular piece of charcoal was placed in the focus of a set of parabolic reflectors, and a stream of electricity directed upon it from a voltaic battery. A light was thus produced of great brilliancy, but of scintillating or, rather, intermittent description. The same was repeated with a stream of electricity produced magnetically from Mr. Saxton's magneto-electric apparatus, with the same result" (vol. xxi., p. 59).

These are all the notices of electric light prior to 1835 that I have met with in the course of many years' historical researches, and they serve to show the great advance that Lindsay made. He found a light brilliant but transitory, and he produced a lamp "which burned steadily for a lengthened period."

Mr. Norrie (*Dundee Celebrities*, p. 214) says the lecture referred to in Lindsay's letter, previously quoted, was duly delivered, and the light shown, at the Thistle Hall, Dundee, on the evening of Thursday, Jan. 15, 1836, and was repeated by general request at the same place on Friday, April 21, 1837. In the hope of obtaining some details as to the construction of the lamp, battery, etc., Mr. A. H. Millar, of Dundee, has kindly searched for me the files of the local papers of the period, but, strange to say, they contain no notice of the lectures. My readers will agree with me that this a very provoking circumstance, as in the absence of details we are left to our own surmises on these most important points.

The producing apparatus was apparently a voltaic battery of some kind, but as to the nature of the lamp itself it is not so easy to guess. In an article on the electric light, which appeared in the *Spectator* early in January, 1849, the writer says: "We remember that many years ago, in his remote Scottish residence, Mr. Lindsay produced a brilliant illumination from minute points of light." This is not much to go upon, yet it gives, I think, a clue to the secret. We have seen that Lindsay was familiar with Sir Humphrey Davy's discoveries in electricity, and, turning to my notes of his experiments on electric light, I find that, in 1802, he designed an "apparatus for taking the galvano-electrical sparks in fluids and aeriform substances," which is thus illustrated and described in the *Journal* of the Royal Institution for 1802 (vol. i., p. 214):

"Fig. 1 represents the apparatus for taking the spark in fluids. A is a tube graduated to grain measures. C is a platina wire hermetically sealed into the tube, and having a piece of charcoal attached to its top. B is a movable platina wire, having charcoal at its top. The effect is produced by making the contact between the pieces of charcoal. In cases where the fluids are very imperfect conductors, the wires may be used without the charcoal. Fig. 2 represents the apparatus for taking the spark in gases; it is used over mercury. A and B are communicating platina wires to which charcoal is fastened, and C is the graduated tube in which the gas is acted upon."

Lindsay's lamp was probably constructed on this principle, with, to use his own words, "contrivances for augmenting the light and rendering it constant." In whatever way the light was obtained, he appears to have contemplated its use in two forms—one to blaze in the open air, incapable of extinction by wind or water; the other in exhausted glass tubes. It is also interesting to notice that he says "it can be sent to any con-

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venient distance," and again, that "the number of lights may be increased without limit." And as to the cost, Mr. Norrie relates that a friend once questioned him on this point, when he replied: "Well, as nearly as I can calculate it costs me about half a farthing per week per light."

These are all important advances, and when to them are added a large faith in the future of electric lighting, and a clear perception of its uses which he was the first to enunciate, we can have no hesitation in saying that, as Sir Humphrey Davy is known and honoured as the father of electric light, so in future history Lindsay should occupy his rightful place as the father of electric lighting.

Lindsay's experiments in electric telegraphy, although not so valuable as those in the department of electric lighting, are still very interesting from a historical point of view, and deserve to be remembered to his credit. We have seen that from 1832 he was familiar with telegraphic projects, and that he made them the subject of illustration in his classes. At this date electric telegraphs were distinctly in the air, but, like electric lighting, they had hardly advanced beyond the laboratory stage.* Lindsay does not appear to have carried them much further for several years, for it was not until 1843 that he conceived the bold idea of a submarine telegraph to America by means of a naked wire and earth batteries, "after having proved the possibility by a series of experiments."

Fig. 1.

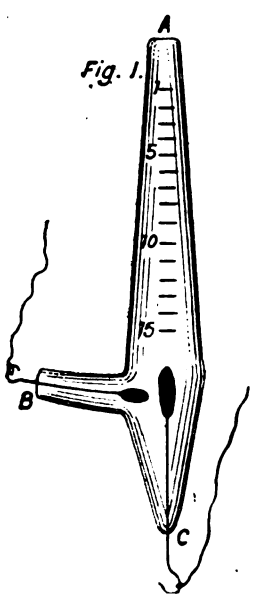
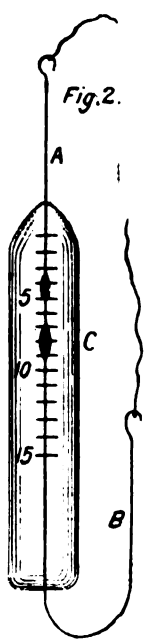


Fig. 2.



It is true that at this time the earth battery was known. It was first proposed by Kemp, of Edinburgh, in 1828; Prof. Gauss in 1838 suggested its employment for telegraphic purposes, and Steinheil, acting on the suggestion, actually used it with some success on the Munich-Nanhofen Railway, 22 miles long; and Bain in October, 1842, employed it for working clocks. Similarly, the idea of signalling with uninsulated wires and without any wire at all was not new, for the possibility of doing so was in a manner forced on the notice of Steinheil in 1838 and on Morse in 1842, but Lindsay was certainly the first to combine the two principles in his daring proposal of an Atlantic telegraph; and this, be it remembered, at a time when electric telegraphy was still a young and struggling industry, and when submarine telegraphy was yet a dream.

On June 19, 1845, the following paragraph appeared in the *Northern Warder*, Dundee:

"Something New.

"A correspondent of a New York paper of recent date has started the project of communicating between England and America by means of a magnetic telegraph! The following is his proposed plan: Suppose a copper wire properly covered and of sufficient size—say, as large as a pipe stem, and long enough to reach from Maine or Nova Scotia to the coast of Ireland—were wound upon reels and arranged on board a steamer, so as to be reeled off as fast as the boat went, and dropped the whole width of the Atlantic. Its gravity would sink it to the depth where the water was so dense as to be of equal gravity, and, of course, beyond the reach of any collision. Beginning and ending upon a bold shore, beyond the reach of anchors, it would be out of harm's way, and exposed to but two kinds of accidents—viz. (1) from separation by its own weight, and (2) the loss of the coating with which the metal must be protected. The steamer 'Great Britain' would carry more wire of this size than would extend to Europe, and its cost, I think, would be less than a million of dollars."

* From the public exhibition of Baron Schilling's needle instrument in Germany in 1835-36 dates the first real start of electric telegraphy. See my *History of Electric Telegraphy to* 1837, Chap. IX.

Anent this paragraph Lindsay wrote as follows in the same paper for June 26, 1845:

"Electric Telegraph to America.

"Sir,—The few lines I now send you have been occasioned by a notice in your last in reference to an electric telegraph to America. Should the plan be carried into effect the following hints should be attended to: The wire should be of pure copper, as otherwise it would be injured by the electro-chemical action of the water. The wire must not be composed of parts joined by soldering, but welded together; this welding can be performed by electricity. In order to prevent the action of water on the wire, a button of a more oxidable metal should be welded to it at short distances; the best metal for this purpose would be lead. If soldered to the wire, it must be soldered by lead alone. No third metal must be used. If welded, it may be done by electricity. In this way the wire resting on the bottom of the sea might last a long time. The one end of the wire is then to be soldered or welded to a plate of zinc immersed in the ocean on the coast of Britain, and the other end similarly joined to a plate of copper deposited in the same ocean on the coast of America. In reference to the expense, suppose the wire to be a ninth or tenth of an inch diameter, then the length of 100in. would contain a cubic inch of copper, and three miles of wire would contain a cubic foot, weighing 9,000oz, of the value of about £36 sterling. Owing to the inequalities in the bottom of the ocean, the distance to America might be 3,000 miles, and the expense £36,000 sterling—a trifle when compared with the resulting benefit. The only injury that the wire is likely to undergo is from submarine eruptions. It may be broken by these. The two ends, however, being accessible, the greater part of the wire may be drawn up, and the necessary length of wire welded to it. It should be remembered that this welding must be done by electricity. To Calcutta, by the Cape of Good Hope, the expense would be £200,000. The wire from Calcutta to Canton would cost £70,000, to New Zealand £120,000, to Tahiti nearly £200,000. A wire might be placed round the coast of Britain, and another along the coast of America. There might be stations at different towns and electric clocks agreeing with each other to a second of time. Each town might have a specific time for intelligence. Suppose Dundee to have the hour from nine to ten. From nine to ten minutes past nine, messages are sent and answers received between Dundee and New York. From ten minutes to twenty minutes past nine communication is made between Dundee and Quebec. The rest of the hour is for intercourse between Dundee and other towns. The same is done with Edinburgh, Glasgow, Liverpool, etc., each town having an hour for itself.—L.

"Dundee, June 21, 1845."

As in his letter on the electric light, so here Lindsay leaves much to the reader's imagination as regards important details, but it is clear that he contemplated an uninsulated wire across the Atlantic in connection with what have come to be known as earth batteries at the stations along the coasts.

His plan of protecting the wire from the corrosive action of the sea-water was evidently borrowed from Sir Humphrey Davy's proposal of 1824 for the protection of the copper sheathing of ships by strips of zinc; while the further suggestion, on which he insists so much, of welding the various lengths of wire by electricity, if not original with him, was at all events a very early recognition of a process* which has cropped up again in recent years, and which is now largely employed.

Between 1845 and 1853 Lindsay does not appear to have done anything in furtherance of his Atlantic project, being probably wholly absorbed in his linguistic and chronological studies. At all events, we hear nothing from him until March 11, 1853, when the following notice appeared in the *Dundee Advertiser:*

"Lecture on the Electric Telegraph.

"Mr. J. B. Lindsay proposes to give a public lecture on the electric telegraph, and to transmit and receive intelligence by means of two machines. The lecture will contain a description of these machines, with their mode of operation, and the most eligible lines by land and water to America, Australia, and other parts of the world will be pointed out. This lecture is appointed for Tuesday evening, March 15, in the Thistle Hall, at eight o'clock. N.B.—Mr. L. claims to have been the first that proposed and described the modern electric telegraph. He was the first that executed and announced a submarine one, and he has now discovered that instantaneous intelligence can be transmitted to all parts of the world without the aid of a submerged wire."

In the same paper a week later a report of the lecture is given as follows:

"Telegraphic Communication.

"On Tuesday evening our learned and ingenious townsman, Mr. J. B. Lindsay delivered a lecture on the above subject, one with which he has an acquaintance second to no man in the kingdom. It would be impossible, in the limited space at our disposal, to give any *vidimus* of the lecture; we can only indicate the outline of a recent discovery made by Mr. Lindsay, involving a principle which, if capable of acting irrespective of distance (and we see no reason to doubt that it is) must by-and-by revolutionise all our ideas of time and

* Electric welding was proposed by Joule in 1856; by Wilde in 1865; and by Prof. Elihu Thomson (America) and Dr. Benardos (Russia) in 1887.

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space. Mr. Lindsay stated the principle to be that submerged wires, such as those now used for telegraphic intelligence between this country and Ireland and France, were no longer necessary. By a peculiar arrangement of the wires at the sides of rivers or seas, the electric influence can be made to pass on through the water itself. This proposition was certainly startling, but he illustrated it on a small scale by means of a water-trough. and, so far as the experiment went, it faithfully developed the principle. Mr. Lindsay, after concluding these experiments, proceeded to point out the lines which appeared to him most eligible for transmitting telegraphic intelligence throughout the world; and, having done so, he wound up with a peroration of great beauty, in which the wonders to be achieved by electric influence in the days to come were eloquently set forth. It is a fine sight to see this learned and philosophic man pursuing the studies of science and literature, not for the sake of any empty applause, but for those pure pleasures they are in themselves so well fitted to bestow. At the same time it is gratifying to know that there are many people capable of appreciating the modest and retiring character of Mr. Lindsay, a fact which was clearly evidenced on Tuesday evening by the numerous and most respectable meeting which then assembled to hear his scientific lecture."

In the following August, Lindsay delivered another lecture (probably the same) in Glasgow, and so sanguine was he at this time of the practicability of this method that he actually patented it on June 5, 1854. The following account, which I have condensed from the specification of his patent, explains the *modus operandi*, and also shows how well he understood the conditions of the problem:

"My invention consists of a mode of transmitting telegraphic messages by means of electricity or magnetism through and across water without submerged wires, the water being made available as the connecting and conducting medium by the following means:

"On the land, on the side from which the message is to be sent, I place a battery and telegraph instrument, to which are attached two wires terminating in metal balls, tubes, or plates placed in the water or in moist ground adjacent to the water at a certain distance apart, according to the width of the water to be crossed (the distance between the two balls, plates, or tubes to be greater than across the water when practicable). On the land which is situated on the opposite side of the water, and to which the message is to be conveyed, I place two similar metal balls, plates, or tubes, immersed as above stated, and having wires attached to them which lead to and are in connection with another battery and needle indicator or other suitable telegraphic instrument. A A in the annexed diagram (Fig. 3) show the position

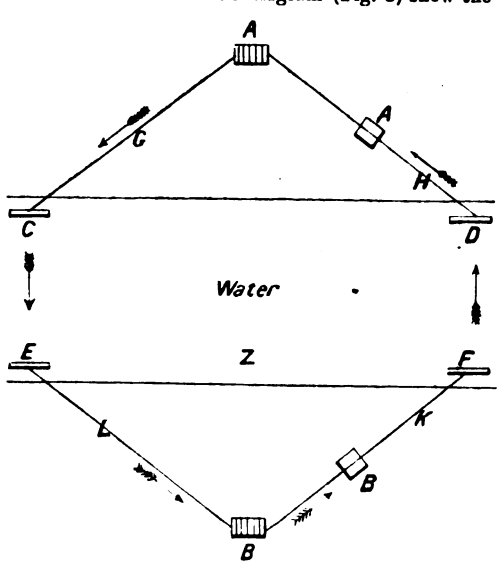

FIG. 3.

of the battery and instrument on one side of the water, Z; B B, the battery and instrument on the opposite side; C, D, E, F, metallic or charcoal terminators; G, H, I, K, wires insulated in the usual way, and connecting the terminators, batteries, and instruments, as shown.

"As regards the power or primary agent, it may be either voltaic, galvanic, or magnetic electricity, and the apparatus for evolving the same, such as is used for ordinary telegraphic purposes.

"As regards the indicating apparatus, I propose to employ any of the instruments in known use which are most efficient for my purpose, observing that the needle indicator may be arranged either in a vertical or in a horizontal position, and that the coil of wire which actuates the needle may be increased or diminished according to circumstances.

"Suppose it is required to transmit a message from A, the operator completes the circuit of the electric current as ordinarily practised.* It will be evident that the current will have two courses open to it, the one being directly back through the water from C to D, and the other across the water from C to E, along the wires I K, through the instrument B, and back from F to D. Now, I have found that if each of the two distances C D and E F be greater than C E and D F, the resistances through C E and D F will be so much less than that through the water between C and D, that more of the current will pass across the water, through the opposite wires, and recross at F, than take the direct course, C D; or, more correctly speaking, the current will divide itself between the two courses in inverse ratio to their resistances. As cases may arise, from local or other causes, such as not to admit of the distance between the immersed plates being greater than the distance across the water, I propose. then, to augment the force of the batteries, and to increase the size of the plates, so as to compel a sufficient portion of the current to cross. I prefer, however, when circumstances admit of it, employing the first method."

Lindsay's first public trials were across the Earl Grey Docks at Dundee, and then across the Tay at Glencarse, where the river is nearly three-quarters of a mile wide. In August, 1854, he conducted a series of experiments at Portsmouth, in which, according to a notice in the *Morning Post* (Aug. 28), he completely succeeded in transmitting messages across the Mill dam, where it is about 500 yards wide. These experiments are also noticed in *Chambers's Journal*, September, 1854, as follows: "Again has an attempt been made to send a signal through water without a wire; this time at Portsmouth, where it was attended with partial success. The thing has often been tried; a few years ago, a couple of *savants* might have been seen sending their messages across those minor lakes known to Londoners as the Hampstead ponds!"*

Lindsay repeated these experiments at intervals and at various places, indeed whenever and wherever he had the chance, his greatest performance being across the Tay, from Dundee to Woodhaven, where the river is nearly two miles broad. On one of these occasions, and when an Atlantic telegraph began to be seriously debated, the difficulty of finding a steamer large enough to carry the cable was discussed, when Lindsay quietly remarked, "If it were possible to provide stations at not more than 20 miles distant all the way across the Atlantic, I would save them the trouble of laying any cable."

In September, 1859, Lindsay read a paper before the British Association, at Aberdeen, "On Telegraphing Without Wires," which drew from Lord Rosse, the president of the section, special commendation. Prof. Faraday and (Sir) G. B. Airy, then Astronomer-Royal, also added their approval of the views enunciated. Prof. Thomson (now Lord Kelvin) was also present, and, as is well known, was then deeply engaged with Atlantic cable projects. History does not say what *he* thought of the poor Dundee lecturer, but, with the experience of 40 years, we can easily guess.

An abstract of the paper was published in the annual report of the association for 1859, as follows:

"The author has been engaged in experimenting on the subject, and in lecturing on it in Dundee, Glasgow, and other places since 1831. He has succeeded in transmitting signals across the Tay, and other sheets of water, by the aid of the water alone as a means of joining the stations. His method is to immerse two large plates connected by wires at each side of the sheet of water, and as nearly opposite to each other as possible. The wire on the side from which the message is to be sent is to include the galvanic battery and the commutator, or other apparatus for giving the signal. The wire connecting the two plates at the receiving station is to include an induction coil, or other apparatus for increasing the intensity, and the recording apparatus. The distance between these plates he distinguished by the term 'lateral distance.' He found that there was always some fractional part of the power from the battery sent across the water. There were four elements on which he found the strength of the transmitted current to depend—first, the battery power; second, the extent of surface of the immersed sheets; third, the 'lateral distance' of the immersed sheets; and fourth, in an inverse proportion the transverse distance, or distance through the water. As far as his experiments led him to a conclusion, doubling any of the former three doubled the distance of transmission. If, then, doubling all would increase the intensity of the transmitted current eightfold, he entered into calculations to show that two stations in Britain, one in Cornwall, and the other in Scotland, and corresponding stations well chosen in America—would enable us to transmit messages across the Atlantic."

A fuller report of this paper appeared in the *Dundee Advertiser*, from which I take the following interesting details:

"Recently he had made additional experiments, and succeeded in crossing the Tay where it was three-quarters of a mile broad. His method had always been to immerse two plates or sheets of metal on the one side, and connect them by a wire passing through a coil to move a needle, and to have on the other side two sheets similarly connected, and nearly opposite the two former. Experiments had shown that only a fractional part of the electricity generated goes across, and that the quantity that thus goes across can be increased in four ways: (1) by an increased battery power; (2) by increasing the surface of the immersed sheets; (3) by increasing the coil that moves the receiving needle; and (4) by increasing the lateral distance of the sheets. In cases where lateral distance could be got he recommended increasing it, as then a smaller battery power would suffice. In telegraphing by this method to Ireland or France abundance of lateral distance could be got, but for America the lateral distance in

* That is, by a key, which is not shown in the diagram. The absence of keys, no doubt, led a writer to say that Lindsay's method consisted "in providing strong enough batteries, one to send the current half the distance and the other to attract it to the other"!

* Can any reader tell me who these *savants* were? Mr. W. H. Preece relates the curious fact that almost the first electrical experiment he ever assisted at was one of Lindsay's, in London in 1853, on "wireless telegraphy." See *Journal* Society of Arts, Feb. 23, 1894, p. 279.

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Britain was much less than the distance across. In the greater part of his experiments the distance at the sides had been double the distance across; but in those on the Tay the lateral distance was the smaller, being only half a mile, while the distance across was three-quarters of a mile.

"Of the four elements above mentioned, he thought that if any one were doubled the portion of electricity that crossed would also be doubled, and if all the elements were doubled the quantity transmitted would be eight times as great. In the experiments across the Tay the battery was of four square feet of zinc, the immersed sheets contained about 90 square feet of metal, the weight of the copper coil was about 6lb., and the lateral distance was, as just stated, less than the transverse; but if it had been a mile, and the distance across also a mile, the signals would, no doubt, have been equally distinct. Should this law (when the lateral distance is equal to the transverse) be found correct, the following table might then be formed:

Zinc for battery.			Immersed sheets.			Weight of coil.		Distance crossed.
4	square feet	...	90	square feet	..	6lb.	...	1 mile.
8	,, ,,	...	180	,, ,,	..	12lb.	...	8 ,,
16	,, ,,	...	360	,, ,,	...	24lb.	...	64 ,,
32	,, ,,	...	720	,, ,,	...	48lb.	...	512 ,,
64	,, ,,	...	1,440	,, ,,	...	96lb.	...	4,096 ,,
128	,, ,,	...	2,880	,, ,,	...	192lb.*	...	32,768 ,,

* My readers will smile at the suggestion of such galvanometer coils, but they should remember that 40 years ago matters electrical were largely ordered by the rule of thumb. The electromagnet first used by Morse on the Washington-Baltimore line (1844), and exhibited in Europe, weighed 185lb. The arms were 3½in. long and 18in. diameter, the wire (copper) being that known as No. 16—the same size as the line wire, it being then supposed that the wire of the coils and of the line should be of the same size throughout. Down to 1860 not a few practical telegraphists held this view. See D. G. Fitz-Gerald in the London *Electrical Review*, Aug. 9, 1895, p. 157.

"But supposing the lateral distance to be only half the transverse, then the space crossed might be 16,000 miles, and if it was only a fourth, then there would 8,000 miles—a much greater distance than the breadth of the Atlantic. Further experiments were, however, necessary to determine this law, but, according to his calculations, he thought that a battery of 130 square feet, immersed sheets of 3,000 square feet, and a coil of 200lb., would be sufficient to cross the Atlantic with the lateral distance that could be obtained in Great Britain."

After the reading of the paper, Lindsay carried out some very successful experiments across the River Dee, in the presence of Lord Rosse, Prof. Jacobi, of St. Petersburg, and other members of the association. In February, 1860, he made Liverpool the scene of his operations, but there, strange to say, he had not the success which hitherto attended him. The experiments failed, being "counteracted by some unaccountable influence which he had not before met with." However, in the following July he was again successful at Dundee in his experiments across the Tay, below the Earn, where the river is about 200 yards wide. This was Lindsay's last public connection with the telegraph, but to the end of his life (June 29, 1862) he remained perfectly convinced of the soundness of his views and of their ultimate success.

Edison and Swan Electric Light Fittings.

At the time of his death a desire was expressed in Dundee that something should be done to perpetuate the name of this extraordinary and many-sided genius. Funds were raised by public

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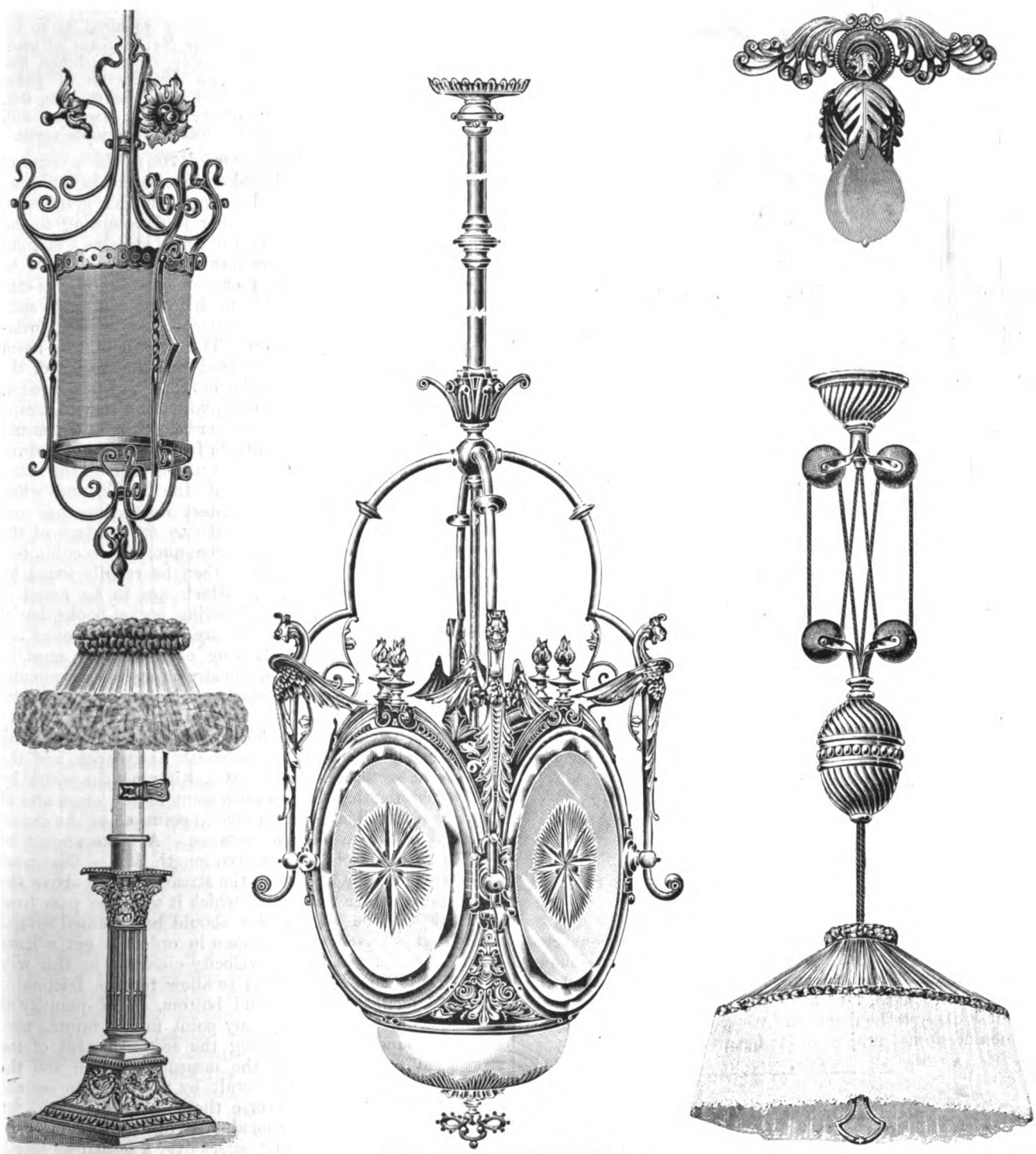
subscription, and a design for a monument was obtained, but, for some unaccountable reason, the project fell through. Lately the idea has been revived by an appreciative writer in the *Dundee Advertiser* (Sept. 6, 1897) who, after claiming for Lindsay the dual honour of being the first to invent an electric lamp and the first to propose an Atlantic telegraph *à la* Marconi, concludes as follows: "When there is a site in Dundee requiring a statue, it should be occupied by some memorial of that earnest, self-sacrificing, forgotten genius—James Bowman Lindsay." I cordially endorse this proposition, and I think I have shown how well it is merited. This year, 1899, is the centenary of Lindsay's birth, and Dundee should not let the occasion pass without some fitting memorial of her greatest son. So

"Up wi' the bonnets o' bonnie Dundee."

They could not be raised in a better cause.



Edison and Swan Electric Light Fittings.

EDISON AND SWAN FITTINGS.

We have received from the Edison and Swan Company that portion of their 1899 catalogue which deals with the various fancy fittings, electroliers, standard lamps, etc., which this firm manufactures and stocks at its showrooms in different parts of the United Kingdom. In it we notice several new designs which were not included in last year's catalogue, and in other cases some of the more convenient types have been improved upon and altered. The list as it stands is most convenient for reference to anyone who has not time to select the goods in the showroom. We notice that the firm has considerably extended the number of electroliers in which terra-cotta and Doulton ware is used. The few illustrations we give herewith are taken from the present issue.

WALL PLUGS.

We have received from Mr. Lundberg, of the Bradbury Electricity Works, Kingsland-road, London, N., some interesting samples of the latest types of wall plugs

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introduced by him. The wall plugs in question, which he calls the "Universal," are made for voltages up to 250, and in no case are fuses provided in them. The illustration we give herewith (Fig. 1) shows the general

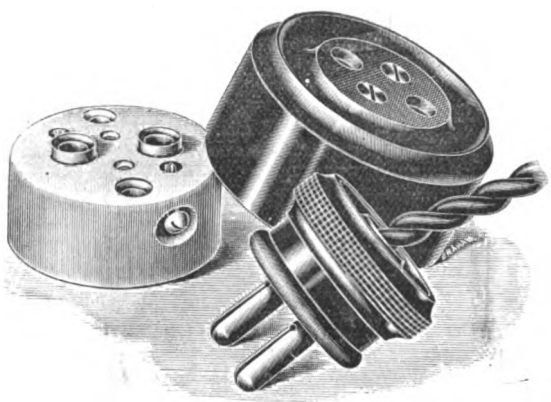

FIG. 1.

arrangement of these plugs, in which all the metal parts are thoroughly protected against external short-circuits and leakage by being embedded in the porcelain base. It will also be noticed that the porcelain covers, when in place, entirely prevent any but the most deliberate

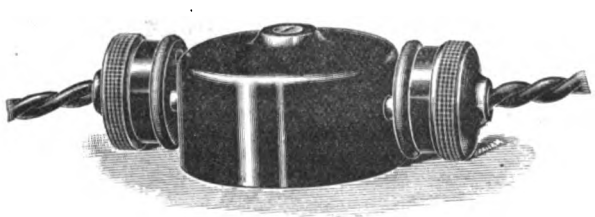

FIG. 2.

short-circuiting of the contacts. Mr. Lundberg has maintained in these new types the connecting plugs of the same gauge and the same distance apart as in the old style, so that the new types are interchangeable with those made some years ago. The detailed construction of the contact

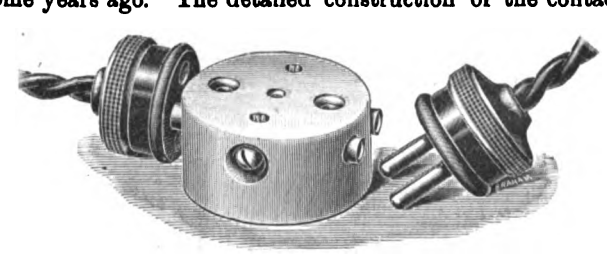

FIG. 3.

tubes and the terminals by which the wires are connected to the same is most ingenious. The twin wall plugs, shown in Figs. 2 and 3, enable two lamps to be supplied off the same wiring point, and also with these designs the plugs are less likely to be damaged by anyone walking about the room and do not project so far from the skirting.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

132. Explain precisely and clearly what the *power factor* of an alternating-current motor is, and why it varies with the load on the motor.—C. T.

133. What is the specific resistance of indiarubber and the prepared paper compound as used for cablemaking? Give a calculation of the predetermined insulation resistance, and compare it with the actual cable as manufactured.—X.

ANSWERS.

Question No. 126.—Suppose a report is required as to the availability or otherwise of a river for purposes of generating electricity by means of water-power turbines, how would you proceed to estimate the amount of power available? Give a reliable method of ascertaining this, by measurement of the water flowing, together with any additional data essential to obtain an accurate result.

Best Answer to No. 126 *(awarded* 10*s.)*.—In a case of this kind the first step to be taken is to ascertain the quantity of water which flows by any point in a given time, and there are two ways of doing this, according to the size of the stream. In the case of small streams a straight length where the current is slow and regular should be chosen, and a temporary dam or weir of stout planks constructed, having a rectangular notch in the centre, of sufficient depth to allow all the water to pass without overflowing the top of the dam. The length of this notch should not be more than two-thirds the width of the stream, and the edges should be bevelled to a sharp edge, the bevel being down stream to allow the water to escape properly. The surface of the water below the notch should not be less than 1ft. About 3ft. in front of the notch drive a stake into the bed of the stream, the top of the stake being level with the bottom of the notch, and when the water has reached its greatest depth measure the depth from the top of the stake to the surface of the water with a thin-edged rule. The number of cubic feet of water flowing per minute can then be readily found by referring to "Weir Tables," which are to be found in "Molesworth," and most engineering pocket-books, but if these are not available, then the area in square feet of the cross-section of the water flowing over the weir must be multiplied by the velocity of the stream in feet per minute.

With large rivers the notched-board arrangement is not practicable, and the following method is therefore adopted: A length of stream of from 50ft. to 100ft. is chosen, having as nearly as possible a uniform width and depth, and the area of the section is found by multiplying the width by the average depth. The measurement of the cross area of the stream should be taken at several points along the chosen length, and the average area taken. A stake should be fixed at each end of the measured length, and a float must be thrown into the middle of the stream a little above the first stake, and the time noted which it takes to pass from one stake to the other; this should be repeated several times, and the average time taken in order to get a more accurate result. From the velocity obtained in this way 20 per cent. must be deducted to allow for the friction of the water against the sides and bottom. The quantity of water in cubic feet passing any point in one minute may then be found by multiplying the sectional area of the stream in square feet by the measured length and the product by 60, dividing the result by the time in seconds taken by the float to traverse the measured length; for instance, suppose the sectional area of the stream to be 40 square feet, and the float passes over a measured length of 100ft. in 50 seconds, then $40 \times 100 \times 60 \div 50 = 4,800$ cubic feet per minute. Deducting 20 per cent. from this for friction, which is easier than deducting from the velocity of flow, we arrive at 3,840 cubic feet as the true quantity of water passing in one minute.

Having obtained the quantity of water flowing, the next thing is to calculate the horse-power, which may be done by the formula $\frac{W \times H}{30,000}$, where W is the quantity of water in pounds flowing per minute and H is the height of the fall in feet. W is, of course, equal to cubic feet per minute × 62·5. This formula gives the theoretical horse-power available, and therefore 25 per cent. must be deducted for friction and leakage in the turbine or water motor before the true power is arrived at. Take the case

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of the stream mentioned above, where the true quantity of water passing was found to be 3,840 cubic feet per minute, and suppose that this stream has a fall at one point of 20ft., which it is proposed to make use of to drive a turbine. The theoretical horse-power obtainable will be: $\frac{3{,}840 \text{ cubic feet} \times 62\ 5\text{lb.} \times 20\text{ft. height of fall}}{33{,}000\text{lb.}} = 145{\cdot}4$ h.p., and 75 per cent. of this amount, or 109 h.p., will be the actual power given off by the turbine shaft.

If the turbine is required to give out a constant amount of power all the year round, then the amount of water flowing must be measured in the driest season of the year, in July or August, as the turbine must be designed to suit the minimum supply in that case; but if the power is used to generate current for lighting purposes the horse-power of the stream may be calculated when the water is at a mean height between its highest and lowest levels, or even when the stream is at its ordinary winter level, as the demand for light will be least in the summer, when the quantity of water flowing is also least. In this case the turbine should be designed to give its greatest efficiency at three-quarter load.

Another important point to be considered is the cost of the dam and the water races for the turbine, which must be of such a size that the water shall not flow at more than 90ft. a minute. The full height of the fall can be counted on if the turbine is provided with draught tubes, which are, in fact, essential with horizontal turbines. For a given power a turbine will in most cases be more expensive in first cost than a steam engine and boiler, but the cost of running, depreciation, and repairs will be less than with a steam plant.—R. S.

Answer to No. 126 (*awarded* 5*s.*).—The first step will be to obtain information upon the amount of water that can be relied upon during dry seasons. Some engineers say take the lowest level for the past 10 years, others say take a longer period, but the further back reliable information can be got the better—after last summer's experience most water-power engineers will agree on this point. Now measure the breadth, depth, and velocity of the river (or portion, if all the river is not to be taken), and thus ascertain the number of cubic feet per minute available at the lowest probable level. Next find the pressure, by allowing 1lb. per square inch for every 2·31ft. of fall, or 62·3lb. per square foot for every foot of fall. By multiplying the number of cubic feet per minute by the pressure per square foot, and dividing by 33,000, we get the indicated horse-power, but allowance must be made for: (1) friction of water in pipes; (2) turbine efficiency; (3) friction of bearings, gearing, etc. (1) This can be calculated (but for short lengths of large diameter it is negligible) by the formula $P = \frac{D^2\ v\ l\ 2\ 25}{2{\cdot}31}$, where P is the pressure lost in pounds per square inch, D diameter of pipes in feet, v velocity of water in pipes in feet per second, and l length of pipes in miles. (2) and (3) In regard to these no definite formula can be given, as they vary considerably with make. If a certain maker's turbine is to be used they can be obtained from the makers and reliable information given as to amount of power available, but a more definite plan would be to communicate to several turbine makers stating quantity of water and fall available, also the proposed length and diameter of pipe line, and get them to give estimates as to power their turbines will give in brake horse-power with the supply. Besides the above the time of heaviest load must be considered. For instance, an inland business centre would have in all probability a heavy winter load and a light summer one, while a holiday resort would have a very heavy load in a dry season and almost a "no load" in winter. With the same quantity of water at lowest probable level in both places it would be safe to put a far larger plant in the former case. Then it would be as well to consider storage. In some stations they charge their accumulators during the day, while others have a reserve supply of water (such as at Foyers), while at Lynmouth water is pumped to a reservoir on a hill 750ft. above the station during the day. With such help-overs as these a heavier load can be handled during dry seasons.—P. T. K.

Answer to No. 126 (*awarded* 5*s.*).—First take your level from a point where the stream is to be tapped to the level of the tail race. Perhaps the easiest and most reliable method of ascertaining the flow of water in a river or stream is first to measure off a convenient distance on the bank, and, if possible, stretch two strings across, drop in a float as near the same specific gravity of the water as can be had—a piece of "swede" turnip comes very near the ideal. Note the time, by a stop watch, which it takes for this float to pass from one string to the other. If this experiment be repeated about half a dozen times and with different floats, a surprisingly accurate result may be arrived at. Having ascertained the rate of flow per minute or per second, multiply breadth by the depth of stream and by the fall in feet from point where stream is tapped to point where water is to act on "turbine" or other engine. This product, multiplied by 62·4 (weight of a cubic foot of water nearly) and divided by 33,000, gives the horse-power in the fall. About 80 per cent. efficiency may be expected. When the fall is between 20ft. and 40ft. "vertical wheels" are more efficient than "turbines" (it is heresy to say so, but truth is mighty); between 10ft. and 20ft. they are on a par, but below 10ft. the turbine has all the advantage. Vertical wheels cannot well be used when the fall exceeds 50ft. Turbines may be employed at almost any fall, say up to 500ft. or 600ft., but the higher the fall the less in proportion is the efficiency, the resistance increasing as the square of the velocity. It would appear, therefore, that for very high or very low falls, "turbines" are best; but for medium pressures, vertical wheels are most suitable. A very even flow of water is necessary with turbines. Should the supply be at all irregular, the effect is exactly similar to lighting direct from a bad type of gas-engine.

Most reliable manufacturers guarantee the horse-power and efficiency of their turbines, or other type of water-wheel with a given head of water, and as a rule it is safe to act on this, but as nothing in a well-thought-out scheme should be left to chance, perhaps it may be well to consider the blades or buckets as levers of the second order, and be certain whether there is sufficient surface provided for the water to act on to produce the guaranteed horse-power.

Numerous other considerations enter into this report. Probably the first will be as to the source of the river or stream. One stream may depend upon mountain or other springs practically inexhaustible, another depends on the drainage water from bogs, marshes or other wet land, the volume of which is a diminishing quantity year by year, and liable to violent interruption if a better system of drainage be introduced, and in any event the available power likely to be seriously diminished, say at the end of ten or a dozen years, as the surplus water is gradually drained away, etc.

Perhaps the safest basis to act upon is to take the average annual "rainfall" in a given district for a period of 10 years. Consider how much of this district is drained by your river. It is presumed that the horse-power required is known and worked out as above; more properly speaking, these considerations are in respect to the maintenance. Let us therefore take the average depth, in inches, of rainfall over the catchment area. An Ordnance or estate survey map will give fairly reliable data as to heights, levels, etc., and we have already a rough idea from observations made on the spot that the fall and volume of water will yield sufficient power to meet our requirements. If this data be not available, it will be necessary to make your own survey, take levels, etc. Take the average annual rainfall in the British Isles as, say, 42in., deduct the average daily evaporation = ·08in., and you have advanced the first step. Now, what become of this rainfall? Does it drop on a dry rocky surface and be carried away in flood immediately? If so, it will be seen at once that a storage reservoir is necessary to retain this, and cost of excavation, construction, and maintenance crops up. If the rain sinks into a loose sandy soil, emerging again in springs at a lower level, then nature has already provided a reservoir and saved us much trouble and expense.

To estimate the volume of rainfall multiply the depth in inches, say 42 by 22,623, result = the number

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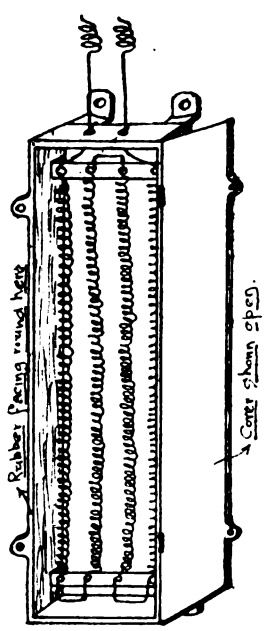
of gallons per square acre, or multiply 3,630 and the result = one cube foot per square acre. Multiply 22,623 by ·08 average daily evaporation, subtract result from the first calculation, and you know whether nature is prepared to do her part in the maintenance, and you have an assurance that your generating station, with its wheels, turbines, and other costly machinery, will not be left high and dry for this generation. If you have a lake or large river which can be conveniently tapped, it will not be necessary to make calculations as to rainfall or anything more than the cost of sluices, tunnelling, etc., volume, and fall in feet.—W. H. MURPHY.

Question No. 127.—In designing a substitutional resistance for an arc lamp, to be placed on the lamp pole or pillar and exposed to the weather, what points must be taken into consideration? Describe a form of resistance suitable for a 12-ampere 43-volt arc lamp.

Best Answer to No. 127 (*awarded* 10*s.*).—The principal points to be considered are (*a*) the shape of the resistance, (*b*) the protection of the resistance material from the effects of the weather. With regard to the shape, it is evident that since the resistance is to be placed on the pole it must be long and narrow, so as to be suitable for fixing. The resistance material itself should preferably be one not easily oxidised, and should also have a fairly low temperature coefficient, so that the resistance of the circuit may be kept constant whether the resistance be newly switched in or have been warmed up by being in circuit some time. Some such alloy as platinoid or Eureka is satisfactory. To prevent all possibility of deterioration by exposure to wet, etc., the wire, made up into a convenient form, should be enclosed in a cast-iron cover, made airtight.



One form is shown in the sketch, and is composed of Eureka wire of No. 13 S.W.G. (·092in. diameter), the total length of wire used being about 100ft., the resistance of this being, as required, $43 \div 3{\cdot}58\ \omega$. The sketch shows this wound into four coils, and if these were wound on a mandril $\frac{5}{8}$in. diameter the length of each coil, when stretched to a suitable degree, would be about 30in. These are shown supported at the ends on insulators fixed to two wrought-iron straps, bent and screwed to the sides of the box. Allowing $1\frac{3}{8}$in. between the centres of the insulators, the width of the box would be about 7in., and the length should be about 32in. or 33in., the distance between the centres of the insulators supporting the top and bottom of the coil being 30in., as stated above. The box should be closed by a hinged cast-iron lid, fitting close to the front, and rendered quite watertight by a rubber facing fixed to the front of the box. The lid will be held to the box by set screws through the lugs shown on the side. The whole will be hung by four lugs of wrought iron screwed on the back and twisted to suit the radius of the pole. The external connections would come through two holes in the top, filled in with pitch after the wires were brought through.

Another form consists of wire bedded in enamel on the back of a corrugated iron plate. This, however, is not so satisfactory, as the enamel heats up and is liable to crack if rain falls on it when in this state. A good result would be obtained if the enamel were replaced by some non-cracking material which could be varnished thoroughly and hardened by baking. This form is more compact than the other, and would probably come out about 24in. by 6in. The thickness would be determined by the closeness with which the wire could be placed in the material used, consistently with good insulation.—T. C.

MUNICIPAL OPPOSITION TO ELECTRICAL POWER DISTRIBUTION COMPANIES.

CONFERENCE IN MANCHESTER.

On the invitation of the Lord Mayor of Manchester (Mr. W. H. Vaudrey) a conference of the municipal corporations of Lancashire and Cheshire was held on Tuesday last at the Town Hall, Manchester, to consider, with a view to organising opposition to, the Lancashire Electric Power Company's Bill, 1899, and the South Lancashire and Cheshire Electricity Company's Bill, 1899. Invitations had been sent to the following boroughs, and nearly all of them were represented: Liverpool, Manchester, Salford, Oldham, Bolton, Blackburn, Preston, St. Helens, Bury, Wigan, Chester, Eccles, Heywood, Middleton, Ashton, Stalybridge, Stockport, Chorley, Accrington, Burnley, Bacup, Rawtenstall, Rochdale, Macclesfield, Warrington, Widnes, Birkenhead, Bootle, Southport, Mossley, Hyde, Darwen, Haslingden, and Nelson.

The LORD MAYOR, who presided, said he thought most of the gentlemen present would know the object of the Bills they had met to consider. The promoters of those Bills proposed to obtain powers to go through the various towns in Lancashire and certain towns in Cheshire and supply electric power for motive and for lighting purposes. Most of the towns represented were probably in the same position as Manchester in regard to this matter. In Manchester they had by a Board of Trade order obtained power to supply electricity for lighting and for motive purposes, and the two Bills they had met to consider would seem to contemplate a trespass on the various towns that had obtained powers of that character. That being so, he thought it was the duty of every town represented, in the interests of the ratepayers, to secure that those Bills should be thrown out when they were read a second time in the House of Commons. In conjunction with the town clerk of Manchester he had framed four or five resolutions which would be submitted to the conference for discussion. He would ask Mr. Alderman Lloyd Higginbottom, chairman of the Electricity Committee of the Manchester Corporation, who had had considerable experience in electrical matters, and who gave evidence last session in regard to a similar Bill from the Nottingham district, to move the first resolution.

Mr. Alderman HIGGINBOTTOM said it might be desirable at the outset to explain the position of the two Bills now under discussion in relation to the Bill which was virtually hung up last year—the General Power Distribution Bill, affecting Lincolnshire, Nottinghamshire, and Derbyshire—which passed the committee stage of the House of Lords. Some of them would remember that there were three Bills in Parliament last session similar in effect to the two Bills they were now met to consider. The principles involved in the three Bills were of such a character that Lord Morley, the chairman of the Lords' Committee, and Sir Courtenay Boyle, of the Board of Trade, were not prepared to say anything in favour of or against them; and to get rid of their responsibility for the throwing out of these Bills, or for sanctioning them, they got a Joint Committee of the Lords and Commons appointed to consider the principles that were involved. That Joint Committee held many meetings, and formulated a report on the proposals contained in the Bills. The promoters of those Bills, if he might say so, rather stole a march before the Joint Committee by putting forward the very best parliamentary counsel they could command, and after a very exhaustive enquiry the committee virtually reported in favour of allowing the principles involved in those Bills. And as those principles over-rode entirely the principles which all municipal authorities had fought for in the past, opposition was organised through the Association of Municipal Corporations, with the result that the Bills were hung up in the House of Lords until this session. It was clear to those who offered opposition that those three Bills were merely the thin edge of the wedge, and that in the event of their being passed other counties might be affected in the same way as Lincolnshire and Nottinghamshire were under those Bills. Not only did the report of the Joint Committee give sanction to the principles of the Bill, but it proposed to

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alter the Electric Lighting Acts of 1882 and 1888 in order to allow those people to come forward and practically enter into competition with local authorities who had been spending the citizens' money under provisional orders. If the report should ever be sanctioned by Parliament, it virtually meant that the recognised control—he laid emphasis on the "recognised"—of the streets of their towns would be done away with. In that case Parliament would practically declare that the monopoly in the supply of electricity which certain towns were supposed to have obtained from the Board of Trade existed only in the mind of the Board of Trade, and could be done away with by the giving of powers to a company. They must devote their most strenuous efforts to prevent Parliament giving effect to the bad action of the Joint Committee. On the General Power Distribution Bill very general support was received by the opposition from members of Parliament throughout the country, but now that other Bills were coming forward it was their duty not to be caught napping. They must enlist all the support they could for their opposition. In Manchester they had put down a large installation, and they also proposed to supply a large number of other authorities—not compulsorily, however, but by agreement. He did not know that they would be so strong in their opposition to these Bills if the promoters proposed to proceed by agreement. At any rate they objected very strongly to a competing company coming into their territory and cutting up their streets and doing what they liked, regardless of the views of the different authorities. He moved: "That this conference of municipal corporations of Lancashire and Cheshire, within the area comprised in these Bills, protest against the same as violating the principle for which municipal corporations have in past years successfully contended, and which have been established by the Tramways Act of 1870 and the Electric Lighting Acts of 1882 and 1888, and determines to take united action in opposition to the Bills."

Mr. CHARLES PETRIE, chairman of the Electricity Committee of the Liverpool Corporation, seconded the motion. He said he looked upon the action of the promoters of these Bills as an attempt to deprive the corporation of the benefit of the capital which they had invested in electrical undertakings. In Liverpool they purchased the electrical undertaking two years ago for something like £400,000, and they had since expended about £300,000 more in its development, and he looked with grave apprehension on proposals which would deprive the ratepayers of their interests in that large undertaking. The promoters of the Bills claimed that they would be able to produce electricity at a cheaper rate than the municipalities could do, but with that he did not agree. In Liverpool the charge when they took the works over was 7½d. per unit; now they had reduced it to 5d. and 4d., and yet they had last year a surplus of £17,000 after meeting interest and sinking fund. The companies that would be formed under the Bills would be dividend-earning companies, which were unlikely to do better for the ratepayers than the corporations were doing at present. He could not agree with Alderman Higginbottom in what he had said on the question of agreements with those companies. He thought corporations could do their work better than the companies could, and as to the Board of Trade, he thought the less they had to do with them the better.

The TOWN CLERK of SOUTHPORT supported the motion.

The TOWN CLERK of LIVERPOOL also supported the motion. The Bills they were met to consider involved, he said, what was practically a grave crisis in the history of municipal undertakings, because they involved the broad question of whether, when a corporation had been authorised to borrow and to spend money on the credit of the rates for public purposes, competition was afterwards to be allowed in the carrying out of those purposes. At present electricity was enjoyed by a very small percentage indeed of the people in any borough—in Liverpool by only 3,000 people out of a population of 700,000. Was it reasonable that the Corporation should have to pledge the credit of the whole body of the ratepayers for the sake of the 3,000? He maintained that it was not, and that when Parliament authorised these undertakings it was, or ought to have been, on the distinct understanding that the local authorities should be allowed to supply the light without such competition as would involve a charge on the rates. The time had arrived when corporations throughout the country should amalgamate and have this question fought out once for all as a matter of principle, and not merely as a matter of detail.

The motion was also supported by the TOWN CLERK of ST. HELENS.

Replying to a question by the Mayor of Stockport (Mr. Thomas Webb), the LORD MAYOR said the meaning of the words "united action" was that they should oppose the Bills in both Houses and at every stage.

On the motion of the MAYOR of SALFORD (Mr. Alderman Rudman), seconded by Mr. Alderman HARRISON (Blackburn), it was further resolved: "That a copy of the foregoing resolutions be forwarded to the Prime Minister, the President of the Board of Trade, and Sir Courtenay Boyle, and to the members of Parliament for the several cities, boroughs, and districts within the areas proposed to be affected by the Bills."

The MAYOR of WIGAN (Mr. J. T. Gee) moved: "That a copy of the foregoing resolutions be also forwarded to the secretary of the Association of Municipal Corporations, and to the District Councils' Association, and to all the district councils and local authorities within the above area, with a request for their co-operation." The motion was seconded by Mr. Alderman HARROP (chairman of the Gas and Electricity Committee of the Oldham Corporation) and adopted.

Dr. PANTON (chairman of the Bolton Corporation Electricity Committee) moved, and Mr. JONES (Birkenhead) seconded: "That the Lord Mayor of Manchester be authorised to communicate the foregoing resolutions to the various municipal bodies in the United Kingdom, and be requested to act as convener of the conference; that an executive committee be appointed, consisting of the following towns—viz., Liverpool, Manchester, Salford, Bolton, Blackburn, Oldham, Southport, Stockport, Bury, Chester, St. Helens, Wigan, Warrington; that such committee be authorised and requested to apportion the expenses in regard to this matter among the various corporations comprised in the conference."

In reply to questions, the LORD MAYOR said the cost would be merely nominal. His view was that the executive committee would advise each town as to the course to adopt with the view of opposing the Bills. The object was to defeat the Bills before the day came for the presentation of petitions.

The motion was then put and adopted.

A vote of thanks to the Lord Mayor for calling the conference and for presiding over it concluded the proceedings.—*Manchester Guardian.*

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Stirling.—The Burgh Commissioners invite tenders for mains, full particulars of which appear in our advertisement columns. Tenders by Jan. 30.

Sunderland.—The Corporation are prepared to receive tenders for various works, full particulars of which appear in our advertising columns. Tenders by 27th inst.

Southampton.—The Corporation invite tenders for the supply of transformers and fittings, particulars of which will be found in our advertisement columns. Tenders by 16th inst.

Belfast.—The City Electric Committee are prepared to receive tenders for the supply and erection of plant, full particulars of which appear in our advertising columns. Tenders by Feb. 2.

Glasgow.—The Corporation invite tenders for providing and erecting generating plant at one or other of their new electricity works. Further particulars appear in our advertising columns. Tenders by Jan. 21, 1899.

Govan.—The Commissioners invite tenders for boilers, engines, dynamos, etc., for electric lighting. Specifications, etc., may be obtained from Mr. W. Arnot, C.E., 79, West Regent-street, Glasgow. Tenders by 23rd inst.

Lowestoft.—The Mayor and Corporation of the borough of Lowestoft are prepared to receive tenders for the supply and erection of various plant, all details of which appear in our advertisement columns. Tenders by Feb. 6.

Ealing.—The Urban District Council invite tenders for the supply and erection of two 500-h.p. steam alternators and one 150-h.p. steam dynamo-alternator, full particulars of which appear in our advertisement columns. Tenders by Jan. 30.

Rochdale.—Tenders are required by the Gas Committee for the erection of buildings required for the proposed electricity works. The plans may be seen on application to Mr. T. Banbury Ball, the manager, at the Gasworks, from whom copies of bill of quantities may be obtained on payment of the sum of £3. 3s., which will be returned on receipt of a bona fide tender. Tenders by noon on Jan. 17.

Barrow-in-Furness.—Tenders are required by the Corporation for the wiring of the free library, Cornwallis-street. Plan of the building may be seen at the office of the Borough Electrical Engineer, Town Hall, and specification may be obtained from Mr. C. F. Preston, town clerk, Town Hall, Barrow-in-Furness, on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders by 12 noon on Jan. 20.

Christiania.—The Secretary of State for Foreign Affairs has received a dispatch from her Majesty's Consul-General at Christiania, stating that tenders are invited by the Norwegian State Telegraph Administration for the delivery of about 140,400 porcelain telegraph and telephone insulators. Tenders must be received at Christiania by 12 noon on Feb. 26. A copy of the specification, conditions, etc., may be examined on personal application at the Commercial Department of the Foreign Office, any day between 11 a.m. and 5 p.m.

London.—The London County Council invite tenders for the manufacture, delivery, and erection complete of four gas-engines, with starting appliances, at the proposed Victoria-embankment electric lighting station, in the parish of St. Martin-in-the-Fields. Persons desiring to submit tenders may obtain the drawings, specification, form of tender, and other particulars at the Engineer's Department, County Hall, Spring-gardens, S.W., upon payment of £2. This amount will after the Council or its committee has come to a decision upon the tenders received, but

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not before, be returned to the tenderer, provided he shall have sent in a bona fide tender and not have withdrawn the same. Tenders will be received up to 10 a.m. on Jan. 31.

London.—The London County Council invite tenders for the manufacture, delivery, and erection complete of four continuous-current dynamos, one motor-generator, two switchboards with switches, measuring instruments, and other work required for the proposed Victoria-embankment electric lighting station, in the parish of St. Martin-in-the-Fields. Any person desiring to submit a tender may inspect the drawings and obtain the specifications, forms of tender, etc., on application at the Engineer's Department, County Hall, Spring-gardens, S.W., and upon payment of £2. This amount will, after the Council or its committee shall have come to a decision upon the tenders received, but not before, be returned to the tenderer, provided he shall have sent in a bona fide tender and not have withdrawn the same. Tenders by 10 a m. on Jan 31.

Shanghai.—The Shanghai Municipal Council invite tenders for a concession for constructing and working about 23 miles of electric tramways on the trolley system in the streets of Shanghai. The special attention of tenderers is drawn to the fact that the tender (if any) recommended by the Council will require ratification by the ratepayers. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 being deposited with Messrs. Pook and Co., which sum will be retained by the Council, and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China (telegraphic address Dynamo, Shanghai; "ABC," fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Tramway Concession," must be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, and received by 12 noon on March 15.

Shanghai.—The following resolution in reference to the telephone system in Shanghai was passed at the last annual meeting of the ratepayers of the Foreign Settlements at Shanghai, north of the Yang-king-pang: "Resolution VIII.—That the Council be and is hereby authorised to enter into negotiations with the China and Japan Telephone Company or any other company, and in its discretion grant a franchise with a view to the community being supplied with an adequate and efficient telephone service at a fixed maximum charge." In accordance with the above resolution the Shanghai Municipal Council invite tenders for a concession for a period of 30 years for the exclusive right of establishing and working a telephone system in Shanghai. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 sterling being deposited with them, which sum will be retained and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China. Telegraphic address, Dynamo, Shanghai (ABC, fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Telephone Concession," to be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, by 12 noon on March 31.

BUSINESS NOTES.

Rhyl.—The Council estimate the cost of laying down an installation of the electric light at £10,000.

Banbury.—The electric lighting of the town is to be considered at the next meeting of the Town Council.

Edmonton.—The Local Government Board have given their consent to the Guardians lighting the workhouse by electricity.

Ilfracombe.—The District Council have decided to call in the services of an expert electrician to advise on the electric lighting of the district.

Bury.—The Local Government Board have sanctioned the borrowing by the Town Council of £15,250 for the purposes of electric lighting.

Buxton.—A local enquiry is to be held into the application of the Urban District Council for sanction to borrow £25,000 for purposes of electric lighting.

Camberwell.—A committee of the Vestry are investigating the cost of lighting the Central Library, the Art Gallery, and the Livesey Library with electricity.

Llanwrst.—The Edison-Swan Electric Supply Company has been granted permission to break up the streets in order to lay electrical cables for lighting purposes.

Barnet.—The Urban District Council have entered into a provisional agreement with the Electrical Power Distribution Company for the lighting of the town by electricity.

Hyde.—The Electric Power Distribution Company have decided not to proceed with their provisional order for lighting the town in view of the opposition of the Town Council.

Weybridge.—The Urban District Council will oppose the provisional order for lighting Weybridge and Walton with the electric light proposed by the Electric Works Company, Limited.

Southport.—The Town Council are determined to oppose the Bills now being promoted by the Lancashire Electric Power Company and the South-West Lancashire and Cheshire Electric Power Company.

Leamington.—The Town Council have resolved to refuse their consent to the Midland Electric Light Company's application for a provisional order.

Mile End.—The Board of Guardians appear to have some trouble with their electric lighting, and they have now resolved to obtain the opinion of an expert from the Phœnix Insurance Company on the matter.

Yarmouth.—The quarterly report of the electric lighting undertaking shows a gross profit of £939. 14s. 9d. for the last three months, or after repaying capital, interest, etc., a clear profit of £369. 14s. 9d. for the quarter.

Bath.—The Electric Lighting Committee have now arrived at the end of the first stage of the heavy contracts for machinery, and the first tests before taking the plant over will be made the next two Sundays, 15th and 22nd.

Poplar.—At the last meeting of the Vestry the report of the Electric Lighting Committee recommending the acceptance of the scheme given in full in our issue of Dec. 30 last was agreed to. This means an expenditure of about £79,000.

Birmingham.—The Corporation's Bill for powers to acquire the undertaking of the Birmingham Electric Supply Company, Limited, provides, in addition to the sum of £420,000, the guarantee of a dividend at the rate of 6 per cent. per annum.

Institution of Electrical Engineers.—A students' meeting will be held at 7.30 on Wednesday, Jan. 18, in the library of the Institution, when a paper will be read on "The Effect of Governors on the Parallel Running of Steam Alternators," by Leonard Wilson (student).

Walsall.—The Streets Committee of the Town Council and the Postmaster-General appear to be still at loggerheads about the question of substituting underground wires in the place of the overhead telegraphs along Bloxwich-road, at Walsall and Bloxwich.

Kilmarnock.—At a special meeting of the Town Council on the 5th inst., it was agreed to make application to the Board of Trade, under the Electric Lighting Acts, 1882 to 1890, for authority to supply electricity for public and private purposes in the burgh.

Perth.—A committee of the County Council has been appointed to look after the interests of the county in the matter of a notice by the Perth and District Tramway Company requesting consent to use electric traction and extension of period for working tramways.

Nottingham.—Colonel Albert C. Smith, R.E., Local Government Board inspector, held an enquiry on Wednesday into the application of the Town Council for sanction to borrow £150,000 for purposes of electric lighting, £35,000 of which is to be expended on extension of mains.

Removal.—The Edison and Swan United Electric Light Company, Limited, are extending their Birmingham branch, and have removed to the International Exchange-buildings, Edmund-street, where they are fitting-up a spacious showroom for the display of electroliers and brass fittings generally.

Watford.—At the last meeting of the Urban District Council, the electric light installation came in for some critical remarks by some of the members. After some discussion it was understood that Mr. Hawtayne and the clerk of the works would be requested to report to the next meeting of the committee.

Whitby.—The Urban District Council have received a letter from the Board of Trade with respect to extending the time of the Whitby Electric Lighting Order, 1891, stating that they would defer consideration of revoking the order for 12 months. The matter has been referred to a committee of the Council.

Worsley.—With respect to the proposal of the Lancashire Light Railways Company, Limited, to construct a light electric railway from the terminus of the St. Helens tramway system to Bolton, the District Council have resolved not to express any opinion so long as the line is not complete and does not enter the Worsley district.

Dudley.—The Town Council have adopted a report appointing Mr. R. Wilson, engineer, to superintend the laying down of electric generating plant at Springsmire, and to make the connection with the tramlines at 3 per cent., and also to pay a competent clerk of the works. A sum of £7,500 is to be borrowed to meet the expenses.

Glasgow.—The Council have adopted the proposal of the Tramway Committee recommending the adoption of the trolley system for the whole of the tramways of the city, which was referred to at length in our last issue. It is estimated that the overhead electric system on the Springburn route will save the Corporation £10,000 per annum.

Direct United States Cable Company, Limited.—An interim dividend of 3s. per share, free of income tax, being at the rate of 3 per cent. per annum for the quarter ending Dec. 31, 1898, is announced, such dividend to be payable on and after the 31st inst. Twelve thousand pounds is to be set aside to reserve fund account, and a balance of about £5,920 carried forward.

Longton.—The Town Council have received a letter from the Potteries Electric Traction Company, Limited, intimating that they had acquired the shares of the North Staffordshire Tramway Company in the Potteries district, including the Potteries Extension Tramways and the Potteries Light Railways. The Council receives a rental of £200 per annum for the Longton lines.

Weston-super-Mare.—The Town Council have confirmed a resolution to the effect that, after a thorough and careful consideration of the proposals of the Weston-super-Mare Tramways

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Company, they are of opinion that the proposed works would not be conducive to the best interests of the town, and consequently withhold their consent to the granting of the provisional order to the company.

Liverpool.—About one quarter (£55,900) of the estimates for paving, sewering, and general purposes of the Health Committee for the current year is to be set apart for street improvements necessitated by the electric tramways. For the electric tramways service a system of 1d. fares will be adopted throughout the city, but 2d. will be charged for a seat in the portion of the car where no smoking is permitted.

Bradford.—The revenue account of the electricity works shows a total income of £20,059, and an expenditure of £8,736, leaving a trade profit of £11,323. Against this are charged interest and sinking fund, amounting to £7,060, leaving a net profit of £4,263. The total profits made since the works were opened have been £19,045. and from this there has been written off for depreciation of plant £7,308, leaving unappropriated the sum of £11,737.

Bangor.—The Town Council want to be on the safe side, and have decided to take further counsel's opinion concerning the guarantee bond proposed to be given by certain ratepayers to cover possible deficiency on the working of the electric light works. In order to prevent the learned counsel overlooking anything. each member of the Town Council is to submit to the town clerk any point or points which he thinks might be submitted to counsel.

Wolverhampton.—At the meeting of the Town Council last week a resolution containing a paragraph as follows was adopted without discussion: "It is expedient for such Council to promote in the next session of Parliament a Bill to empower the Corporation of Wolverhampton to construct tramways and street improvements, to make further provision in regard to tramways in and in the neighbourhood of Wolverhampton, and in regard to the electric lighting," etc.

London County Council.—Mr. Baker was enabled to start work at the London County Council's offices on Friday last; the Council having agreed that, in consideration of the Nottingham Town Council allowing Mr. Baker to come to London now instead of in three months' time, as originally intended, they will permit him to give the Nottingham Council every assistance in his power in the furtherance of the Bill which they are to bring before Parliament this session.

St. Helens.—From the Corporation year book for 1899. by Mr. W. J. Jeeves, town clerk of St. Helens, it appears that the electricity account figures with £13,560, and the tramways account with £22,664. in the total borough debt of £508,136. The electric supply for the year ending March 31 to private consumers was 35,758 units. Works are in course of construction at Boundary-road for the supply of electric energy to the tramways and also public and private lighting.

Lynn.—The Public Works Loan Commissioners have decided to advance the Corporation £27,000 for the purposes of electric lighting, repayable in 25 years, and £1 000 for the purpose of wiring the town hall and other municipal buildings, to be repayable in 10 years, the interest to be 2¾ per cent. and 2 per cent. respectively. The committee's recommendation that in certain streets the standards for lamps should be placed in the centre of the roadway has been referred back to the committee.

Stockport.—The Gas and Electric Lighting Committee have decided to oppose the application of the Lancashire Electric Power Company so far as it relates to the supply of electrical energy in the district covered by the lighting order obtained by the Council, and, with regard to the South Lancashire and Cheshire Electricity Company's Bill, the town clerk was instructed to ascertain whether the area of proposed supply by this company comprised any portion of the lighting area of the Corporation.

Bexhill.—Notice has been given to move at the next meeting of the Council that the resolution of the Council giving consent to the scheme promoted by the British Electric Traction Company, Limited, for the construction of a tramroad from Kewhurst to St. Leonards be rescinded. The Bexhill Town Association has asked the Urban Council to call a public meeting to pass a resolution opposing the two schemes for tramways, as well as the light railway, but it is stated that the Council has no power to grant that request.

Stourport.—At the last meeting of the Urban District Council, the question of allowing the electric tramway company to make an additional turn-out in Foundry-street, which has already twice engaged the attention of the Council, was again introduced in a motion favouring the proposal, but the majority adhered to the resolution already passed not to grant the permission. It was suggested that if the company would purchase the old White House, and widen the road at that point, the Council might then grant the permission asked.

Derby.—With regard to the decision of the Town Council (referred to in our last issue) to borrow £25,000 for the extension of the work carried out by the Electric Lighting Committee, it was proved during the discussion on the subject that the undertaking had of late made such rapid progress that a deficit of £3,000 had within the short period of two years been converted into a profit, and that the proposed extensions were absolutely necessary in order to enable the committee to carry on and extend their business in an efficient and profitable manner.

Stretford.—The question of rescinding resolutions previously passed by the Urban District Council declaring that it was expedient that the Council should take up their provisional order of 1897 authorising the supply of electricity for lighting and haulage purposes throughout the district, and that with this object a consulting or resident engineer should be appointed, has been adjourned for three months. The Council is divided upon the point as to whether the scheme of electric lighting and haulage should be completed and controlled by the Manchester Corporation or by the Stretford Urban Council.

Llandudno.—Since the opening of the electric lighting station, Mr. Preece and the Council's resident electrical engineer, Mr. Morton, have been busy completing the construction of a refuse destructor (one of the Beaman and Deas type, constructed to deal with 60 tons of refuse per 24 hours). This was formally opened at a special meeting of the Council, held on the 9th inst., at the electric lighting station, Mr. T. T. Marks, C.E. (chairman), presiding The total cost of the electric lighting plant, including the destructor, is close on £30,000, of which the destructor accounts for about £7,000.

The Exchange.—Electric traction companies are improving all along the line. Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to the Potteries Electric Traction Company, Limited, for 13,334 ordinary shares of £10 each and 20,000 5 per cent. cumulative preference shares of £5 each, and to allow the following securities to be quoted in the official list: Brazilian Submarine Telegraph Company, Limited, further issue of shares of £10 each; Edison and Swan Electric Light Company, Limited, further issue of £150,000 4 per cent. debenture stock.

Manchester.—Although two years must elapse before the tramways can come under municipal management, the committee appointed by the City Council has already made enquiry as to the most suitable form of car to be introduced. The type of car which most commends itself to the committee is one which has been brought into use in Dublin. As was intimated at the last Council meeting, tenders are being invited for three sample cars. These will consist (1) of a car suitable for ordinary traffic capable of accommodating 53 passengers, inside and out; (2) a car to carry 63, to be used in times of pressure; and (3) a "single-deck" light car, to carry 20 passengers, all inside.

New Partnership.—We are informed that Messrs. Wardrop and Whitaker have dissolved partnership, and that Mr. C. C. F. Monckton, late engineer and manager of Messrs. Boustead Bros.' electrical department in Ceylon, has joined Mr. Wardrop in the business. Great progress in electrical work has been made in Ceylon under Mr. Monckton's management, and all the principal Government buildings, hotels, and merchants' offices in Colombo have electric light and power from Messrs. Boustead's central station. The firm will henceforth practice as civil and electrical consulting engineers, under the title of Wardrop and Monckton, at 1, Army and Navy Mansions, Victoria-street, Westminster.

Gas-Engines.—We are informed that Messrs. Crossley Bros., Limited, of Manchester, have just received from the London County Council a second order for an installation of gas-engines which is the largest which has ever been put down in this country, and possibly in the world. It consists of eight double-cylinder horizontal gas-engines, four giving 260 i.h.p. maximum each, and four of 210 i.h.p. each, also four engines of 5 i.h.p., combined with air compressors and hydraulic pumps. These engines are to be built on Messrs. Crossley's well-known "Tandem" principle, and all are to work with coal gas. They are to be used for driving centrifugal pumps at the Lots-road pumping station.

Bray.—From the Commissioners' yearly accounts for 1898 we note the electric account as follows: Received from last account, £266. 19s. 4d.; sale of current, house wiring, and rent of meters, £1,958. 8s. 11d.; balance against, £173. 18s. 10d.; total, £2,398. 7s. 1d. Expended—Capital purposes, £186. 3s. 4d.; generating, distribution, interest, and sinking fund, £2,212. 3s. 9d.; total, £2,398. 7s. 1d. General assets and liabilities—The general assets and liabilities (revenue) show a balance against of £2,838. 8s. 5d.; electric ditto, against £1,268. 3s. 3d.; and harbour ditto, £243. 4s. The consolidated loan fund account balanced at £3,980. 8s. 7d. Under the general expenditure electric lighting of streets is put down as £537. 19s. 10d.

Taunton.—At last week's meeting of the Town Council the recommendation of the Electric Lighting Committee, that the Council join the defence fund for resisting Mr. Rucker's claim threatening proceedings against all local authorities and companies using the alternating system of distribution, was adopted. The committee reported that the electric light undertaking had continued to progress during the last year, and the increase on the output was about 50 per cent. on ordinary days and 100 per cent. on Sundays. With the exception of the light going out on No. 1 sub-station on Dec. 21 for half a minute, there had not been a single mishap to the incandescent lighting during the past year on the large sub-stations.

Ormskirk.—At a special meeting of the Urban District Council last week a letter was read from their parliamentary agents, advising the Council to oppose the Bill now before Parliament for the incorporation of the Lancashire Electric Power Company and the South Lancashire and Cheshire Electricity Company, on the ground that it was an attempt to make money out of the ratepayers and to establish a valuable monopoly. It was stated that Warrington Corporation, Lathom and Burscough, and other public authorities had decided to oppose either the one or the other body, or both, in their application to Parliament, and the Council decided to memorialise against the Bills of both companies, limiting their expense in this respect to £5.

Greenwich.—At the last meeting of the District Board of Works a letter was read from the assistant secretary (Fisheries and

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Harbour Department) of the Board of Trade submitting for any observations the Greenwich District Board might wish to offer a draft amended form of consent to an extra high-pressure supply being given by the London Electric Supply Corporation, together with an amended description of the system to be adopted by that company, for the supply of energy under their orders of 1889 and 1896, in the form in which it was proposed to approve it, subject to regulations for securing the safety of the public and for ensuring a proper and sufficient supply of energy. The letter was referred to the Parish Committees.

Sunderland.—The Corporation have resolved to give notice, within six months after Aug. 16, 1899, that they require the Sunderland Tramways Company, Limited, to sell to them their undertaking under the Sunderland Tramways Order, 1878, so far as the same is within the district of that borough, upon terms of paying the then value (exclusive of any allowance for past or future profits of the undertaking, or any compensation for compulsory sale, or other consideration whatsoever) of the tramway, and all lands, buildings, works, materials, and plant of the said company suitable to and used by them for the purposes of their undertaking within such district, such value to be in case of difference determined as provided by the Tramways Act, 1870.

Hampstead.—The General Purposes Committee of the Vestry is considering a letter from the Vestry of St. Margaret and St. John, Westminster, referring to the notices of proposed private Bill legislation next session, and to the general question of intercommunication within the metropolitan area by underground electric railways, stating that they had made representations to the London County Council urging that any further underground railways should be based upon a considered and formulated plan of inter-communication throughout the county of London generally, to be defined by Parliament itself, with a view to the present and prospective needs of the constantly increasing population of the Metropolis and suburbs, and requesting to be informed of any action taken upon this suggestion.

Wolstanton.—The report of the Highways Committee, submitted to the Rural District Council on Tuesday, stated that a deputation from the British Electric Traction Company had met the committee and offered, under a penalty of £500, to guarantee that the works in Wolstanton should be completed within three months of the expiration of the time at present allowed on condition that the Council would agree to the extension of six months for which the company are at present applying. On the recommendation of the committee, the Council agreed not to oppose the application on these terms. It was also decided that a lease for 21 years, with option of a further 21 years' lease, be granted to the company, on payment of £5 a year, to lay a branch tramway along the Marsh at Wolstanton.

Garston.—On the 9th inst. a special meeting of the District Council was held for the purpose of considering the adjourned report of the Special Purposes Committee upon the proposed transfer of the Council's electric lighting order, obtained in 1897, to the British Insulated Wire Company. At the previous meeting a resolution was proposed for the adoption of the committee's report, and the discussion was now continued at great length. An amendment was now brought forward that clauses be inserted in the agreement providing that the electric works and refuse destructor be not erected in a residential district, and that the Council be allowed to repurchase the undertaking at the expiration of 14 years on the best terms possible. Both amendments were defeated, and the committee's report was adopted.

"Newcastle Daily Journal."—The offices of this paper are the first in the Northern Counties in which electricity has been adopted in the production of a newspaper. There a full installation of the most recent and improved Linotype composing machines is now being completed, and the newspaper will henceforth be "set up" by machines of this class, which has revolutionised the work of the compositor. For the installation of these machines Mr. John Thompson, C.E., of Newcastle, was engaged in the designing of the required shafting, lighting, etc. The work was executed by Messrs. Ernest Scott and Mountain Limited, electrical engineers, and on their suggestion it was arranged that the machines should be driven by the Langdon-Davies patent alternating-current motors, manufactured by the latter company at Southwark.

Personal.—Mr. Aldworth, manager of the Isle of Man Tramways and Electric Power Company, has been appointed by a committee of the Nottingham Corporation manager of the municipal tramways.—Mr. F. Bruton, of Bolton, has been appointed assistant engineer at the Ashton-under-Lyne electricity works.—The electricity department of West Ham was from the commencement under the Highways and Parks Committee. It is now to be under a new committee, called the Tramways and Electric Lighting Committee. At the last meeting of the old committee a recommendation was made that the salary of the borough electrical engineer, Mr. J. J. Steinitz, should be at once increased by £200 per annum. This was carried unanimously by the committee, and subsequently unanimously confirmed by the Council on the 10th inst.

Queenstown.—The Admiralty have decided on lighting Haulbowline Dockyard with electricity, the first move in connection with which was made on Saturday, when Mr. Ashdown, who is consulting constructor to the Admiralty, arrived from England, and, in company with Rear-Admiral Lake, proceeded to Haulbowline, where particulars were gone into and arrangements made to prepare plans and specifications for the electric lighting of the island on the most approved principle. The docks, wharves, fitting shops, and principal establishments will be first lit, and probably the remaining portion of the island later on. The lighting will be given out to contract, and the intention of the Admiralty is that the work should be undertaken as quickly as possible. There is evidence of much activity generally throughout the works just new, and a very large staff engaged as a result.—*Cork Examiner.*

Appointments Vacant.—The Eccles Town Council require a switchboard attendant.—Applications are invited for the positions of shift engineers for the Croppers Hill Power Station, St. Helens.—The Corporation of Worcester require two improvers as switchboard attendants.—The Corporation of Wigan are prepared to receive applications for the appointment of an electrical engineer. For particulars of these vacancies refer to our advertisement columns.—The Metropolitan Asylums Board invite applications for the appointment of assistant engineer from qualified engineers who have had practical experience, especially in electric lighting and general steam-engine and boiler economy. The salary will be £350 per annum. Candidates must not be less than 25 nor more than 35 years of age. Further particulars may be obtained from Mr. T. Duncombe Mann, clerk, Norfolk House, Norfolk-street, Strand, W.C. This is open until the 23rd inst.

Silverdale.—At the last monthly meeting of the Silverdale and Knutton Council a deputation from the British Electric Traction Company attended with respect to the proposed tramway line to Silverdale. It was intended to start with the work at once. He had two proposals to place before them for their consideration. Owing to the narrowness of the roads in some places between Silverdale and Newcastle, it would be advisable that the line should be laid alongside the path instead of in the middle. The second related to the materials to be used in constructing the way. The company wished to use macadam asphalte instead of stone setts. This would facilitate the construction very materially. The company would be prepared to put down setts at any time if the Council desired it. The company was responsible for the proper condition of the line. It was resolved to recommend the Rural District Council to sanction the putting of the line near to the footpath on the road to Newcastle, but in the centre of the streets in the village itself, and also to sanction the use of macadam asphalte instead of stone setts—the lines to be laid both in Church-street and High-street. It was decided that the annual parish meeting should be held on the 25th inst.

Hereford.—The Town Council have adopted a report of their Electric Lighting Committee, stating that out of the 17 tenders received the committee have selected four which seem to them specially worthy of consideration and attention, and from a comparison of these tenders and an analysis of the figure they comprise, as well as of the figures contained in some of the other tenders and estimates, they feel justified in advising the Council that the cost of the whole of the machinery and plant, including all the expense of installation and of laying the cable, other than the expense of such work as will be performed by the Council itself, will be approximately £12,000. Adding to this £1,000 for meters and connections, £2,000 for the cost of the site and laying it out, £4,000 for buildings and trenches (which the committee propose that the Council's own workmen shall undertake), and £1,000 for legal charges, contingencies, etc., a total of £20,000 is arrived at, and the committee advise that an application should at once be made to the Local Government Board for leave to borrow this sum. The committee are agreed that the form of power should be steam, though they have not finally decided on the type of engine; and they are also satisfied that a low-tension three-wire system is the one best adapted for their purpose. The committee intend to consider still further the tenders above referred to, and to obtain further advice and particulars. They hope to be prepared with a definite scheme by the time the necessary enquiry in connection with the loan to be asked for is held.

Fulham.—The Vestry have received a report from their consulting engineer on the question of a water supply to the Vestry's electric lighting station. It states that it is undesirable to make use of the Thames as a source of supply for boiler-feed purposes. The question therefore resolves itself into one of the relative cost of obtaining a supply from (1) the Chelsea Water Company and (2) from artesian wells. In the former case a softening plant must be put down, whereas in the latter case this may be dispensed with if analysis proves the water to be soft enough as pumped. The average quantity of water required by the machinery provided for in the specifications is estimated approximately at 22,000 gallons a day, or, say, 8,000,000 gallons per annum, when the station is in full work. The engineer says that it will be desirable to run the main whether wells are sunk or not, and so does not take into account the cost of the supply from the Chelsea Water Company's main in the Town Mead-road. He estimated the total capital expenditure for town supply at £1,360, and for wells supply at £2,083. This would require an annual expense for the former of £319, and of £219 for the latter. So that, even if it is found necessary to put down the softening plant in conjunction with the wells, the difference in annual charges in favour of the wells' supply will be £100 per annum. The engineer says that this result is attainable largely because it is possible to put down a low figure for the cost of pumping, which, however, was ample, owing to the fact that the destructor would always be in work. He advises that the softening plant be put down, and recommends that an advertisement be issued in the *Engineer* and *Contract Journal* stating that the Vestry propose to sink one or two artesian wells, and are prepared to receive from suitable firms the terms and conditions under which they would undertake the work. The Vestry intend to circulate 1,000 copies of a notice "to builders and others" re supply of electrical energy. They have also instructed the engineer to prepare rules and regulations for wiring, etc. Additional lighting is to be provided in Hurlingham and Sherbrooke roads.

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Southwark.—At Tuesday's meeting of the Vestry the following report of the Electric Lighting and Dust Disposal Committee was submitted: "(1) Southwark Electric Lighting Order, 1892.—Your committee have to report that they have considered the two letters from the Board of Trade, enclosing copies of letters from the County of London and Brush Provincial Electric Lighting Company, Limited, asking permission to change the system of the supply of electrical energy. The committee find that the company desire to change the system laid down in the Southwark Electric Lighting Order, 1892, and the regulations of the Board of Trade of May 7, 1895, to a system of two-phase alternating currents, which request the committee do not, however, deem it advisable to accede to. As the Board of Trade desire an immediate reply, your committee directed the vestry clerk to accordingly write to the Board stating that this authority does not agree with the company's proposal, and recommend that their action be approved. (2) Generating stations and supply of electrical energy.—Your committee have to report that they have considered the letter from the Vestry of Hammersmith, asking this Vestry to support the views of that authority with regard to certain suggestions contained in the report of the Joint Committee of both Houses of Parliament on the above subject. In the report it is stated (*inter alia*): Question 3—In the case of powers being given for the erection of a generating station outside the area of supply, they (the committee) think that powers may be properly given for laying the mains in streets leading from the generating station to the boundaries of the area of supply. In such case, the local authority liable to maintain these streets should have the same option of themselves breaking up and reinstating the streets at the undertaker's expense, as is now given in the provisional orders to local authorities within the area of supply, and should be empowered accordingly. The committee are of opinion that while it may be advisable to maintain the veto of local authorities as to erection of overhead wires given by Section 14 of the Act of 1882, in respect of other electric wires, it is not advisable that in the case of overhead wires for traction purposes, the local authority, other than the London County Council and county boroughs, should have an absolute veto. While due weight should be given by the Board of Trade to the representations of local authorities, the committee think that in the case of wires for purposes of traction it would be sufficient to give a *locus standi* to such authorities. The committee consider that the provisions of the Electric Lighting Act, 1888, which require the consent of the local authority as a condition precedent to the granting of a provisional order should be amended. In their opinion the local authority should be entitled to be heard before the Board of Trade, but should not have, so to speak, a provisional veto only to be dispensed with in special cases by the Board of Trade. Your committee recommend that this Vestry concur with the following suggestions of the Vestry of Hammersmith with regard to the proposals contained in the report of the Joint Committee of both Houses of Parliament as to Electrical Energy (Generating Stations and Supply) under the heading "Question 3"—viz.: (*a*) That the local authority within the area of supply should have the power of deciding the route the mains are to be laid, as well as the power of themselves breaking-up and reinstating the streets; (*b*) that the Vestry strongly object to the second and third paragraphs under Question 3 of the report, and in the event of any legislation being brought forward on the lines indicated in these paragraphs, the Vestry should take up a strong position in opposition, and use every effort to retain its power of veto both in regard to wires for the purposes of traction and application for provisional orders."

Sheffield.—At Wednesday's meeting of the City Council, Alderman Styring, in moving the minutes of the Electric Light Committee, said, according to the *Sheffield Daily Telegraph*, the committee, on taking possession of the undertaking, were sorry to find things were not in such a satisfactory condition as could be wished. To meet the requirements it was necessary to work all the machinery to its full capacity. There were no spare machines, and the management were absolutely dependent day by day on all the machinery keeping in good working order. He was sure members of the Council would agree that that was not a desirable state of things, and that there ought to be an ample margin of power to meet all emergencies. The late company had been exerting themselves for some time past to remedy the present state of things. Two new and powerful machines were put down. They should have been in working order by the end of 1897, but owing to the engineers' strike the machines were only got to work two or three months ago. It was then found they would not yield the looked-for amount of current, but owing to the exigency of the situation they were worked for as much as they would yield. As soon, however, as the days lengthen, and the demand for current became less, the machines could be put into the state they ought to be in, and the Council might rely on it the committee would do everything that was possible to provide adequate machines for supplying all other demands. He was sorry that the first time the minutes of the committee were presented he had to ask the indulgence of consumers with reference to what occurred on Monday night, when there was a serious stoppage of the light. It was due to what was called the short-circuiting of the current behind the switchboard, and the stoppage, which was the most serious that had occurred during the last four years, was entirely beyond the control of anyone connected with the undertaking. He had told the manager in the most explicit terms that the committee would spare no expense to prevent, as far as possible, any repetition of such a mishap. The lamps wired during the last year were 17,865 as compared with 13,561 in the previous year, an increase of about 22 per cent. That brought up the total number of lamps to 73,853. The number of lamps wired last year was approximately one-third of the total aggregate previously wired. The current sold during the year was 978,086 Board of Trade units, compared with 738,499 in the previous year, an increase of 32 per cent. It would be remembered that the late company were empowered under the agreement between them and the Corporation, to carry on the undertaking during the last year on behalf of and for the benefit of the Corporation. Although the accounts of that carrying on were not completed, he was in a position to say that the gross revenue for the current sold and meter rents during the year was £17,104. 15s. 4d., against £14 823. 10s. in the previous year. That was a very satisfactory increase in itself, but it was still more satisfactory when the fact was taken into consideration that the price of the current was in March last reduced from 5d. to 4d. One of the conditions of the purchase of the undertaking was that the company should receive 10 per cent. interest on its capital employed during the year. That interest had been paid, absorbing a sum of £9,712. 6s. 6d. There had also to be paid out of revenue the debenture interest, £1,125, making a total payment out of revenue for the year of £10,837. 6s. 6d. The accounts were in an advanced enough state to show that after making the payments he had mentioned there would be a sum of not less than £3,000 clear profit on revenue account for the Corporation as a result of the last year's working. As to the policy of the committee, the first thing to be done was to make the light perfectly efficient so far as that could be done; next, to make it as cheap as possible for the consumers, and then do what they could in the way of securing a profit for the Corporation. That was a policy he had every confidence in submitting to the Council, and he had every confidence the Council would support the carrying of that policy into effect. The minutes were adopted.

PROVISIONAL PATENTS, 1899.

JANUARY 2.

2. Improvements in apparatus for connecting electric mains. John Somerville Highfield, 34, Wolseley-road, St. Helens.

8. An improved electric reversing switch with liquid resistance. William Henry Vaughan and Thomas Foster, 17, St. Ann's-square, Manchester.

20. A new or improved electric heater. Thomas Edgar Weaver, 19, Newbridge-street, Wolverhampton.

44. Improvements in apparatus for electrically controlling engines, electromotors, and other machinery. William Horatio Hatfield, 4, South-street, Finsbury, London.

JANUARY 3.

96. Improvements in supports for electric conductors. Johan Marinius Andersen and Albert Anderson 11, Southampton buildings, Chancery-lane, London. (Complete specification.)

101. Electrodes for storage batteries. Theodore Arthur Willard, 52, Chancery-lane, London. (Complete specification.)

102. Means for producing battery electrodes. Theodore Arthur Willard, 52, Chancery-lane, London. (Complete specification.)

108. Improvements in direct-reading electricity meters. John Henry Noad, 73, St. Stephen's-road, Upton Park, London.

132. Improvements in or in connection with electrical motors for working lifts, cranes, machine tools, and like stationary machines. Robert Arthur Dawbarn, and Arthur Barnes Mountain, 46, Lincoln's-inn-fields, London.

133. Improvements in and in connection with electric railway and tramway propulsion. Robert Arthur Dawbarn and Arthur Barnes Mountain, 46, Lincoln's-inn-fields, London.

153. Improvements in dynamo-electric machines or motors. Henry Monnard, 45, Southampton-buildings, Chancery-lane, London.

JANUARY 4.

155. An improved means of sealing enclosed arc electric lamps. Arthur Edmund Baines, Finsbury House, Blomfield-street, London-wall, London.

163. An automatic switch (for use in conjunction with electric bells that ring continuously when the door of the shop or like place is open). Samuel Crowther, 23, Delph-mount, Woodhouse, Leeds.

165. An improvement of the electrical cord grip lamp-holder. Christopher Thomas Briscoe and Edwin Jones, Central-buildings, Richmond-terrace, Blackburn.

193. Improvements in telephones. C. J. W. Hensinger, 55, Chancery-lane, London.

200. Improvements in or connected with enclosed arc lamps. George Thomas-Davies, 40, Chancery-lane, London.

214. Improvements in apparatus for electrically interlocking the block and mechanical signals on railways to render it more efficient and certain. Luiz de Moraes Gomes Ferreira and Henry James Pryce, 4, South-street, Finsbury, London.

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216. **Improvements in electric railways.** James Grieve Lorrain, Norfolk House, Norfolk-street, London. (Frederick Carleton Esmond, United States.)

JANUARY 5.

218. **Improvements in safety plugs for electric installations.** Joseph Mühlenthaler, 42, Neuenweg, Barmen, Germany.

252. **Means for uniting the filament and leading-in wires of an incandescent electric lamp.** John Thomas Lister, 52, Chancery-lane, London. (Complete specification.)

278. **Improvements in electrically-propelled road vehicles.** William Peck, 47, Lincoln's-inn-fields, London. (Complete specification.)

287. **Improvements in cooling appliances for alternating-current and rotary phase current motors.** Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske, Actien-Gesellschaft, Germany.) (Complete specification.)

JANUARY 6.

293. **Improvements in electrical reaction or choking coils.** Arthur Edmund Baines, Finsbury House, Blomfield-street, London-wall, London.

338. **Improved electric arc lamp for portrait photography.** George Wilson Morgan, 393, Union-street, Aberdeen.

356. **The manufacture of incandescent materials suitable for electric lighting.** Ludwig Wilhelm Gans, 24, Southampton-buildings, Chancery-lane, London.

JANUARY 7.

380. **New or improved switches, wall sockets, contact makers, and the like for use with incandescence electric lamps in which the filament is formed of substances which conduct only at high temperatures, to which it is previously heated by a hot shunt.** Charles Andrew Lee, 43, Paulton's-square, Chelsea, London.

387. **Improvements in and connected with the manufacture of iron wall carriers for insulators and other objects.** Friedrich Unterberg, 5, Water-street, Liverpool. (Complete specification.)

405. **Improvements in jacks used in combination with electrical annunciators or indicators for the automatic replacement of the shutter or signal flag.** August Eckstein and Richard Penteny Eidsforth, Peel Works, Adelphi, Salford.

407. **Improvements in insulated overhead conductors for electrical railways and tramways.** Edouard Duesek, 40, High Holborn, London.

416. **Improvements in electrical heaters.** Arne Barman, 77, Chancery-lane, London.

422. **An improvement in or relating to electric light switches.** Colin Edmund Campbell, 19, Southampton-buildings, Chancery-lane, London.

427. **Improvements in electric igniters for gas-engines.** Walter Henry Cotton, 15, Took's-court, Cursitor-street, London. (Complete specification.)

428. **Improvements in apparatus for overhead traction.** Charles Antoine Mary, 47, Lincoln's-inn-fields, London.

SPECIFICATIONS PUBLISHED.

1897.

29257. **Electric signalling, particularly on railways.** Boult and Boult.

29665. **Telephone systems.** Ritter.

30065. **Key switch holders for incandescent electric lamps.** Huisman and Gover.

30295. **Automatic locking lever and lifting lever combination for electrical lifts, cranes, or other machinery.** Holt.

30678. **Method of retransmitting telegraphic messages, and apparatus for use in connection with the said method and for other purposes.** Rymer-Jones.

1898.

331. **Preventing sparking when making and breaking electric circuits.** Müller and Tudor.

2299. **Joints between the glass globes of electric arc lamps and the supports by which they are carried.** Guérin.

2522. **Electrical striking mechanism for bells.** Eckstein and Coates.

2761. **High-tension electric switches.** Cowan and Still.

2784. **Electric switches.** Immisch.

3862. **Electrical conductors.** Edmunds.

4514. **Electrolysis and cathodes therefor.** Feeny. (Becker.)

21341. **Armatures of multipolar dynamo-electric machines.** Siemens Bros. and Co., Limited, Dumar, and Grimston.

22964. **Plug switches or wall contacts for electric circuits.** Vandam and Marsh.

23243. **Electric accumulators.** Ribbe.

23397. **Enclosed arc lamps.** Lewis and the Mutual Electric Trust, Limited.

23716. **Secondary or storage batteries.** Haddan. (Miller.)

24171. **Voltaic cells having dry plates which may be regenerated.** Schloss.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1899.	Corresponding week 1898.	Increase or decrease.	Total receipts for half-year. 1899.	1898.
		£	£	£	£	£
Birmingham Tramway	Jan. 7	3,851	3,547	+ 304	—	—
Blackpool and Fleetwood Tramroad	,, 7	166	—	—	166	—
Bristol Tramways and Carriage Co.	,, 6	2,506	2,464	+ 42	—	—
City and South London Railway	,, 8	1,143	1,124	+ 19	2,179	2,174
Dover Tramways	,, 7	155	117	+ 37	155	—
Dublin U.T., elec. cars	,, 6	461	94	+ 367	—	—
Dublin S.D. Electric Tramways	,, 6	510	337	+ 173	510	337
Halifax Corporation Tramways	,, 4	265	—	—	7,118*	—
Liverpool Overhead Railway	,, 8	1,339	1,439	- 99	—	—
South Staffordshire Tramways	,, 6	457	541	- 84	—	—

* Since June 29

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	20-21
Bournemouth and Poole Electric Supply, Limited, Ord.	10	11-11½
—— 4½ per cent. Cum. Pref	10	10¾-11¼
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	16-17
—— 6 p. c. Cm. Pf., 30,001-40,000 (all paid)	10	13-13½
—— 5 per cent. Perpetual Debenture Stock	100	119-121
Brush Electrical Engineering Limited, Ordinary	2	1¾-2
—— Non. Cum., 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	111-115
—— 4½ per cent. 2nd Debenture Stock	100	101-104
Callender's Cable Company, Debentures	100	110-113
—— Ordinary	5	9¼-10¼
Central London Railway, Ordinary	10	9¼-10¼
——	6	5¾-6¼
—— Pref. Half-Shares	1	1⅛-2
—— ,, ,,	5	4-4½
Charing Cross and Strand	5	11½-12½
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	9-10
—— 4½ per cent. Debentures	100	113-115
City of London, Ordinary	10	22-24
—— ,, 90,001-100,000	10	21-23
—— 6 per cent. Cumulative Pref.	10	15½-16½
—— 5 per cent. Debenture Stock	100	125-130
City and South London Railway, Consolidated Ordinary	100	67-69
—— Ordinary	3	3½-4
—— 4 per cent. Debenture Stock	100	133-135
—— 5 per cent. Pref. Shares	10	14½-15½
—— ,, ,, '96	10	14-15
County of London and Brush Prov. Elec. Light Co., Ord.	10	13-13
—— ,, ,, No. 30,001-40,000	10	11½-12½
—— 6 per cent. Cum. Pref.	10	14½-15½
Crompton and Co.	3	2½ 2¾
—— 5 per cent. Debentures	—	89-94
Crystal Palace District, Ordinary 5 per cent. Stock	100	125-130
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2½-3
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	96-98
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5-5½
Electric Construction, Limited	2	2½-2¾
—— 7 per cent. Cumulative Pref.	2	2⅝-3⅛
—— 4 per cent. Perp. 1st Mort. Deb.	100	105-107
W. T. Henley's Telegraph Works, Ordinary	10	23½-23¾
—— 7 per cent. Preference	10	18-19
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9-10
—— 7 per cent. Preference	5	9½-10½
Imperial Tramways, Limited	6	16½-17½
India Rubber, Gutta Percha, and Telegraph Works	10	21½-22½
—— 4 per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	13-14
London Electric Supply, Ordinary	3	3-3½
—— 6 per cent. Pref.	5	6-6½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	102-104
Metropolitan Electric Supply, Limited, Ord., No. 1-62,500	10	18-19
—— ,, ,, No. 62,501-85,000	4	10½-11
—— 4½ per cent. First Mortgage Debenture Stock	100	115-119
National Telephone, Ordinary	5	5⅝-5¾
—— 6 per cent. Cum. First Pref.	10	13-15
—— 6 per cent. Cum. Second Pref.	10	13-15
—— 5 per cent. Non. Cum. Third Pref.	5	5⅜-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	99-102
Notting Hill Electric Lighting Company, Limited	10	17-18
Oriental, Limited, 1879	1	1½-1⅝
—— £5 Shares	5	7-7½
—— £4½ Shares, New	4½	6½-6¾
Oriental Telephone and Electric Company	1	⅞-1
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6-6½
Royal Electrical Company of Montreal	1½	150-155
—— 4½ per cent. First Shares Mortgage Debentures	100	105-107
South London Electric Supply, Ordinary	3	3-3½
St. James's and Pall Mall, Limited, Ordinary	5	17-18
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	37-41
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	100	111-114
Westminster Electric Supply, Ordinary	5	15½-16½

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NOTES.

Enemies of the Telegraph.—One thing the Cuban ruralist must learn, says the *Telegraph Age*, is not to cut down telegraph wires when he wishes to bale his hay. The custom is not strictly up to date.

Mr. J. W. Swan.—All those who attended the meeting of the Institution of Electrical Engineers on Thursday week regretted to hear that through ill-health the president (Mr. J. W. Swan) had been ordered by his doctor to spend the next month or two in a warmer climate. We trust the indisposition is only temporary, and that he will be back to preside over the Institution meetings before the end of the session.

Gas v. Electricity.—The following extract from the *Harrow Gazette* is not a calculation by either an electrical or a gas engineer: The figures show the relative cost of lighting the school chapel by gas and by electricity, with gas at 4s. 3d. per 1,000 and electricity at 8d. per unit. The average cost of lighting by gas in 1893, 1894, and 1895 was £20. 1s. 8d.; the average cost of lighting by electricity, with additional lights under the organ loft in the south aisle, in 1897 and 1898, including cost of gas-meter and burner, was £17. 10s. Meter rent was included in each case.

Another New Tramway System.—What is termed an over and under ground street railway system has, says our contemporary, *Electricity*, of New York, recently been patented. It is described in the following words: "With this system it is claimed that the difficulties experienced in running cars during the winter, when the tracks are covered with snow, will be overcome. The inventors employ a large conduit, in which the tracks are laid, while the body of the car runs above ground. The trucks will run on the underground track, and a support will extend from each track, through a slot, to the bottom of the car." Surely this latest addition is not seriously meant.

Electricity Distribution Bills.—A meeting was held last week at the Westminster Palace Hotel of a special committee appointed by the Association of Municipal Corporations to protect the interests of the towns of the country against the attack of electric light and power companies during the coming session. The proceedings were private, but it is reported that the committee unanimously resolved to advise the local authorities affected to cause the various Bills to be opposed at every stage. The committee will draw up a statement showing how the interests of the ratepayers will be affected, and this will be forwarded to every member of Parliament, with a request for help. The facts will also be laid before every corporation, district council, and parish council in the country, and their co-operation solicited.

Thargomindah.—This extraordinary name has been given to a small town in the middle of Australia, which reckons amongst its municipal attractions an electric lighting plant. The Agent-General for Queensland, in his paper read before the Royal Colonial Institute on Tuesday last, referred to the fact that in this town the water obtained from an artesian well furnished enough motive power to provide the township with from 150 to 200 16-c.p. lamps. It is estimated that 27 h.p. could be taken from the water as it leaves the borehole. We hope that if the general system to increase the water supply of Australia is eventually adopted, that in other places a similarly good result will be obtained as a by-product. Sir Horace Tozer also referred to the increasing use of electric light in the larger towns, and to the fact that the tramways in Brisbane, which are worked on the overhead system, are highly appreciated.

Temporary Employment.—At the present day, when all trades and professions are said to be overcrowded, it is quite refreshing to hear of an industry in which there are practically unlimited vacancies. The only drawback is the rate of premiums required by the life insurance offices from those engaged. We refer to the work of gathering rubber in the Congo Independent State. According to the British Foreign Office report, the European employés of the great rubber trading company, the Société du Haut Congo, are usually engaged for two years each, but their average service has not exceeded seven months, after which, if not buried, they are confirmed invalids. The actual work of rubber collection is, of course, performed by the natives, but no effective work is obtained from these except under the supervision of outsiders. Facts like these cannot be too widely circulated to prevent young men being tempted by seemingly high salaries to take up vacancies so caused.

X-Rays in Egypt.—At a general meeting of the Röntgen Society held recently Major J. Battersby, of the Royal Army Medical Corps, read a paper on "The Present Position of the X-Rays in Military Surgery." He testified that those rays were of inestimable service in the recent Nile expedition for detecting fractures, etc., and he thought it safe to prognosticate that they would soon be as useful in medicine as they now were in surgery. Out of 21 cases in which he could not localise the bullet by ordinary methods, accurate diagnosis resulted from the use of the rays, the remaining one being that of a soldier who was too ill to be examined. For use in the field the apparatus should be as light as possible. Attention should be directed to the best way of generating the electrical current. In the Soudan they used a small dynamo driven by means of a tandem bicycle. They worked under great difficulties, while the water of the Nile was as dirty as the Thames at Westminster, and all the developing had to be done with it. One day, in the middle of delicate operations, the roof of the X-ray room was blown off.

Rapid Surveying.—We understand that an arrangement is being effected by which a rapid survey of a road or district can be made by means of a bicycle ridden through the same. The idea is briefly as follows: The rider of the bicycle would traverse the roadway in question on the machine, which is equipped with a continuous tape. The length of the tape used would indicate the distance traversed, and the direction would be indicated at intervals by a needle pointing to the magnetic north being stamped on to the tape. A pendulum would also give periodic records of the grade of the road. In this way it is hoped that a rough idea of the roadway and the contour of the country will be obtained. The inventor expects to reduce the errors to about 1 per cent., but with more expensive instruments he hopes to get even less than this. The oscillations due to bad roads will without doubt be one of the greatest troubles in working this instrument. The next point which rises in our mind in connection with it is that in a well-surveyed country like England it is hardly required at all, and that in a new country the roadways suitable for cycling are few and far between.

A Novel Combination.—What may be justly termed "a novel combination" has recently been introduced into some of the trains upon the Hungarian State Railways. It consists in lighting the gas-jets in the different compartments by means of electric igniters. This is a case of electricity holding the candle to gas with a vengeance. The arrangement is said to effect economy in the working costs, which is not difficult to believe, since it gives the car

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attendant complete control of the gaslights, he being enabled from a central switching point to effect the illumination of all compartments or throw them into darkness as circumstances may require; or should any of the compartments happen to remain unoccupied, these may be cut off from the supply at will. This arrangement has certainly something to be said in its favour when applied to old rolling-stock, especially on lines over which numerous tunnels exist, but for new construction, at any rate, it is not likely to find much favour over here in face of the excellent system of train lighting by electricity pure and simple which we are pleased to see finding fairly extensive adoption upon some of our railways.

The Electro-Harmonic Society.—The following is a programme of a smoking concert to be held at the St. James's Hall Restaurant, Regent-street, W., on Friday evening, Jan. 27, at eight o'clock. The musical directors for the evening will be Mr. T. E. Gatehouse and Mr. Alfred E. Izard: Part I.—Overture "Barber of Seville" (Rossini), the Orchestra; song, "Annabelle Lee" (Henry Leslie), Mr. Ager Grover; pianoforte solos, (*a*) "La Fileuse" and (*b*) "Rigaudon" (Raff), Mr. Alfred E. Izard; character sketch, "Fancy Faces" (Seldon), Mr. Charles E. Nott; song, "In a Distant Land" (Taubert), Master Willie Gammage; orchestral selection, "Hungarian Dances" (Brahms); song, "My Heart's Desire" (F. Rosse), Mr. Musgrove Tufnall; humorous sketch, Mr. Roland Henry. Part II.—Vocal duet, "Tenor and Baritone" (H. Lane Wilson) (by desire), Mr. Ager Grover and Mr. Musgrove Tufnall; violin solo, "Rhapsodie Hongroise" (Hauser), Mr. T. E. Gatehouse; new song, "River of Dart" (Edith Cooke), Mr. Ager Grover; burlesque sketch, "The Charge of the Light Brigade" (Black) (in four spasms), Mr. Charles E. Nott; song, "Damon" (Max Stange), Master Willie Gammage; song, "Sir Hal, the Squire" (F. Rosse), Mr. Musgrove Tufnall; orchestral selection, "Serenata" (Moskowski); humorous sketch, Mr. Roland Henry.

Calcutta Tramways.—The extract below shows what our contemporary the *Indian Engineer* thinks of the electric tramways question in Calcutta. They say that it is greatly to be regretted, both in the interests of the Calcutta public and also of the shareholders of the Calcutta Tramways Company, that the London board of directors of that concern have seen fit to reject the exceedingly fair terms which had been agreed upon by their local agent and the Corporation of Calcutta for the provision of electric traction to their roads. The tram service of Calcutta is a disgrace to any city having pretensions to civilisation, and the condemnation extends to the whole concern—track, cars, and traction. The only remedy at present open to the town appears to be to proceed against the company on the many points of breach of agreement in the tram service, which are ready to hand, in the hope that the trouble thus given them will result in a desire to close with the terms offered. A commencement has undoubtedly been made by the company in the laying of new track, but it is the upkeep of the road which requires attention in order to prevent what the tram tracks have been up to date, a danger to all other vehicular traffic. For the present system of horse traction no apology of any sort can be offered. It is out of date, utterly inadequate, and inhumane.

Convertible Cars.—We notice in the *Street Railway Review* a description of a new type of convertible car manufactured by the J. G. Brill Company for the Brooklyn tramways. These cars are arranged so that they can be run all through the summer as open cars, and that at any time they can be easily and quickly changed into closed cars. The car is fitted with transverse seats, and when used as a closed car has a passage down the centre which can, if required, be filled up with additional seats in the summer time. At each seat of the cars there are a series of upright wooden posts. In grooves in these posts the panels and windows for closing the car slide. From the description given we gather that the panels which come up to the height of the back of the seat are first pulled down, and after that the upper part containing the window frames and sashes are also pulled down and fastened. All these sliding parts are contained in the ordinary way in the roof of the car, and the arrangement by which the glazed sashes come round the curved grooves at the top is exceedingly neat. The lower panels are made either of metal sheet or fibre. Layers of carpet are provided to keep the car warm. The only question which strikes one in reading the description is as to whether the various panels can be prevented from vibrating seriously after the car has been in use for some time.

Calcium Carbide.—The *Moniteur des Industries Electriques* reports that the Patent Office at Berlin annulled last month the Bullier patent. The original patent was taken out in 1894 by a French chemist intimately connected with Prof. Moissan. It was claimed for it that it was the only practical process for the production of carbide of calcium by means of an electric furnace. Until now the patent for Germany was the property of a company manufacturing aluminium in Neuhausen and electro-chemical products in Bitterfeld. The Allgemeine Electricitäts-Gesellschaft is largely interested in the latter factory. It is stated that the holding of this patent was a great hindrance to the development of acetylene lighting in Germany, as the proprietors only rarely granted licenses to use it. In consequence of the above decision, a fall in the price of calcium carbide may be looked for in the near future. An exactly similar invention was made about the same time by an American expert named Wilson, who obtained American and English patents in 1894. These patents would seem now to rest on a somewhat insecure basis, since the first publication of the discovery of calcium carbide was made by a German (Prof. Borchers) 10 years ago. This was probably the reason for the present action of the Patent Office, although Prof. Borchers did not try to utilise his discovery in any practical way.

An Arc as a Disintegrator.—An interesting note upon the use of the electric arc for the production of metals in a finely-divided state was read by Dr. Bredig at the recent annual gathering of the German Electro-Chemical Society at Leipzig. We give below a brief summary of the report of this paper appearing in *Kuhlow's Review*: "Dr. Bredig had been investigating the phenomena attending the discharge of high-tension alternating currents under the surface of various liquids. He observed that when metal poles of small diameter were used a cloud of finely-divided solid matter was formed around the arc, and on further investigation this proved to be of the same chemical composition as the metal used for the poles. The state of subdivision was so fine that the water or other liquid appeared as though some colouring matter were in solution, and several days were requisite to obtain deposition of the metal upon the bottom of the vessel. Zinc, lead, silver, gold, and platinum were all obtained in a state of extreme subdivision in this way. In the case of zinc, the author states that two Russian chemists had already published a note upon the phenomenon. The results obtained are attributed by Dr. Bredig to the condensation by the water of the metallic vapour, which always surrounds the electric arc, when metallic poles are used. The method is of laboratory service for the production of finely-divided platinum, capable of the so-called catalytic action, direct from platinum wire.

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The Automobile Club.—At a meeting of this club held last week, the subject of accumulators for motorcars was introduced by a paper read by Mr. Northey. Mr. W. H. Preece took part in the discussion, and referred to the charges made by the various electric light companies for power for charging accumulators. He pointed out that the usual charge in London was 3d. per unit, although in Shoreditch and St. Pancras areas it could be obtained for 2d. from the Vestry. He stated, however, that at Edinburgh, if a regular supply was required, the Corporation supplied it at 1½d. per unit. It is worthy of note in this connection that the London Electric Cab Company have been compelled to put down their own plant for charging accumulators, as the companies' charges were found to be exceedingly heavy. Mr. Preece also referred to the progress made by the Post Office in the use of automotors for the work of the Department. Afterwards one of the members of the committee appointed by the Postmaster-General to consider the question stated that as soon as anyone could offer to do the work at the present cost, the better they would be pleased. They were willing to give every encouragement to inventors, and they had an open mind as to whether the vehicles should be propelled by oil, gas, steam, or electricity. Already several types had been tested, and one at least worked very well.

The "Proceedings" of the Municipal Electrical Association.—A glance at the 1898 issue of these *Proceedings* shows that the Municipal Electrical Association is doing good work. The biggest part of the volume is taken up with the third ordinary general meeting, which was held in London last June, and the full discussion on the various papers then read will be found in the present volume. The approved standard clauses for specifications of electrical work are given at the end of the book. These are exceedingly useful for reference, and will, we trust, be generally adopted by all consulting engineers. They were drawn up by a general committee of manufacturers and borough electrical engineers, and are both reasonable and fair to all parties interested. Although on the first persual it would seem that the contractors gain most by the use of these clauses, the ultimate benefit to the community of the more reasonable requirements will be great, as the contractor will be able to give concessions in the prices on his produce. We also notice that the association is offering a prize of the value of £5. 5s. to be competed for by the associates of the association for the best paper read on any subject connected with municipal electric engineering. The subject may be selected by the associate, but we note that for some reason or other he has to obtain the approval of the council before reading his paper. This seems to us a needless regulation, and one which may lead to considerable friction. The society has inaugurated a benevolent fund, which, we trust, will find support. It should, in the present state of the industry, be some years before many grants will be required, and by then the fund should be financially strong.

South African Learned Societies.—We have just received the last issue of the old year of the *Journal* of the Chemical and Metallurgical Society of South Africa, together with a copy of the constitution and rules of this society, which has its headquarters in Johannesburg. The reports of their meetings, with the discussion on the papers on mining process, are most interesting reading. The members express their opinions freely, and in one case the president opened the discussion by reminding those present of the motto of the society, "Suaviter in modo fortiter in re." The fight then began on the subject of "A Zinc Process for the Precipitation of Gold from Weak Solution." The Siemens and Halske electrical process had its supporters in the room, and also its opponents. One of these said that there was a field for the Siemens-Halske process, but not on the Main Reef. That field would be where there were impure ores, containing other metals than gold which are freely soluble in cyanide, such as carbonate of copper, etc. Such an ore was found at Pilgrim's Rest, where the zinc in a very short time after having been placed in the precipitation boxes looked like so many ribbons of copper. When the Siemens-Halske process was started, the bead from the first clean up carried no less than 30 per cent. of its own weight of copper. The speaker drew attention to the great uncertainty of the Siemens and Halske process. One day the solution leaving the boxes may be down to two grains of gold per ton, while the next day it is a not infrequent thing to find it leaving the boxes at the same value as it went in. The chief supporter of the electrical process said that these variable results were due to overloading the equipment and to irregular working. Steady results were got in most of the mines where the process was in use.

Controlling Apparatus for Boosters.—The *Electrical World* in its last issue for the old year describes fully the power plant recently installed by the Capital Traction Company at Washington. A few extracts from this article, with illustrations, will be found elsewhere in this issue. Our contemporary especially comments on the requirement of a controlling apparatus used in connection with electrical boosters for traction work. Thus the ordinary means of cutting out an electrical generator in case of emergency are not sufficient for the dynamo using a booster, owing to the peculiar nature of its winding and load. Especially is this the case in series-wound, motor-driven boosters, used to raise the voltage of the current supplied to the longest feeders, the generating end being series-wound and direct-coupled to a 600-volt motor supplied with power from the main circuit. The contingency which calls for a special protective apparatus is the opening of the motor circuit. In this case the torque generated between the armature and field of the booster generator tends to reverse the direction of rotation of the machine, and as it is series-wound it tends to run away as a series motor. This accident is provided against by connecting the "tell-tale" of the motor circuit-breaker through a battery circuit with an electromagnetic relay, which in turn closes the circuit of an auxiliary magnet on the booster circuit-breaker, tripping it, and opening the booster circuit. This rather indirect method of control might be improved by using a double-pole circuit-breaker instead of the single-pole breaker in the motor circuit, the added pole being connected up in the booster generator circuit. Both circuits would then be opened simultaneously. Our contemporary considers that a better method would be the provision of some arrangement for throwing the boosted feeder over on to the 'bus bars direct. This avoids the entire interruption of current to the feeder, and at the same time gives clear warning to the attendants at the power station that something is wrong.

Electrical Working of Railways.—A lecture was recently delivered by Mr. A. P. Feldmann before the Cologne Society of Electrical Engineers, in which he chose for his subject "Electrical Working on Main Lines." The speaker, who produced abundant statistic material in support of his arguments, contended that electrical working of main lines was improbable for some time to come, especially in relation to goods traffic, which latter he considered would probably always remain a domain of the steam locomotive. On the other hand, electricity was adapted to supplement steam-locomotive working where

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the latter could not be carried on economically, such as the working of single express cars upon branch lines, and for shunting purposes at small stations, since hereby the wasteful practice of keeping locomotives under steam during periods of rest might be avoided. Such system of working was also adapted for lines over which the traffic resembled that of tramways—for instance, district railways and connecting lines between neighbouring towns. He further said that in his opinion the principle of the Heilmann locomotive was quite wrong. Accumulator locomotives were at the present time, and, indeed, even for heavy trains, practical possibilities, but, except for shunting purposes, not economical. Whether, for instance, it were possible to develop an electrically-worked express service for passengers over long distances still constituted a very doubtful question. In any case this would entail the necessity of separating the passenger from the goods traffic, and even then considerable difficulties relative to the distribution of the generating and sub-stations remained. In the discussion which followed, this pessimistic view was not generally shared. The electrical working of railways should naturally be treated from quite a different standpoint than the steam method of working now in vogue. Instead of trains running at considerable intervals, a frequent service of short trains or only single cars must be inaugurated, which plan would enable the principal difficulties with regard to the disposition of generating stations and distribution of the electrical energy to be overcome with far greater ease.

Conference of Science Teachers.—This conference concluded its meetings on Friday, 13th inst. One of the subjects of discussion then entered into which most directly concerns the electrical engineer, is the teaching of mechanics. A paper was read on this subject by Mr. S. H. Wells. The point in his paper which excited most attention was the statement that in teaching elementary mechanics the most suitable apparatus is that which is most simply constructed. Now, it may be admitted that certain important mechanical laws may be illustrated by means of very simple appliances; but in other cases friction plays such an important part that other properties are entirely masked. Mr. Wells got over this difficulty by claiming that simple apparatus, such as that whose use he advocated, if it failed to illustrate the law which it was designed to determine, it at least proved the important *rôle* played by friction. Similarly, we might urge, a chemist whose experiments failed through careless manipulation or the use of impure chemicals, might claim that he was teaching the importance of precision and cleanliness. But, as a matter of fact, experiments such as those now in question, if they serve any useful purpose, can only do so by enforcing the advice: "Go thou and do otherwise." Only, as there are many wrong ways, and only one right way of doing a thing, it may be worth while to remember the aphorism of Wilhelm Meister, "Experience is an excellent but a most expensive tutor." Mr. W. W. F. Pullen put the whole matter very clearly when he said that apparatus designed to illustrate mechanical laws should be rendered as frictionless as possible, whilst, on the other hand, the efficiency of pulleys, screws, and such like elements of machinery, actually constructed for commercial purposes, should be studied under the conditions in which they are intended to be used, thus gaining knowledge of the allowance which must be made for friction and other disturbing causes. The whole subject of discussion at first sight may appear somewhat trivial; but the technical student generally has so little time to devote to purely scientific study that the importance of utilising that time to the best advantage can scarcely be over-rated. Speaking of the answers occasionally given to examination questions, Prof. Ewing mentioned the following: To the query, "What is a vacuum?" an intelligent youth had replied, "The place where the Pope lives." This answer is not without psychological interest to the intelligent teacher.

Electric Locomotives in France.—We have referred in a recent number to the electric locomotive which was tried last November on the lines of the Paris, Lyons, and Mediterranean Company. The locomotive was designed for high speeds, but up to the present time only very moderate speeds have been obtained from it. It will be remembered that in this case accumulators were used to supply the power for the trials, and that the lines were not equipped with continuous conductors. A full description of this locomotive will be found in the issue of *L'Energie Electrique* for Jan. 1 this year. From this we gather that the locomotive was first thought of in 1893, and that it was built by Sept. 14 1897. At a somewhat later date the accumulators were added, but it appears to us that the design is seriously hampered by using accumulators at all. There are on the locomotive two driving axles, on each of which the armature of an electric motor is constructed. Two commutators are provided for each motor. The four-pole field-magnet systems appear from the illustrations to be exceedingly cumbersome. In fact, the type of field design is more in keeping with central-station plants than with electric railway engineering. These heavy field magnets are carried in a frame which has two direct bearings on the shaft, but springs from the frame of the locomotive prevent the whole weight coming on these bearings. The armature discs used are 27in. diameter and 21in. long, and the conductors are all embedded in holes in the core. These conductors consist of copper bars having a cross-section of 64 square millimetres, which are insulated by means of micanite tubes. There are said to be 150 conductors to each armature, but we are not sure if this refers to the whole armature or to one circuit only. The motors are supplied by accumulators on the locomotive, while the main supply is drawn from another series on the tender placed behind the engine. We are surprised to find that in the controller liquid resistance is used, but we hardly think that it would be found serviceable in regular work. We hope in due course to hear of some extended trials on this locomotive, and hence refrain from publishing the calculations which are given in our contemporary's columns.

One Use of Aluminium.—Dr. Goldschmidt, of Essen, recently described his method of obtaining high temperatures by means of the heat of combination of aluminium and oxygen. A *résumé* of his methods appear in *Kuhlow's Review*. Attention is drawn to Dr. Goldschmidt's statement that the substitution of sulphides for oxides, and magnesium or calcium carbide for aluminium, while less effective, also gives serviceable results. The early attempts to utilise this well-known property of aluminium are described, and their failure is attributed to the methods employed. Instead of obtaining the reaction throughout the whole mass at once, which means explosions and damage, Dr. Goldschmidt arranged matters so that the reaction started at one point and was gradually communicated throughout the whole mass, thus giving a continuous source of heat. In preparing chromium it was found necessary to add a superoxide of some kind, to enable the operation to go on continuously. Oxide of lead, copper, or permanganate of potassium served very well, and by keeping the oxide of chromium in excess, a regulus of chromium free from aluminium was finally obtained. By mixing in some iron ore the charge is attenuated, so to speak, and the reaction

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takes place less violently and more slowly, the intensity of the heat is less, and simple heating effects are produced. Thus a rivet is covered with a mixture of iron ore, sand, and aluminium filings. The mass is ignited by a special cap made of aluminium powder and some substance giving off oxygen freely, a strip of metallic magnesium inserted in the cap serving as a fuse. By lighting the ribbon the reaction is started and the whole mass is soon aglow. On breaking the shell the rivet will be found white-hot and ready for hammering up. Brazing can also be carried out readily in this way where the use of ordinary appliances would be out of the question. Welds are easily made, and holes in ½in. iron plates are melted through in very short spaces of time. Coming now to the question of obtaining pure metals, Dr. Goldschmidt describes a new method of making chromium. He takes a mixture of chrom oxide and powdered aluminium, places them in a crucible lined with magnesia, and starts the operation in the manner described above. The chromium may be drawn off at one place and the slag at another. Nearly all the metals can be reduced; thus even alloys, such as ferroboron, ferrotitanium, chrom-manganese, chrome copper, etc., can be readily produced. Pure aluminium is, of course, used where pure metals are desired. For simple heating effects, the 50 per cent. crude aluminium of commerce is said to be quite effectual and much cheaper. These applications open out a wide field for a large consumption of aluminium, which will entail enlarged factories and more electrical plant.

The Electro-Chemical Equivalent of Silver.—Messrs. G. W. Paterson, jun., and Carl E. Guthe contribute to the December number of the *Physical Review* an interesting article on the new determination of the electro-chemical equivalent of silver. The authors point out that the discrepancy of the values for the mechanical equivalent of heat obtained by the electrical method and those found by the direct method, has suggested the possibility of the difference being due to an error in the standards used. The value of the ampere was suspected to be wrong, and this led them to attempt a redetermination of its value by a new method. The electro-chemical equivalent of silver has been repeatedly determined, and was found to be 0·0011156 grm. by Mascart, 0·00111794 grm. by Lord Rayleigh and Mrs. Sidgwick, and 0·0011183 grm. by Fr. and W. Kohlrausch. In the first two cases an electro-dynamic balance was used, and in the last an accurate tangent galvanometer. Heydweiler compared Lord Rayleigh's and Kohlrausch's methods directly, and came to the conclusion that the error in the two methods could not be larger than 0·1 per cent. Köpsel found 0·0011174 grm. with a balance built according to von Helmholtz's directions. The experiments by Pellat and Potier, using Pellat's absolute electro-dynamometer, gave 0·0011192 grm. For a number of years Kahle has been at work at the Imperial Institute in Berlin using Helmholtz's current balance, but the definite report of this valuable investigation has not yet been published. In the preliminary report 0·0011182 grm. and 0·0011193 grm are given according as the silver was deposited from a fresh or old solution. In all the experiments mentioned the value of the electro-chemical equivalent of silver depends upon the accurate knowledge either of the acceleration due to gravity or of the horizontal intensity of the earth's magnetic field. The authors measured its value entirely independent of g or H by balancing the moment due to the electro-dynamic action of the two coils of an absolute electro-dynamometer designed by them against the torsional moment of a wire with very small elastic fatigue. The measurements are finally reduced to measurements of mass and length only, and the authors considered their results to be accurate to at least 1 in 5,000. The authors proceed to describe in detail the apparatus used by them on the various steps in their investigations, which led them to believe that the mentioned accuracy can be obtained. As the result of a number of experiments carried out during the month of June, they found the electrical equivalent of silver to come at 0·0011192 grm. per ampere per second. This value is about $\frac{1}{9}$ per cent. larger than the accepted value, but agrees with the average value found by Pellat and Potier, and with the value Kahle found when using an old solution of silver nitrate. The article is well illustrated, and is concluded by a *résumé* of some recent publications of Kahle's investigations, which agree almost identically with those of the authors.

Some Fallacies Regarding Electrolysis.—Mr. Albert B. Herrick has an excellent article in the *Street Railway Journal* on the electrolytic trouble caused by the earth returns on electric tramways. He points out that the deterioration of pipes so caused has been much exaggerated, and that it can always be prevented if care is taken in laying down the tramway system. Thus, "the electrolytic effect familiar in laboratory work is the transference of metal from one plate to another by a current of electricity when immersed in the proper salt solution of that metal, but the electrolysis that occurs in the railway ground returns is of an entirely different character. The earth in which the metal is buried is an insulator, but it becomes a conductor by the absorption of moisture, and its resistance may vary from nine-tenths of an ohm to over a megohm per cubic yard, this resistance being varied by the amount of water and the solvent salts present. When the current leaves a metallic surface which is buried in the earth it does not carry with it the decomposed metals, as in a plating bath, and deposits them on the cathode. Instead they lie adjacent to the surface acted upon, and when the metal is iron generally forms oxides. These oxides increase the resistance to the flow of current, and consequently the resistance of the return circuits *viâ* the earth. This effect is actual as well as theoretical. It is often unconsidered, but the gradual falling off of the current returned by the water-pipe system can be noticed in roads where the ground returns are properly located and bonding maintained. The disastrous predictions made years ago regarding the destruction of piping systems by the railway return current have not been realised; and this may be owing to the above condition of electrolytic currents destroying their own paths of conduction. Some of the recent examples of electrolysis that have been unearthed have many appearances of having been formed at a very early period in the art of electric railroading." The author then describes practical tests to ascertain the current flowing in pipes and from the rails to pipes buried in the earth. All the methods consist of providing additional circuits of variable resistances and noting the difference produced in the voltage between the points when certain definite currents traverse the short-circuits so produced. The author then deals with preventive methods of reducing the differences of potential between the rails and earth, and naturally gives the earth booster system as used at Bristol and Dublin a good mention. Speaking of instances of usual corrosion, he mentions one where poor insulators were used for the feeders, which were supported on iron poles. After several poles had broken off at the surface of the earth, an examination was made. It was found that the iron had been eaten away by the leakage current which, in wet weather, escaped through the light insulation to earth over the cement foundation. This reduced the strength of the poles where they had to bear the greatest strain.

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A NEW TRANSMISSION PLANT.

BY CHAS. W. PARKES.

The advantages of transmission in the service of mining and smelting have been shown since the plant of the Helena Water and Electric Power Company was put into operation. This plant is situated at Canyon Ferry, on the Missouri River, 18½ miles from Helena, Mont., U.S.A. The river is dammed to a height of 55ft. by a stone dam of massive construction (Fig. 1). The power-house is of stone, and at present contains four 750-kw. generators, built by the Westinghouse Electric Manufacturing Company, of Pittsburg. These generators (Fig. 2) are connected direct to turbines built by the Dayton Globe Ironworks, of Dayton, Ohio, U.S.A., and at a speed of 157 revolutions per minute deliver 550 volts to the switchboard. The fields are excited from two 100-kw. direct-coupled generators (125 volts) connected to smaller wheels. These operate at 225 revolutions per minute and are built by the same makers as large machines.

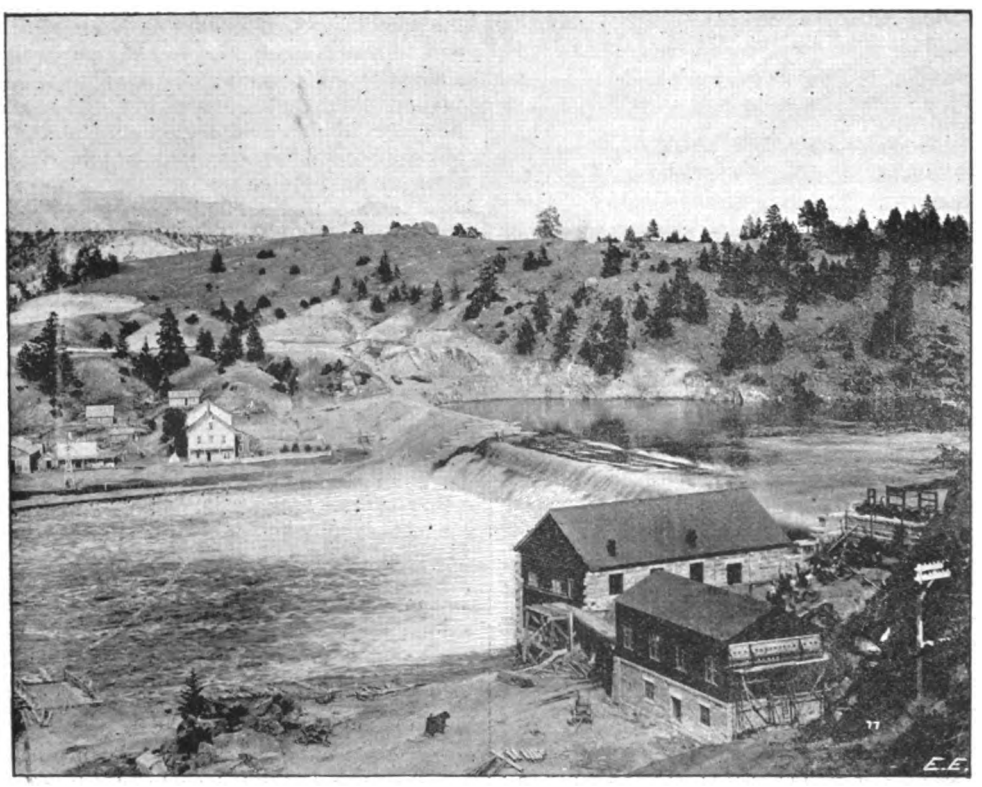

FIG 1.—The Power House and Dam at Montana Ferry. The Pole Line coming from the Transformer House is seen in the Foreground.

The switchboard, of white marble, is made up of nine panels, each 2ft. by 5ft. 6in., fitted with voltmeters, ammeters, and wattmeters, together with necessary switches and synchronising devices, arranged to run any or all machines together. The transformer house is 100ft. distant, and contains eight 300-kw. step-up transformers.

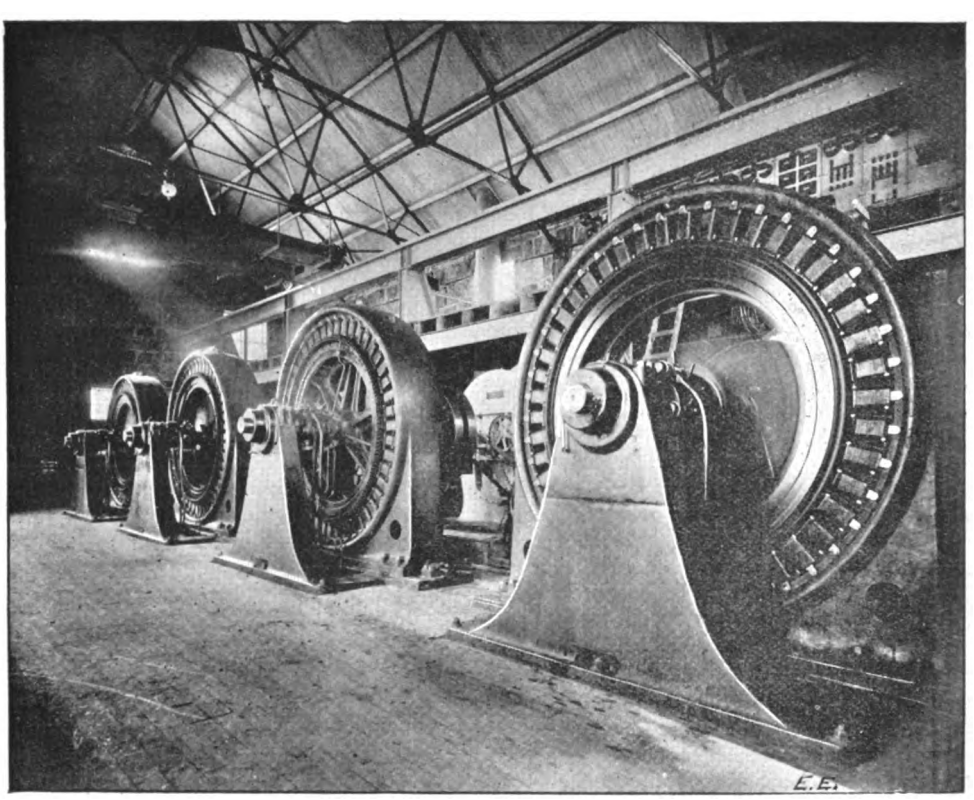

FIG. 2.—View Inside the Power House, showing Two-Phase Generators.

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Here the initial voltage of 550 volts is raised to 10,500, and carried through a bank of lightning arresters to the line. These arresters are of the Westinghouse manufacture, being known as the "Wurts non-arcing metal arresters." The pole line which crosses the mountains is composed of four three-wire circuits, of No. 1 hard-drawn copper wire, and is very strongly constructed. During last December the storms were unusually severe, but there was no interruption whatever.

Situated 13½ miles distant from the generating plant are the works of the Helena Smelting and Refining Company. All the work of crushing, hoisting, and handling is done by means of induction motors. In Montana, where labour is dear, this item is very important. The blast for the three smelting furnaces is furnished from two 36in. compressors, driven by two 175-kw. induction motors. The sampling works, where the grinding and crushing, preparatory to assaying and roasting, is carried on, are operated by one 100-h.p. motor. In the pump-house are two direct-connected pumps (Fig. 3), one of 100 h.p. and one of 50 h.p. In the machine and blacksmith shops are one (20 h.p.) each. The hoisting is done by means of one 100-h.p. motor. The total capacity of motors in use is about 800 kw. The residence of the manager, and the rooms and offices of the staff, are all heated and lighted from the same transformers which furnish the power. Since the introduction of electricity into these works, especially with reference to the air-compressors, the number of heats on each 12-hour shift has been increased from 45 to 64, which is gratifying alike to the directors and shareholders. Two miles north-east from the smelter is the concentrating plant of the Helena and Livingstone Company. This plant is used to concentrate the ores preparatory to delivering to the smelter. Most of the machinery used in this plant is designed and owned by the superintendent, so that a detailed account of the same would be out of place here. The grinders, six in number, also the hoists from ore bins, are operated by a 500-h.p. induction motor. The "Peck" concentrators, which are the chief features of the plant, are connected by a line shaft to another 500-h.p. motor. The high rate of speed at which it is necessary to operate these machines (in some instances belts are running 13,000ft. per minute) made it necessary to introduce some special features which made the demands on these motors especially severe. The hoisting, pumping, lighting, etc., of these works is all done from the power transformers. The plant of the Helena Light and Power Company is situated 18½ miles from the generating plant. Here are six 150-kw. reducing transformers, from which are operated the lighting and power circuits in the city of Helena. The secondaries from three transformers of 1,100 volts are carried to three-phase 'bus bars, to which are connected the various circuits. In one leg of each circuit is placed a Stillwell regulator, which controls the voltage 10 per cent. up or down. At present there are six circuits in service, with a maximum of 412 kw. The street railroad is operated from two 175-kw. rotary transformers, which at 750 revolutions per minute, with 320 volts on the primary rings, deliver 575 volts (direct current) to the 'bus bars. The arc machines are operated from a line shaft, on each end of which is a 100-h.p. induction motor driven from the same circuit as the rotary transformers. The transformers and all the electrical apparatus used on these plants were furnished by the Westinghouse Electric and Manufacturing Company, who, through their engineer, Mr. Charles W. Parkes, installed the generators, motors, etc., and turned the plant over to the local company in commercia operation.

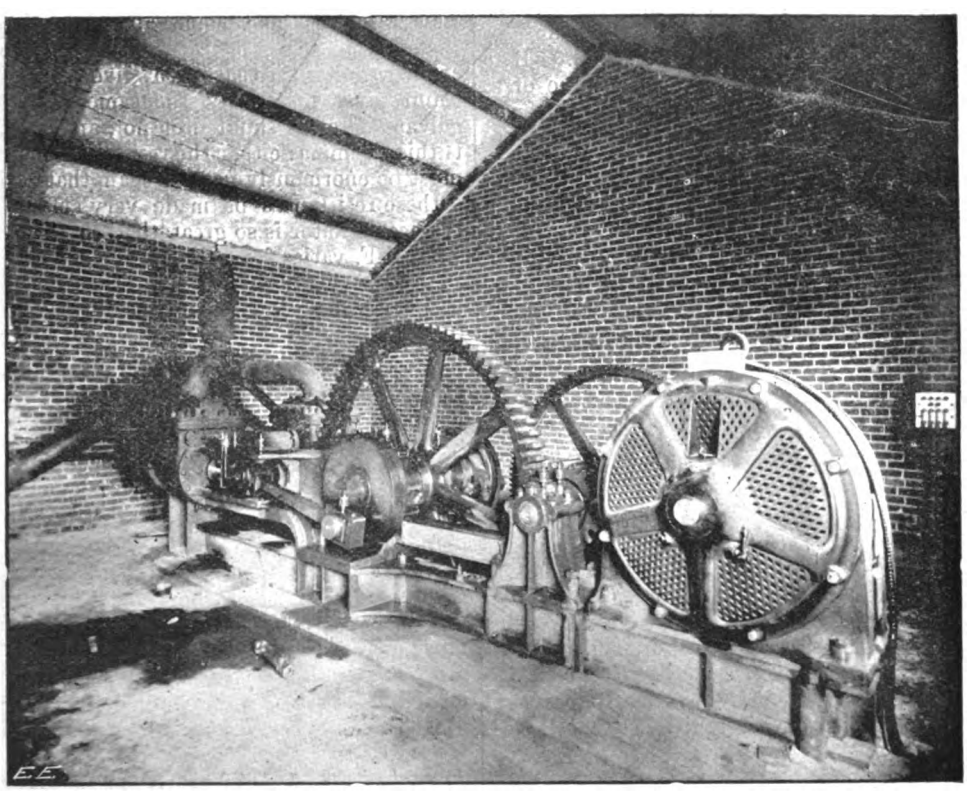

FIG. 3.—An Induction Motor Driving a 100-h.p. Pump at Helena.

NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

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CXXXVII.

In charging, the potential difference at the accumulator terminals (which has been termed E in Section CXXXII.) is necessarily higher than the E.M.F. (e) which it overcomes. In discharging, the potential difference (which in this case we will term p.d.) is necessarily lower than the E.M.F. (e) of the cell. The equation for current is then—R being the external resistance in the circuit, and r the internal resistance of the cell—

$$C = \frac{\text{p.d.}}{R} = \frac{e}{r+R};$$

whence

$$\text{p.d.} = e\frac{R}{r+R}.$$

The following curves, due to Prof. Ayrton, show the fall of p.d. and of e, and also the rise of r, in the case of an E.P.S. (1888 type) cell, discharged at the constant rate of

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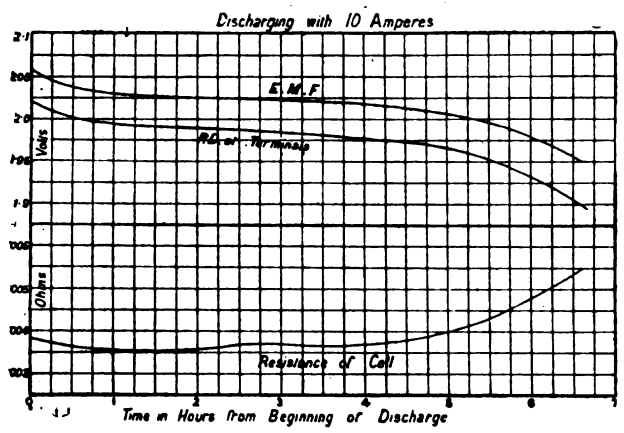
10 amperes, the density of current being $\Delta = \cdot 029$. The value of r at any period is here given in thousandths of an ohm.



It may be useful to point out that, when both current and current density are given, the total peroxide (or spongy-lead) active surface is virtually indicated. If a be the size of the plates—viz., the area of one surface of a plate—and n the total number of plates, the total surface, *either* positive or negative, will be $a\,(n-1)$. If a be taken in square inches, and Δ be the current per square inch of, say, peroxide surface, then since

$$\Delta = \frac{C}{a\,(n-1)}, \quad \text{(Section LXXXVI.),*}$$

$$\text{total peroxide (active) surface} = a\,(n-1) = \frac{C}{\Delta} \text{ square inches.}$$

Thus, in the case of the above-mentioned cell, the total area of peroxide surface was

$$\frac{C}{\Delta} = \frac{10}{\cdot 029} = 344 \text{ square inches (approximately).}$$

CXXXVIII.

It may be here noted that when the cell above referred to was discharged immediately after charge, the "quantity efficiency" was found to be 97 per cent. and the "energy efficiency" to be 87 per cent. But when the cell was left at rest for 16 days after charging, the former value had fallen to 65 per cent. and the latter to 57 per cent.

It is necessary to define what is meant by efficiency in the above case. The term has, in fact, been applied to at least three different ratios; and, in order to prevent confusion, care must be taken to distinguish between them. These are:

$$\text{Commercial efficiency} \begin{cases} \text{Quantity} \begin{cases} \dfrac{\text{Ampere-hours in external circuit of accumulator}}{\text{Ampere-hours supplied by dynamo}} \\ \text{Energy} \begin{cases} \dfrac{\text{Watt-hours in external circuit of accumulator}}{\text{Watt-hours supplied by dynamo}} \end{cases} \end{cases}$$

$$\text{Efficiency of conversion (energy)} \begin{cases} \dfrac{\text{Total watt-hours stored in an accumulator}}{\text{Watt-hours supplied by dynamo}} \end{cases}$$

$$\text{Electrical efficiency} \begin{cases} \text{Quantity} \begin{cases} \dfrac{\text{Ampere-hours in external circuit of accumulator}}{\text{Ampere-hours stored in accumulator}} \\ \text{Energy} \begin{cases} \dfrac{\text{Watt-hours in external circuit of accumulator}}{\text{Watt-hours stored in accumulator}} \end{cases} \end{cases}$$

It is the electrical efficiency that is referred to above. This varies very considerably according to the rate of discharge, as will be illustrated further on. With a high rate of discharge, it may be assumed that the ampere-hours which cannot be utilised remain stored as a residual charge in the battery; but this is by no means the case in regard to the watt-hours. The reason of this I have traced to the fact that, in a rapid discharge, monoxide of lead, instead of sulphate of the metal, is produced by the reduction of peroxide of lead. It is true that this monoxide subsequently becomes converted into sulphate; but this subsequent conversion, although attended with a recuperation of E.M.F., produces *heat* instead of electrical energy. Some recent experiments in electric traction appear to establish the fact that, when very high rates of discharge are required, economy of energy, as well as of time in charging, may be effected by utilising only a portion of the charge, and recharging immediately.

Other useful definitions of efficiency may require to be considered, as, for instance, the ratio of the horse-power hours developed at the periphery of a driving wheel to the horse-power hours expended by the engine which drives a dynamo to charge an accumulator working a motor utilised for traction.

CXXXIX.

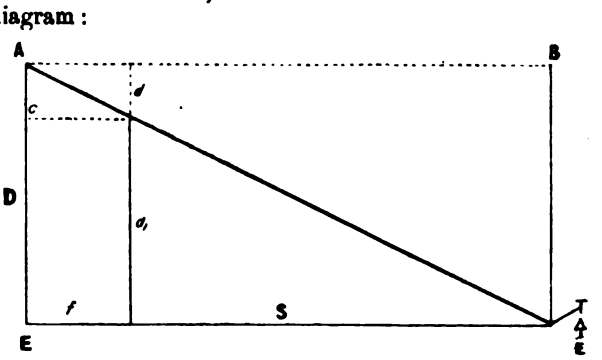
The measurement of the internal resistance of a single accumulator cell of ordinary dimensions is a matter of some difficulty, and in any case requires considerable skill. The ordinary methods used by telegraphists for measuring the resistance of primary batteries are quite inapplicable. The reason of this becomes apparent when it is considered that any battery of which the resistance is negligible in comparison with that of a given galvanometer and its shunt gives practically the same deflection whether the galvanometer be shunted or not, and that, moreover, there is this dilemma: either the resistances inserted in the circuit must be enormously greater than that to be measured, or, if these resistances be made very small, the current from the accumulator is so great that the battery polarises, and its E.M.F. varies from time to time.

Without entering into any elaborate method of measuring the resistance of an accumulator cell, it may be pointed out that these difficulties may be to a great extent avoided by the use of a condenser of given capacity, of which the charge, or the potential (these varying in the same ratio), is measured by means of a ballistic galvanometer or of an electrometer (1) when the condenser is charged from the cell when on open circuit, and (2) when it is charged from the cell when this is *momentarily* circuited through a resistance or shunt not incomparably greater than the internal resistance of the cell.

The first mention, so far as I know, of a condenser method of measuring the resistance of batteries was by Mr. H. R. Kempe, in Vol. I. of the *Journal* of the Society of Telegraph Engineers (1872-73), p. 419. He applied the method to a battery of high resistance—viz., one of 100 Daniell cells. The same method, and a modification of it, illustrated by means of a diagram similar to that reproduced herewith, was anonymously described in the *Telegraphic Journal* of Feb. 1, 1878. In Kempe's "Electrical Engineer's Pocket-Book," 1890, the same device is described as "Muirhead's method," p. 29. It is generally referred to, however, as "Munro's method." In my own practice I modified this method by using an electrometer, instead of a ballistic galvanometer, in conjunction with the condenser, and subsequently by dispensing with the latter. I also modified the original method, as shown.

CXL.

The theory of the condenser method of measuring the internal resistance of cells, and that of the various modifications of this method, will be understood from the following diagram:



Let E and p be respectively the negative and the positive poles of a cell. (In order to represent the fall of potential in the circuit, when closed, by a single triangle, the negative

* In the formula given under this section, current is indicated by I, derived from the French *intensité de courant*. There is in this country, however, an insuperable objection to the use of any symbol other than C for current.

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pole, E, is supposed to be connected to earth; the potential being thus + throughout the circuit excepting at E, where it is nil.) In connection with the + pole, p, of the battery, is one end of the shunt wire, S; the other end is attached to a key by means of which it can be connected to E, thus completing the circuit. E is repeated twice; but in each case it indicates the same point—viz., the negative pole of the cell, which is at zero potential. When the circuit is open, the distribution of potential is shown by the dotted line, A B; when the circuit is closed, the distribution is shown by the hypothenuse of the triangle. Now, when the cell is on open circuit, let the terminals of a condenser be respectively connected to p and E through a ballistic galvanometer. The "throw" of the needle will indicate the potential at p; it will be D = A E. Still maintaining the contacts, circuit the cell through S by depressing the key; the potential at p will now become A E − A c = d_1; and a reverse throw of the needle, d = A c will indicate a partial discharge of the condenser.

Then, by similar triangles:

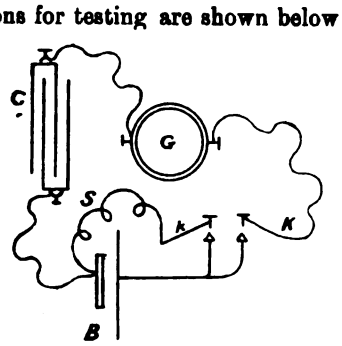
$$d_1 : S :: D - d_1 : \rho.$$

But $$D - d_1 = d.$$

Thus the resistance of the cell is

$$\rho = S\,\frac{D - d_1}{d_1} = S\,\frac{d}{d_1}.$$

The connections for testing are shown below:



When K is depressed, the deflection D is obtained. If, whilst K is still down, k be momentarily depressed, the deflection d is obtained, in the reverse direction; the condenser being partly discharged through G.

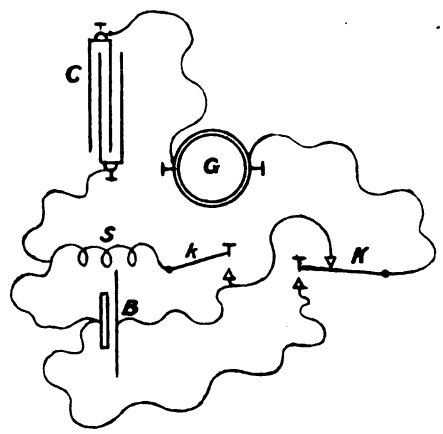
If the condenser be now wholly discharged, by connecting its terminals, and if k and, immediately afterwards, K be depressed, the deflection d_1 is obtained in the original direction. $d_1 + d$ should = D.

CXLI.

However small we may make the resistance, S, it is usually, in the case of a large accumulator cell, much greater than ρ. The deflection, d, corresponding to the latter resistance is consequently very small in comparison with d_1 and D. It is necessary, therefore, to obtain the "throw" d_1, as well as D and d, and to check the readings by observing whether the sum of d and d_1 is equal to D. With the above arrangement of apparatus, it too frequently happens—even when the observed "throws" have been duly corrected for air resistance by adding to them one-fourth of the difference between the throw and the next return on the same side of zero—that the results obtained are not verified by this necessary equivalence. One reason for this is that the deflection d is not on the same side of zero as d_1 and D. It occurred to me many years ago that the above condenser method of measuring the resistance of cells might be so modified as to obtain the three throws, D, d, and d_1, in quick succession *on the same side of zero.* To effect this, as shown below, was not a very difficult matter; but I remember that the late M. du Moncel—who, I think, describes this modification somewhere in his voluminous works—expressed to me, through a friend, his appreciation of its practical value.

1. By depressing K, the throw D is obtained.
2. When K is released, and k is momentarily depressed, the throw d is obtained.
3. By depressing K whilst k is down, the throw d_1 is obtained. But here a difficulty arises, which, unless it be obviated, results in a false value for d_1 and vitiates the test.

By depressing k the throw d is produced, and d_1 can be obtained only after the needle of the galvanometer has returned to its position of rest. Before it can do so, however, the accumulator, circuited through S, begins to "polarise," and the throw d_1 is lower than its true value with constant E.M.F. There are two ways of obviating this difficulty: First, the galvanometer may be short-circuited before k is depressed, and remain short-circuited



until K is to be depressed—*i.e.*, for the fraction of a second necessary to allow of the passage of the current which would produce the throw d; or, secondly, k may be depressed, and then instantly K must be depressed so as to be in position between the stops, after which k may be released. When, now, K is brought into contact with the lower stop, a correct value for d_1 may be obtained, which when added to d will make up the value of D.

INSTITUTION OF ELECTRICAL ENGINEERS.

Telegraphy by Magnetic Induction.

BY S. EVERSHED, ASSOCIATE.

(Concluded from page 47.)

In the relays on the Lavernock-Flat Holm telegraphs the greater length of rectangle—4cm.—results in a lower value for r—namely,

$$r = \frac{4{\cdot}0}{1{,}000} \text{ dynes.}$$

The power required to work a 4cm. rectangle at any amplitude can now be calculated from the value for r just given, and the known frequency—16 periods per second—for, as we have already seen, the mechanical power expended is

$$M = r\,a^2\,p^2.$$

Let $r = \frac{4}{1{,}000}$, $a = \frac{1}{10}$ cm., $p = 2\,\pi \times 16 = 100$:

then $M = 0{\cdot}4$ erg per second ($a = 0{\cdot}1$cm.);

or, if $a = 0\,01$cm.,

$M = 0{\cdot}004$ erg per second ($a = 0{\cdot}01$cm.);

and so on.

An amplitude of $\frac{1}{10}$mm. is, however, far more than is necessary under favourable conditions. The author has repeatedly worked a twin-rectangle relay with less than two mils between the contacts, and a relay was purposely set up at Woodfield Works with the contacts two mils apart to ascertain how often accidental shaking made contact. The relay was tested every day by alternate current to see that it was in working order, but in the course of a three weeks' trial no accidental contact occurred.

Taking two mils—say 0·005cm.—as the limiting value for the clearance between contacts, the mechanical power expended becomes

$M = 0{\cdot}001$ erg per second ($a = 0{\cdot}005$cm.).

This must be considered as the limit of sensibility for this particular relay. When the clearance is reduced to less than two mils, difficulties arise from the electrostatic attrac-

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tion between the rectangles drawing them into contact, and when in contact the elastic force of the wires is insufficient to pull them apart again.

It is clear, however, that the energy received in a secondary circuit can be detected by means of a synchronous vibrator of the kind described in which frictional resistance has been reduced to 4×10^{-3} dynes. Returning to equation (4^a), and assuming the resistance of the rectangle is negligible compared with the least possible resistance of the secondary circuit, we can now write

$$M = r a^2 p^2 = \frac{p^2 s^4 W_p V_t^2}{32^2 D^6 \rho^2}.$$

Hence,
$$a = \frac{s^2 V_t \sqrt{W_p}}{32 D^3 \rho \sqrt{r}}. \quad . \quad . \quad . \quad . \quad . \quad (10)$$

When, as in the former example, $V_t = 1{\cdot}1 \times 10^5$ c.c., $s = 10^5$ cm., $W_p = 200$ watts, $D = 10$ km., $\rho = 1{\cdot}7 \times 10^{-6}$ ohms, and, in addition, $r = 4 \times 10^{-3}$ dynes, the amplitude will be

$$a = 0{\cdot}014\text{cm. (about } 5\tfrac{1}{2} \text{ mils)};$$

so that, if the rectangle is used as a relay, and set to its maximum sensibility, it would be possible to work with a weight of copper amounting to

$$1{,}000 \text{ kilos} \times \frac{0{\cdot}005}{0{\cdot}014} = 350 \text{ kilos},$$

or about one-third of a ton.

Or, still using 1,000 kilos, the distance may be increased by multiplying by $\sqrt[3]{\frac{0{\cdot}014}{0{\cdot}005}} = 1{\cdot}42$, bringing up the distance to 14·2 km.—a value only a little less than the limiting distance found for readable signals with a telephone as receiver. A very small rate of absorption of waves would, however, tell enormously against the telephone, while the vibrating rectangle, working at so low a frequency as 16 periods per second, would not be appreciably affected.

It is interesting to note that when the telephone and the rectangle are worked under exactly the same conditions as regards primary power and distance and size of circuits, but at frequencies of 400 and 16 periods respectively, the total power available for the telephone is more than 600 times as great as that available for the rectangle. Yet the rectangle gives a *visible* indication, for by means of a magnifying glass the vibrations are easily visible down to about half a mil.

It has already been remarked that this synchronous vibrator may contain the germ of a "speaking" instrument. It has ample sensibility for practical purposes, and is not likely to be affected by a moderate rate of absorption. It is to be hoped that some means will be discovered for enabling it to be used for indicating Morse code signals, either directly or by employing it as a relay.

Absorption.

So far as the author is aware, the absorption of electromagnetic waves by the earth—considered as a solid conductor—has never been calculated or measured under the conditions assumed in this paper. What is wanted is a complete series of observations of the absorption at different frequencies and over different distances, and it would be desirable that observations should be made in several different localities of widely differing geological character. The author hopes to be able to carry out at least a part of this investigation in the course of the next few years.

Apart from absorption, it is clear that communication by magnetic induction can easily be established in those cases where the ordinary telegraph line or cable is impracticable. The author has endeavoured to illustrate the fundamental principles involved in the working of induction telegraphs, and if he has in any way cleared the ground for future investigators and thrown a little light on matters relating to the design of appropriate receiving apparatus, the object of this paper will have been fulfilled. In conclusion, the author desires to express his sense of the great obligation he is under to Mr. Preece and Mr. Gavey for their kindness in giving facilities for his investigations, and placing at his disposal the results of the many experiments carried out by them in connection with wireless telegraphy.

Improvements in Magnetic Space Telegraphy.

BY DR. OLIVER LODGE, F.R.S., MEMBER.

Part III.

Detectors.

A large number of devices for improving the detector of the fluctuating current at the receiving station were made and tried, and a few of them may be here described.

Tone Telephone.—Not only was it considered desirable that the two circuits should be attuned to each other and to the sending dynamo or intermitter, but also it was thought well to make the receiving telephone so that it would only or chiefly respond to one particular note. I had found that the diaphragm of a Bell telephone need not be free everywhere except at the edges, but might nearly as well be fixed all over to a thin deal sound-board upon which the ear was directly pressed. Consequently I proposed to use this sound-board idea for a tone telephone. One good form is represented in Fig. 3, where

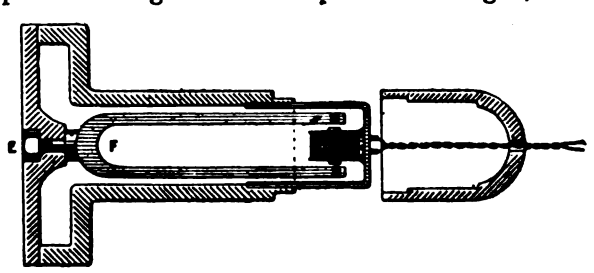

Fig. 3.

F is the tuning-fork, screwed into a sound-board, with its prongs highly magnetised, and with a short iron electromagnet between its prongs, round which the received alternating currents were to circulate. The whole was mounted in a compact case, in general appearance like a Bell telephone, and the result was very sensitive to the proper note—distinctly more so than an ordinary telephone when both were in circuit. The ear was laid right upon the wooden end, E, which holds the stem of the fork; and though of course the sound did not rise and decay quite sharply, yet signals could be clearly read, and the damping of the fork might be at any time increased, at the expense of a little sensitiveness, whenever sharper—*i.e.*, quicker—signals were wanted. Such a tone telephone

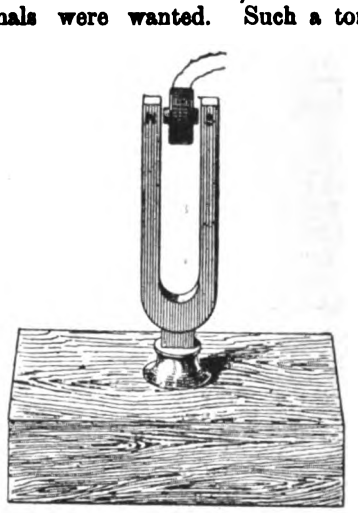

Fig. 4.

arranged on a large sound-board, or with a resonant jar, may serve as syntonic "call," accurately discriminating one station from another. Fig. 4 shows an alternative form of it. Another use for which a magnetised tuning-fork telephone is convenient, is to serve as a weak local sender for the purpose of detecting whether the receiving circuit is properly adjusted or not. Thus, for instance, suppose signals are expected from a distant station, and are not being received, it may be because the receiving circuit or its apparatus has gone out of tune a little; so its tone can

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be tested by twitching with the fingers the tuning-fork of a tone telephone whose local circuit is properly arranged in inductive connection with the main receiving circuit. It gives at each twitch a feeble alternating current, which should make the receiving instruments decidedly respond. If they do not, they must be adjusted till they do.

Coherer.—Another totally different form of detector was suggested by my old experiment of the syntonic jars, where the air-gap was filled by a pair of knobs in near contact, and with a local battery and bell—in other words, with what is now called a coherer circuit. So now the receiving condenser can be shunted by a coherer, and a relay worked by the signals so obtained. But to the sinuous disturbance of an alternator a coherer turns out practically insensitive; it is to electric jerks that it responds. Accordingly, when the sender is of the make-and-break kind a coherer answers, but when it is of the slowly alternating kind it fails.

Coherer Call.—By inserting an interruptor in the receiving current so as to jerk any induced sinuous current that it may find there, the coherer can be made to work, and

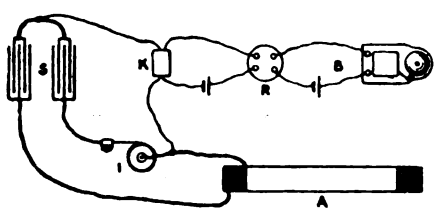

FIG. 5.

one plan of its connections is shown in Fig. 5. It may not at first be apparent why there should be two condensers in series in this figure, but it must be remembered that the interruptor must not be allowed to affect any portion of the local battery current; else, of course, the coherer will respond when no signals are being sent.

Bolometer.—A bolometric call was also tried and was found to work, but as it was not specially successful, the details of it will not be given.

Vibrating Coil Telephone.—For the purpose of disturbing a sound-board, and in general of producing a mechanical effect in solids or liquids as opposed to gases, it was thought probable that an iron diaphragm was not the best plan, but that the whole receiving coil might be mounted so as to be itself capable of vibration in a strong magnetic field. An early form of the vibrating coil telephone and

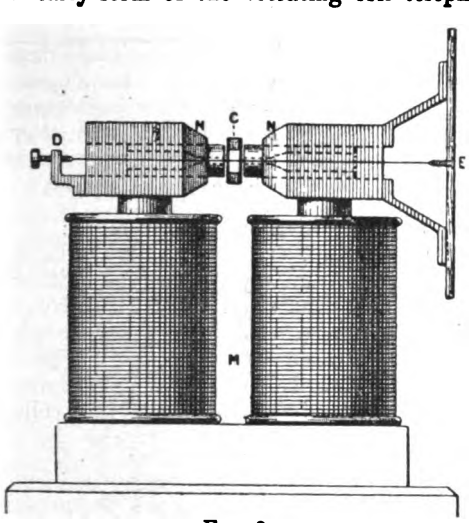

FIG. 6.

sound-board is shown in Fig. 6, where M is a large horseshoe magnet with perforated pole-pieces, one of which carries a sound-board with a stretched wire from its middle passing right through the perforations to a screw tightener, and carrying, rigidly attached to its middle, a light fine-wire coil, matted together with shellac, and placed between the pole-pieces. The magnet was magnetised, not in the customary way, but with its adjacent poles of the same sign, so that the lines of force spread out through the coil, and give it the chance of cutting them rapidly if it moves at all axially. On passing feeble alternating currents through the coil the sound-board was strongly affected by its taut wire. A subdivided iron core was also placed in the coil, but whether by reason of the increased mass, or for some other reason, it did not now work so well. Another form was then made with a magnet specially designed, as shown in Fig. 7. All the iron was well annealed, plenty of field winding put on, and the air-gap was an annulus $\frac{3}{8}$in. square in section and $1\frac{1}{2}$in. in diameter. No attempt was made to subdivide the iron, because in this arrangement it is plain that eddy currents are all to the good. They do not occur in any moving part, so the only effect is to diminish the impedance of the receiving coil. The coil is powerfully damped by the strong field, and a certain strength of field is therefore best. The coil was attached direct to a wooden disc, and the thicker this disc, the higher the note to which the

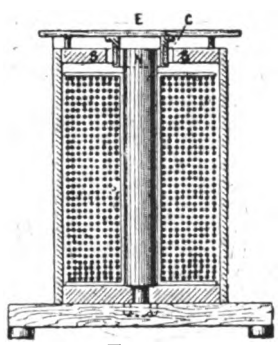

FIG. 7.

arrangement most powerfully responded. By placing the ear on the wood the first-made instrument on this plan was exactly as sensitive as the best of the usual patterns of telephone—for instance, the Collier or the Ader pattern. Tambourine membranes and many other plans were tried for holding the coil, but the simple wooden sound-board answered best. The wooden disc need not be clamped at its edge. It has a circular nodal line, and in three points on this circle it was sometimes clamped so that it could vibrate freely like a circular sort of harmonicon reed. Thus mounted it was very sonorous, at least before the coil was put on. The load of the coil had to be taken into account in finding the nodes, and they were accordingly found experimentally. When the plate was unloaded its nodal line was at 0·68 of its radius, which agrees with theory. The loading, however, spoiled all this and greatly increased the damping, so that considered as a syntonic receiver it was not successful. The coils at this time were of copper, and heavy. Now they are of aluminium, and much lighter. The present plan of a large sound-board, and a light coil rigidly attached to its

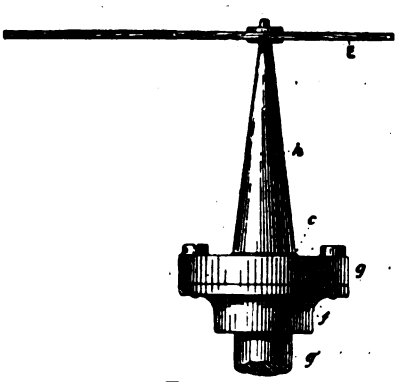

FIG. 8.

middle by either a light wooden tripod or a light cone (Fig. 8), was then designed, and has not been improved upon.

Magnifying Telephone.—Instead of using the vibrating coil to affect a sound-board direct, it was obvious that it might be used first to affect a microphonic contact in a local battery circuit, and thus cause fluctuations in a stronger current than that induced from a distance, and so send on a more vigorous disturbance to another telephone, and thus cause a louder noise. For this purpose, after several microphonic transmitters had been tried, a Berliner was ultimately chosen, and arranged as in Fig. 10. Here

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the ordinary telephones are arranged so that the disturbance can be heard direct without magnification and compared with the magnified disturbance. The telephone T_1 serves for both determinations, according to the key which

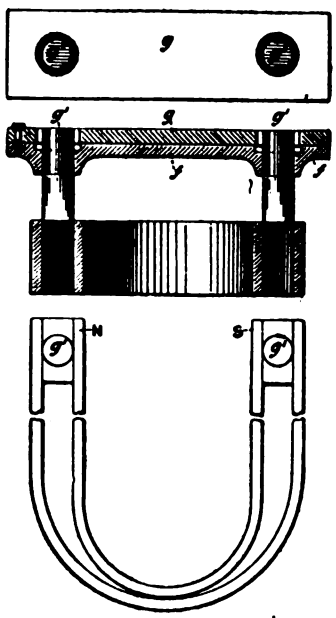

FIG. 9.

is pushed down. The telephone T_2 was a duplicate of the same make, and was switched into either circuit when T_1 was out of it, so as to keep everything similar. It was found during the experiments that T_2 was unimportant; the resistance and inductance of the rest of the circuit were great in comparison. At this early stage, and with the Berliner transmitter, it was found that magnification was easy when the original effect was fairly large, but that when the original effect was barely audible magnification became difficult, and never very marked. In these early trials the tripod merely pressed against the mica disc of

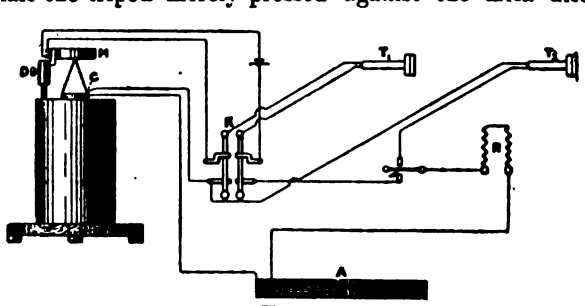

FIG. 10.

the transmitter; but the mica was now removed and the tripod attached to the coil pressed against the carbon plate instead; but this was no improvement. Hitherto the coil was *pressed* up, resting on elastic pellets below, and was under considerable restraint; now, finally, the tripod was attached rigidly to the centre of the carbon plate of the Berliner transmitter, and the coil was allowed to hang freely in the magnetic air-gap. This was much the best plan; but for more exact tuning, a spiral spring pressing upwards is still sometimes used to regulate the dominant pitch appropriate to the disc and coil as a vibrating system.

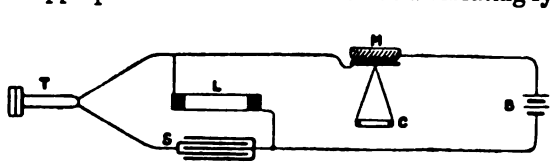

FIG. 11.

The method of connecting the magnifier to the telephone listened to was usually as follows (Fig. 11): T is any telephone, diagrammatically indicated; M is the Berliner microphonic transmitter, with receiving coil hanging on a tripod from its carbon plate; B is a battery of three storage cells; and L is a self-induction coil, without iron, which carries most of the steady current which is necessary to the good action of a microphone, but diverts the jerks and fluctuations mostly through the telephone, even though this be of high resistance. Sometimes a condenser, S, was inserted in its circuit, too, with the object of assisting through the telephone fluctuations of a definite pitch, and of other pitches not too far removed from that. A transformer could be used instead of the self-induction shunt, but the advantage of a transformer is more felt on long lines; for a compact apparatus it serves too, but it wastes more power than the L-shunt.

The following arrangement (Fig. 12) was tried as receiver at my house of the signals sent from college, two miles away: A is the cable once round the garden, connected to the thick winding of a Hedgehog transformer, H. Its thin

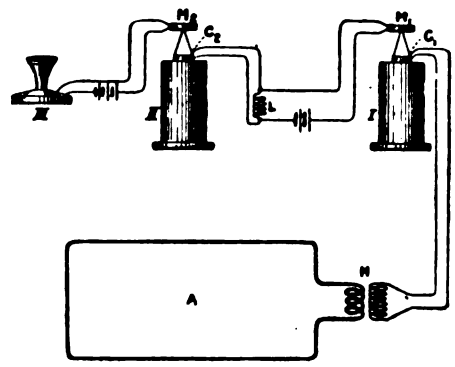

FIG. 12.

winding is connected to the fine-wire suspended coil of the first magnifying telephone, I. The currents from its transmitter, M_1, are taken to the fine-wire coil of the next magnifier, II., shunted by the low-resistance self-induction coil, L. III. is the final telephone of the series—viz., an ordinary Western Electric loud speaker (two ohms), in series with the transmitter, M_2. Under these circumstances the signals could be heard with the ear 2in. from the funnel of III. But the Hedgehog wasted a lot of power, its volume of iron being considerable, and the hysteresis and eddy losses at high frequency being very marked. An improved arrangement consisted in interposing a 20-microfarad condenser (the largest then available, kindly lent by Dr. Alex. Muirhead). This was not enough to tune up the circuit, except when the thin-wire circuit of the Hedgehog was unclosed. So the following plan (Fig. 13)

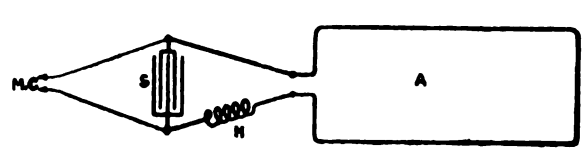

FIG. 13.

was adopted, and was a decided improvement: M C is the magnifying arrangement, as before; H is the thick wire of the Hedgehog, inserted merely as extra self-induction; S is a condenser having a capacity of 20 or 21, or sometimes as much as 24, microfarads (a small plug condenser being added in parallel to vary and improve the tuning). Thus the note was enhanced by resonance, and the signals became almost loud. (The tuning reinforcement at the college end

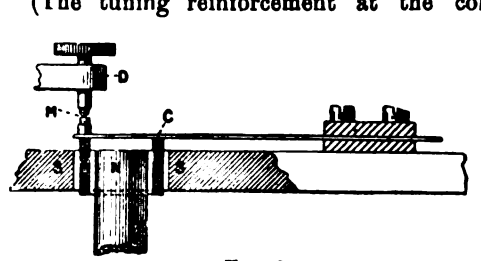

FIG. 14.

happened, however, on this particular occasion to be rather poor.) This must serve as a sample of a great number of experiments made with all manner of condensers and different notes, an especial amount of variation being practised at the sending end.

It is to be remarked that fine wire coils to the telephones are by no means the best for this particular purpose, and

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afterwards ribbon coils of thin aluminium strip were used instead. Transformers and L shunts could then be dispensed with; but small telephonic transformers are still usually employed, to prevent the constraint exerted on the hanging coil by a steady current passing through it. Small transformers don't waste much, and a little waste of power matters nothing where there is a local battery. The Berliner, or such-like granular transmitters, though serving well to magnify an already audible current, do not serve to pick up and magnify an inaudible one. For this purpose a better and more precise apparatus has to be constructed—viz., the reed or the tuning-fork magnifying telephone with only a single pair of carbon contacts. This is shown in Figs. 14 and 15, and its essence is that the coil is hung to a reed or

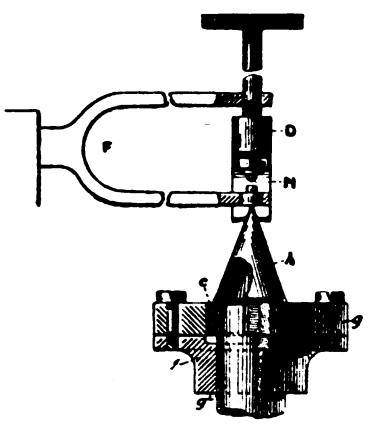

FIG. 15.

fork or vibrator of definite pitch, and carries also a pellet of carbon which presses lightly upward on another fixed pellet, thereby constituting a single-contact microphone. Such an arrangement, as is well known, is excessively sensitive to utterly imperceptible mechanical disturbances, and the minutest fluctuations of current now passing through the hanging coil give ultra-microscopic tremors sufficient to vary the resistance of the light carbon contact perceptibly; the energy of a single-cell local battery being thus brought into action, enough energy is imparted to disturb (through another hanging coil) one of the ordinary granular transmitters, which then passes on a stronger current to the loud speaker, or the "call." Or it may be that two reed magnifiers in series are desirable when the received current is exceedingly faint. The single-point magnifiers do not carry big currents, and they require delicate, though easy, adjustment; but when properly made and adjusted they work extremely well with pure tones. The multiple-contact microphones work better for articulate speech, as is well known. I find graphite carbon the best for these single contacts, and I am indebted to Mr. Swan, to Le Carbone, and to Mr. Acheson for several specimens of soft carbon which answer much better than the harder arc lamp variety.

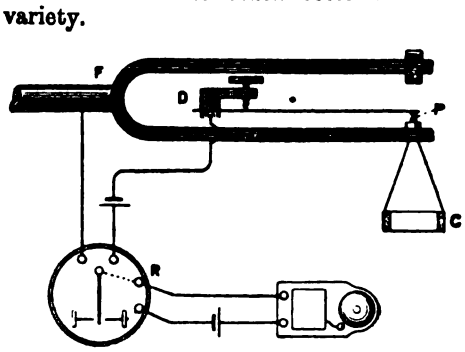

FIG. 16.

The last telephone of the series has been so far represented as one of ordinary pattern, but it is obvious that the vibrating coil attached to a wooden sound-board may be employed; and, further, that such sound-board telephone may have an application to the human voice and the acoustics of buildings. It is also manifest that when the vibrations are magnified they may be used to work a relay and ring a bell, or actuate a Morse instrument, or anything else; just as the phonoporic receiver, for instance. I am indebted to Mr. Langdon Davies for the loan of one of his phonoporic receivers. The bell-ringing arrangement that we at present prefer is a coil telephone of the tuning-fork pattern, so that (if protected from mechanical shaking) it shall only respond to a definite note, and not to casual currents in the line. The light coil (Fig. 16) hangs to the

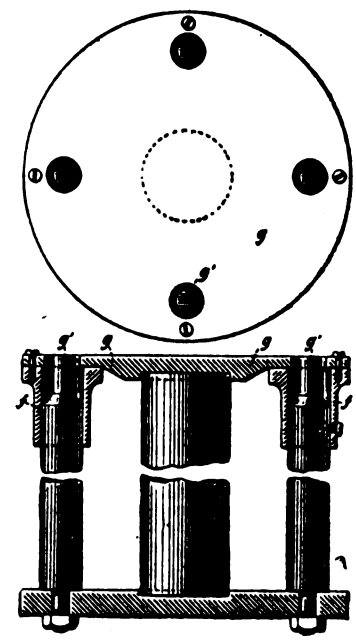

FIG. 17.

limb of a large tuning-fork, and on this or on the other limb is a light metallic contact which dances when the limb vibrates, thereby practically breaking a local relay circuit and letting its tongue fly over so as to close a bell circuit. C is the last series of the suspended magnifying telephone coils; F is a tuning-fork on firm stand; K is also rigidly supported, and carries a thumbscrew for adjustment of spring; P is a platinum stud contact carried by a very light spring, and this forms part of the local polarised relay circuit, R, which rings a bell in the very ordinary way in any office where calling up is desired. It may be thought that a light coil is hardly competent to shake appreciably the massive steel limbs of a tuning-fork, but when it is isochronously attuned to the pulsations of the received disturbance a tuning-fork is wonderfully sensitive, even to aerial vibrations, as is well known in an ordinary resonance experiment, and the fact that it is not sensitive to disturbances of accidental frequency is wholly advantageous. The light trembling spring is, however, readily disturbed by any sort of shaking, and if the relay is too delicately adjusted it may give spurious calls due to mechanical tremors. From these it must be guarded.

Continuous working at the subject for over a year on the part of Mr. Benjamin Davies and myself, with occasional aid from instrument makers, has naturally resulted in a mass of observations and experiments. What is now published is but a fragmentary selection, but the paper is quite long enough.

DISCUSSION.

Before the discussion on the papers on "Wireless Telegraphy," by Dr. Lodge, Mr. Evershed, and Mr. Preece, was continued, premiums gained by members and students were presented by Prof. S. Thompson, who presided owing to the absence of the President through ill-health. The following is a list of those to whom the premiums were awarded: The Institution premium to Mr. Horace F. Parshall, M.I.E.E., for his paper on "Earth Returns for Electric Tramways"; the Paris Electrical Exhibition premium to Mr. Robert Hammond, M.I.E.E., for his paper on "The Cost of Generation and Distribution of Electrical Energy"; (the Fahie premium was not awarded because no telegraphic or telephonic papers had been read during the session); the extra premium to Mr. Leonard Andrews, M.I.E.E., for his paper on "The Prevention of Interruptions to Electricity Supply"; the premium for original communications to Mr. H. N. Allen for his paper on "Sparkless Reversal in Dynamos." Students' premiums were awarded to Mr. J. M. Donaldson for his paper, "Notes on the Dover Electric Tramways"; Mr. Maurice Solomon, for his paper on "Hertz Waves and Wireless Telegraphy"; and Mr. E. E. Tasker, for his paper on "Alternate-Current Motors." Salomons scholarships were awarded to Mr. Tom Rolls Renfree,

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King's College, London; and to Mr. H. J. Tomlinson, University College, London.

Mr. S. Evershed then said he should like to correct a slip of the tongue which he had made at the last meeting. It was in describing a line for induction telegraphs round Kent that he said he was appalled by the size of the condenser. What he really meant was, of course, to effect any good results a very large condenser would be required with a proposed periodicity of about 12 periods per second. Of course, that could be reduced by using a higher frequency.

Dr. Oliver Lodge said he would not take up much of their time. Mr. Evershed had corrected one slip, but he (the speaker) had expected him to have corrected another. That was when Mr. Evershed compared his relays at Lavernock with a telephone. He had neglected the self-induction of the circuit, and also the frequency effect. In one of the paragraphs of his paper it was stated that the current could be independent of the frequency, and that, no doubt, wasso when the frequency was high, say at 400. He had to correct a slip of his own in saying that the power required would be very much greater at a high frequency than at a low. When working at Lavernock the conditions were very different from those prevailing in a laboratory, where the air was calm and where there was no outside disturbance. He admitted that Mr. Evershed's coil was working practically at Lavernock, while his (Prof. Lodge's) system of relays had only so far been successfully tried in the laboratory. He had been asked, at the last meeting, what power was needed to work the telephone relay. Dr. Lodge then described the arrangement he had adopted to ascertain the exact power used to obtain an audible signal with his magnifying telephone. For the purpose he used two coils, 50ft. apart, with a frequency of 384. He found that in the receiving circuit a voltage of a micro-volt and a current of a micro-ampere gave a just audible signal. The product of these two quantities did not represent the power used in the telephone, but only that in the complete receiving circuit. The telephone itself, owing to the exceedingly small movement of the coil, had exceedingly little back E.M.F., and he did not, like Mr. Evershed, consider the instrument as a motor. He took no precautions to make his telephone relays specially sensitive, but found that they were on the average 30 times more sensitive than the ordinary telephone. The next subject he wished to speak of was concerned with the opacity calculations and the damping effect of the earth. Since the last meeting he had got to the bottom of the matter. From his calculations he had come to the conclusion that, although their equations were different in some respects, both Mr. Whitehead's and Maxwell's were right. If any of them were wrong at all, it was Maxwell's. Mr. Heaviside's general view of the whole subject was perhaps the best. He would like to ask Mr. Evershed if in his experiments the lightship was of iron, and if the cable was placed inside the ship? Also, he wanted to know if the submarine cable was sheathed in iron? Last time he said he had received from Prof. J. J. Thomson a solution of the absorption equations in a general form. The day previous he had had another note from Prof. Thomson saying that if the earth conducted anything like as well as sea-water, they might as well have a perfect conductor. For this reason they could not then work properly with horizontal coils, owing to damping currents induced in them by the earth. Mr. Preece might be glad to hear that since the last meeting he (the speaker) was coming round to the use of vertical coils. Prof. Thomson's result was a great argument in favour of the use of this method of placing the coil, as by setting it vertical to the earth the earth's induction would help, not hinder its working. At a small distance apart the effect of the coils was doubled, owing to the perfect conductor below it. There was one thing in favour of horizontal coils as considered mathematically. That was that with the earth, a uniform conductor, the received signal should be the same at all distances. That could hardly be the case. When near, they did work, but what would be the effect when placed very far apart? He should like to say why he had been thinking that vertical coils were the better. Horizontal coils would be of no use near a steel mast on a ship. Vertical coils might very well be used. With a vertical coil some idea of the relative positions of the sending and receiving stations would be obtained by observing the angles at which maximum and minimum signals were received. With the horizontal coil no sense of direction was obtainable. If the suggestion of Sir H. Mance, of having two distinct periods of vibration, were adopted, it might be possible to get the exact position of a ship if there were two signalling stations in the neighbourhood. (By a blackboard diagram Dr. Lodge showed how the bearings of each signalling station would be ascertained.) He was greatly obliged to Mr. Preece for the offer of the aid of the Post Office in his experiments. He thought it probable that before very long all the islands adjacent to the United Kingdom would be connected with it by this means, and he was sure that something would soon be done by America in the same way.

Mr. W. P. Granville said that, in attempting to discuss the paper, the practical side of the problem must not be forgotten. It would be well for them to get some idea of the difficulties which would arise in this subject. If it came into general use, it would, of course, only be used where it was almost impossible to use conducting wire. He would like to refer to the work of one of their past-presidents, Mr. Willoughby-Smith, whose name had been courteously introduced at the last meeting. On the wall they would see some of the original diagrams which he had had prepared for his paper, showing the means by which he measured the absorption of various metals. Mr. Willoughby-Smith had on that occasion mentioned his idea that signals might be possible with moving trains, and in other cases where connecting wires were impossible. Mr. W. Statham Smith and himself had tried some experiments on outlying rock lighthouses, principally in Alum Bay. The Fastnet lighthouse was a very excellent example of a case where wireless telegraphy would be especially useful. But the lighthouse was built of iron, and according to Dr. Lodge that was a fatal obstacle to his method. Also, with regard to Mr. Evershed's system, a summer breeze on that rock would blow down his coil, let alone a wintry gale. That was a typical lighthouse where it was impossible to use ordinary telegraphy. He and Mr. Smith had also attempted to lay a cable there, and it failed almost at once, on account of the abrasion of the cable against the rock. They were now transmitting signals by means of a cable which terminated in a bare, exposed end in the smooth water some little distance from the rock. Another conductor from the rock to the water at the base enabled them to signal with the current leaking from the end of the main cable. He referred to a statement made by Dr. Lodge in his paper, saying that the whole matter of whether wireless telegraphy would come into practical use or not might be settled by experiment. In the case quoted, it was absurd to say so. It seemed to him, also, that the current in the earthed coil might be picked up by any other earth lines, and the conduction where the receiving coil was not earthed might largely exceed the receiving current. That might explain why the signals could be heard in Cheshire, but could only be heard two miles through the air. Whatever system of wireless telegraphy was used, however, he was sure that mother earth would affect the results very largely. With regard to the absorption of the different metals shown in the diagram on the wall, copper ½in. thick absorbed 95 per cent. of the energy. The iron was most remarkable for its quick rise until a certain percentage was reached and then absorption stopped. A peculiar fact was that although ½in. copper took up a large amount of energy, ¼in. copper scarcely took any at all. He had brought these subjects up merely to present to their notice the practical side of the problem from actual observations made by himself.

Major Brett said that personally he was sorry that Dr. Lodge had forsaken Hertzian waves, because he thought that if it was a survival of the fittest these waves would survive. As to the relative methods of the systems before them, Mr. Evershed's was, as he pointed out, the easier. The wave method possessed the great advantage that by means of it experiments might be carried out more easily and cheaply, there being no trouble in moving the apparatus from one place to another. He did not think that Mr. Preece's system was the only one in practical use. Marconi's method had been working for some time between Bournemouth and the Isle of Wight. Since the last meeting the problem of communication with lightships had been solved. Wireless communication had been established between the South Foreland lighthouse and the Goodwins lightship. The weather was very rough and stormy when the messages were sent, but they were transmitted and received very well. When the assistants on the ship were too upset to work the apparatus, a sailor who had a slight knowledge of the Morse code sent the signals. It would interest the last speaker, perhaps, to learn that although that was an iron ship with wire stays, the messages were not influenced in the least. As to the speed of messages sent by this means, wireless telegraphy was not going to replace wire telegraphy, and as long as the ships' crews, etc., got their messages properly, he didn't think they would mind only getting them at 10 words per minute. There was one other point he would like to bring forward. It had been suggested that earth conduction had a great deal to do with the success of Marconi's system. At his suggestion, Mr. Marconi made some experiments to find out whether that was correct. He worked the apparatus after having carefully removed all earth connection, with the result that, if anything, the signals were stronger. He (the speaker) believed more in the possibilities of the Hertzian waves, but he admired the beautiful apparatus which Dr. Lodge and others had shown to them.

Mr. Dane Sinclair said there was one thing he should like to say about the conductive capacity of the earth. All the speakers had spoken as if it were a constant quantity. That was not so, as it varied greatly in different places; for instance, a sandy soil like that near the seashore was a very bad conductor, but a good clayey soil was an almost perfect one. The solution of the subject would never be reached till the fact of the varying conduction was fully realised. Also it was harder to obtain earths for small than for large distances. There was one point which he thought might have been pressed more strongly, and that was when, say, Dr. Lodge signalled from Liverpool to London the message came in two ways—namely, by earth conduction and through the air.

Mr. A. C. Brown said he should like to know which frequency was the best for wireless telegraphy. From what he had heard during the discussion, it seemed to him that a low frequency was better for transmitting and a high frequency for receiving. Both these could be combined by splitting up the current before it came to the receiver. If Prof. Fleming in his experiment with a bare cable in the water had split up the current at the receiving end, he would without doubt have obtained good results. If Mr. Preece would take his rapid make-and-break out of the transmitting circuit and put it in the receiving circuit, he would obtain much better results. The use of condensers had been referred to, and he found that better for the purpose than the ordinary plain current. Syntony was practically impossibile at present, and apart from this any other signals tuned to the same note might make the instruments sound when not intended. An electrical vibrator should be placed in the electric circuit so that it would only operate when signals were sent from the corresponding circuit.

Dr. O. Lodge, in replying, said that Mr. Granville had questioned him about having said that certain experiments were absurd.

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He was very sorry if he had said such a thing, for he thought that experiments were never absurd. Mr. Granville had also pointed out that if one of the coils was earthed, the earth might still have some effect. That might be so; he could not say. Major Brett had said he was sorry that he (the speaker) had forsaken the Hertzian waves. In that he was mistaken, as although not experimenting with them so much as formerly, he still did something in that way. Besides, Mr. Marconi was going to read a paper on the subject before them within a few weeks, and hence he had curtailed his remarks on that subject. In his paper he had said that the system at Lavernock was the only one in practical use. By that he meant that it was the only one used by such people as the military authorities. He should be the last to deny that the coherer could be affected by Hertzian waves. He did not understand why, after his experiments, Mr. Marconi used an earth when he found the signals stronger without it. Mr. Sinclair had said that it was more difficult to get earths for small than for large distances. The resistance of the earth was the same whatever distance it was, and the resistance at the earth-plates would be independent of the distance.

Mr. Evershed also, in reply, said he had not any other correction to make, as Dr. Lodge supposed. He (Dr. Lodge) objected to the statement that the telephone required 600 times as much power to work than the rectangle. The reason that this was so was because the telephone was working at 400 periods, while the vibrating rectangle was only working at 16 periods. Dr. Lodge himself brought forward a method of working by means of condensers, and when there was no self-induction available, the power at 400 periods was 625 times as great as at 16 periods. He was glad that Dr. Lodge had given them the amount of current which it took to work his telephone. As to that gentleman's questions as to the ship and coil, the ship was built of iron, and, of course, the coil was not put inside the ship. The cable was armoured, because if it had not been it would not have lasted a week. He had calculated the absorption of the armour, and as it was only 10 per cent. he did not mind it much. In his experiments on absorption he took zinc to represent the sea. Mr. Whitehead and Mr. Heaviside were at loggerheads over their equations. He had tested them and found that both Mr. Whitehead and Mr. Heaviside's gave a fair result, but Maxwell's did not apply to the subject at all. Mr. Sennett had mentioned Wimshurst's idea of using a swivel on the cable. Any idea like that would be useless at such a place as the Fastnet lighthouse, where it would very quickly be destroyed, owing to the heavy surf. Dr. Lodge had now abandoned horizontal coils, and he (speaker) was now left sole champion of their cause, and even he thought that vertical coils were the only practical ones. It seemed to him that with those on ships as Dr. Lodge described, as long as the signals were heard on board, the ships were safe, but when they ceased a collision was to be expected. He should like to ask Mr. Granville what the death-rate was on the Fastnet Rock. Absorption was, to his mind, the only thing to be cleared up now in order to make his system practical anywhere. Major Brett advocated Hertzian waves. These he himself thought to be the method which would finally be adopted. Mr. Brown mistook what he had intended to say. What was really meant was regarding the leakage current. If it fell so greatly between 0 and 16 periods per second, what would they do at 400 periods per second?

Prof. S. P. Thompson then moved a hearty vote of thanks to the readers of the papers, which was carried unanimously.

INSTITUTION OF CIVIL ENGINEERS.

At the ordinary meeting on Tuesday, Jan. 17, Mr. W. H. Preece, C.B., F.R.S., the president, in the chair, two papers were read—"The Effects of Wear upon Steel Rails," by William G. Kirkaldy, A.M.I.C.E., and "On the Micro-photography of Steel Rails," by Sir William Roberts-Austen, K.C.B., F.R.S., A.I.C.E.

In the first paper the author recounted how experiments he had carried out on two steel rails which had broken under traffic had led to his devoting special attention to the subject and to a wider investigation. It was found that the breakage of rails resulted from failure commencing at the top surface, and not from the bottom, as appeared to be the usual belief, and that the deterioration was confined entirely to the top or running head. The deterioration was of the nature of a mechanical hardening of the surface under the action of the rolling load. In some cases this hardening further developed into a species of disintegration by the formation of minute transverse cracks, which, by gradual deepening, ultimately resulted in failure, unless the rail was removed in time. A description was given of the tests specially devised for ascertaining readily, and in a practical form, the extent of deterioration in worn rails. Briefly, this consisted in bending the rail in reverse directions and comparing the behaviour.

It was explained that as the bottom member of a rail was found to be undeteriorated in quality by wear, it became possible to determine very closely the original quality of any rail (apart from the loss of substance) by testing it under bending stress in the normal direction—that was, keeping the worn head in compression—also by testing specimens prepared from the bottom member, under tensile stress. If no deterioration was present, the rail, when bent with the worn head in tension, would bend to a degree corresponding with its behaviour with the worn head in compression. To illustrate this, examples were given showing the wide divergence in some worn rails between their original properties, as brought out under the normal direction of bending, and their behaviour when the direction of test was reversed. The leading features were illustrated by diagrams. A few representative rails taken from under various conditions of service were referred to. On the one hand, in the case of a rail after being subjected to severe brake action, the deterioration was very clearly marked; while on the other hand, in the case of a rail that was under favourable conditions, although after the exceptionally long life of 23 years' main-line service the deterioration was very slight. The author drew special attention to the significance of this latter rail. From the commencement he refrained from taking an alarmist view of the condition of rails, considering that where failures or breakages had occurred, there would be definite and special causes sufficient to account for them. He anticipated that the great bulk of rails, where under favourable conditions as to service, would not necessarily be found in a bad state. Reference was made to a number of other rails found to remain in excellent condition after various lengths of service up to considerable periods of time.

Striking instances of very severe and rapid deterioration, accompanied with the development of induced flaws, were mentioned, illustrated with figures reproduced from the original reports.

The following questions suggested themselves in dealing with this subject: (1) Did all rails suffer alike as to the nature of the deterioration? (2) Did not the quality of the steel affect the resistance of rails to deterioration? (3) Did not the commencement and progress of deterioration of any rail depend on and vary greatly with the nature of the traffic, but still more on the special conditions due to its "situation"?

The author classified the conditions due to "situation" as follows: (*a*) effects of wear on rails situated under favourable conditions—for instance, when on the level, straight and free, or nearly so, from stoppages of trains; (*b*) effects of wear on rails situated under unfavourable conditions—for instance, where subject to brake action more or less severe; (*c*) effects of wear on rails situated at the starting positions of trains, where the skidding or climbing action of the driving wheels of locomotives come into play.

Some of the questions were answered tentatively, in so far as appeared warrantable from the data already obtained. Reference was made to the probability that the severe deterioration found in the first broken rails examined was produced by the skidding of wheels during starting of trains. It was stated that there had since been no opportunity of testing any rails definitely known to have been subject to such conditions. A comparison followed the behaviour of the ordinary form with the deep form of fish-plate joints as regarded relative strength. Comments were made, in passing, regarding the microscopic examination of steel, and the author's reasons were stated for not introducing such when dealing with this subject; also regarding chemical analysis and the use thereof in aiming at reproducing steel found most suitable from rails of known life and satisfactory behaviour.

A few observations were offered, in the form of suggestions, as to whether it be practicable to find an alloy of steel which would better resist the induction and the rapid spreading of flaws, the simple or ordinary carbon steel being very susceptible to the rapid spreading of a flaw whenever one was induced, or even by the presence of any defect originally in the steel. Emphasis was laid upon the desirability of obtaining a careful record as to the duty performed by worn rails in all cases where further investigations were carried out.

In the second paper a statement was given of the principles which guided micro-photography of steel rails.

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WHERE THE SHOE PINCHES.

There is a good deal of truth in the statement so frequently heard, that any work constituting a Government monopoly ceases to be progressive. While admitting the large substratum of truth, we must venture to contend that the ceasing to be progressive is only so in a comparative sense. Every inventor of every good and of every bad thing feels personally affronted if the Government does not take up his invention—that is, if the said invention comes within the scope of any Government department. It is never remembered that probably not more than one in a thousand of these inventions contains even the germs of success, and usually the most successful apparatus is almost changed in identity between that which forms the patentee's article and that which forms the commercial article. We have heard it asserted again and again that the British telegraphic system and apparatus is the best in the world; and, on the contrary, we have heard men bemoaning the harsh treatment of the Department and the little incentive given to inventors. In certain directions no doubt grave mistakes have been made, and, instead of being remedied at the earliest opportunity, have been continued; but the mistakes of officialdom have been worst when exerted upon parliamentary action. It is certain that the action of the Government depends largely upon the advice obtained from the departments interested. While, then, we admit that departmental activity is not altogether neglectful of internal progress, and does admit and sometimes adopts suggestions from outside, it is seldom that it gives advice which leaves private action free to develop any industry or branch of industry in a natural manner. This is particularly the case in matters electrical. No matter in which direction we turn, the same thing occurs—a block from the legal side.

With regard to telephony, the Government—that is to say, the department interested—has been like a little puppet attached to a balloon—jumping this way and that according to the breath of wind that flies the balloon. Policy there has been and is none. A lot of old women in council would have done better, for they would have quarrelled, and then kissed, and then all agreed to something. The policy of the Government has been the policy of Micawber — a waiting for something to turn up. In other directions, instead of agreeing that lighting, traction, etc., are progressive industries, and that such industries will be crippled in development by inelastic rules, they seem to have had a desire to come to finality, with the result that almost before an Act is passed and rules framed they are found to become drags instead of aids. In fact, the Acts passed have been such as largely discourage private enterprise in many directions, and also have unduly favoured posterity at the expense of the present generation. Perhaps the forthcoming agitation of private adventurers to set some bound to municipal action will open up these questions anew.

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ARCHÆOLOGIA.

There are times when we confess to a feeling of thankfulness that everything said to be discovered yesterday is not new. Mr. Fahie is a kind of electric sleuthhound, hunting about to discover pioneers of the science, either pure or applied, which we all think is the most prominent science that is known to the world. Some of us know how carefully and intelligently he delved into the early history of telegraphy, and in his well-known book claimed credit for some who had till then been ignored. Again he has been seeking heroes, and claims attention for another of his *protégés*. We will not go into the history of the man, nor endeavour to fix his true position in the annals of the science, but it really seems that the latest discovery of Mr. Fahie only missed being one of the greatest of the world's benefactors because other studies claimed his attention. It is disappointing that the literature of J. Bowman Lindsay's experiments concerning the electric light is so scanty, for his ideas, so far as we can gather from the few references given us, seem to have been connected both with arc and with incandescent lighting. However, it is easy to forgive any investigator in those early days for not continuing experiments on lighting. He had to do with batteries, and then, as now, the first point to be considered was "cost." Every experimenter, so far as we can gather in those times, was soon convinced that electric lighting was not practical, and a mere laboratory toy was soon put aside. Unfortunately for Lindsay, the dynamo was not yet, and nothing of a practical character came from his hands. There were dozens of men interested in those times in matters electrical. The *Mechanics' Magazine*, which Mr. Fahie refers to, the still earlier *London Mechanics' Register*, the *Magazine of Science*, *Sturgeon's Annals*, *Walker's Electric Magazine*, and other periodicals published from the twenties to the fifties, all contain curious letters and articles upon electrical subjects. From 1824 onwards, under the auspices of Dr. Birkbeck, lectures on electrical subjects were common, and many of the sentences reported indicate a wider knowledge of the subject than is usually understood. Our columns are hardly suitable for even archæologic electric lore, except in small doses. Names are mentioned throughout the pages of the periodicals above mentioned, of men utterly unknown to the present generation of readers. It is difficult for busy men to trouble about the exact status of these pioneers in electrical matters, yet many would like to have a short *résumé* of the work to be credited to each of these early workers; and if Mr. Fahie in his well-earned leisure would give us something of the kind, mankind electrical would be thankful. Unfortunately, Mr. Fahie is too sympathetic. He gets enamoured with the work of his last hero, and imagines we ought all to follow his example. Workers have no time to assimilate non-essentials, and ask for bare, bald facts, leaving the full details to the leisured class. Still, our thanks are due to Mr. Fahie for his biography of Lindsay, and we trust he will continue his researches.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

MUNICIPALISATION.

SIR,—Having swallowed the camel of municipal supply of electricity, why strain at the gnat of manufacture of fittings? Is not the question you want to raise one of *principles?* People nowadays don't care a hang for principles, but judge everything by the standard of temporary expediency, and in consequence place themselves in most illogical positions. Take your strong case of "pure water." If the municipality is itself to supply pure water, why not pure food? But if people would stand out for the principle that the duty of the municipality was to see that pure water and pure food were provided and leave private enterprise to supply them under reasonable restrictions, as long as it would do so, we should know where we stand.

It certainly is time that something was done to bring business people face to face with the position they have created for their own undoing. A short time ago I noticed in your journal that Shoreditch Vestry had refused the Hydraulic Power Company permission to lay mains in their parish on purpose to compel everybody who wanted power to use the municipal electric supply, and now the North Midland corporations are up in arms because private enterprise is promising to supply electricity at a cheaper rate than they can, and so break down the municipal monopoly. This state of things foreshadows a coming municipal tyranny, and it is time that men were up and doing if they wish to save their country's prosperity.—Yours, etc.,

T. W. E. H.

SIR,—The principle underlying the questions referred to in your issue last week will have to be settled once for all ere long. The settlement must be in the nature of a compromise, and the sooner we know how far municipalisation is going to lead us, the better. Just now the various authorities seem to be laying their hands upon the tramways, and I want badly to know how this is going to work out. It is all very well for sentimentalists and foolish faddists to point to the work of various authorities in certain directions, but the work is bad for all that. A lot of authorities are pulling down what they call rookeries, and building up sanitary blocks, but the folks who lived in the rookeries do not become tenants of the palatial dwellings. Oh, no! They have to make other rookeries; but, thank goodness, says the lady visitor, this district is now so very superior to what it was. The sanitary dwellings are not for the very poor. They have to go elsewhere, and so the authority does a "lot of good" over those few square feet of ground. But how about that other district to which the old inhabitants have gone? Suppose in the ordinary course of business it is desired to open up a building estate near a town, is the authority going to extend its tramway to assist in the development? At once there arises the question of boundaries, and this, added to the somewhat speculative character of the work, will stop tram extension. There cannot be much speculation in the authority's work; the return must be pretty certain, or out go the councillors at the next annual election. A private adventure concern can do what an authority cannot, and ofttimes confers immense benefits in such cases as the one indicated. Cannot the whole question be solved, and Parliament asked to say, So far and no farther?—Yours, etc.,

INTERESTED.

TELEGRAPHY TO THE GOODWINS.

SIR,—My attention is called to an article in your paper of last week in which you state, quoting apparently from the *Daily Chronicle*, that "arrangements are being made at the South Foreland and on board the South Goodwin lightship for experiments in wireless telegraphy." In this connection I beg to state that an installation of wireless telegraphy is now at work between the East Goodwin light-vessel and the South Foreland lighthouse, distant 12 miles, and not three miles, as stated. This installation started without a hitch on Christmas Eve, and

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has continued in the same satisfactory way ever since, notwithstanding the terrific storms which have been experienced in the meantime. This installation has nothing whatever to do with the experiments which took place in the neighbourhood of Fort Burgoyne, and which were conducted by the Post Office.

It may interest you to hear that all the apparatus, which was very little, was brought to the lightship in an open boat and rigged up in the course of an afternoon. Great use has been made of this installation by the crew of the lightship and their families, and, of course, it is available for the authorities at Trinity House.

The sending and receiving is so easily done that members of the crew have been using the instruments successfully, and this was fortunate, as Mr. Marconi's assistant suffered a good deal from sea-sickness, which is not to be wondered at considering the weather.

We should be glad to give you every opportunity for seeing this installation if you wish, or two other stations which we have, one at Poole, and the other at the Isle of Wight, which are distant 18 miles. We have had the station on the Isle of Wight for more than a year, and the corresponding station at Bournemouth up to about three months ago, after which it was moved to Poole, four miles further away. These stations have been of great use for training the staff and testing instruments, etc., and they have been visited by many people, including some eminent experts. It might interest you to pay us a visit at one or other of these stations, and if you do so you will be well received and every opportunity given you of testing our system of wireless telegraphy.

In connection with an installation between England and France, we are only awaiting the promised permission of the French Government to put up a station on the French side. There has been more delay in this connection than we anticipated, but we are informed that everything is in order, only that it has to go through the ordinary course of red-tape.

I hope that you will kindly see your way to correct some of the mistakes I have pointed out in your article.—Yours, etc., HENRY W. ALLEN, Secretary,
The Wireless Telegraph and Signal Company.

[We are glad to see that at last information on this subject is becoming available to technical papers, and we trust that the sensational and silly paragraphs which have regularly appeared elsewhere will be discontinued in consequence.—ED. *E. E.*]

ELECTRICITY AS AN EXACT SCIENCE.

SIR,—From a note headed as above on p. 36 of your last issue, Mr. Howard B. Little would seem to be engaged on a work of supererogation. All that he has yet unearthed as regards "the wonders of the magnet" was unearthed by me 15 years ago, and I do not suppose that he can add anything fresh to what I have collected on the subject in the first chapter of my "History of Electric Telegraphy to 1837," published by Messrs. Spon, London, 1884.—Yours, etc., J. J. FAHIE.

HIGH-VOLTAGE POWER TRANSMISSION.*

BY CHAS. F. SCOTT.

(Continued from page 51.)

TESTS AT NIAGARA.

Some measurements have been made upon the Niagara-Buffalo transmission line. There are two circuits of three wires each, one of which was in service and the other was available for tests. Each circuit consists of three cables, each of 350,000cm., approximately 0·7in. in diameter. The cables are run on porcelain insulators, and are on the same cross-arm. Adjacent insulators are 18in. apart and the circuit is spiraled, so that each of the three wires occupies the middle position for a third of the distance. Current from one of the 5,000-h.p. generators was applied to the line through a raising transformer, by which the voltage can be increased by small steps to 100,000 volts. This transformer is part of a high-tension testing outfit which is described by Mr. C. E. Skinner in the *Electrical World*, March 5, 1898. The wattmeter is a Thomson inclined-coil instrument with a high-resistance shunt of German-silver wire wound on glass plates. The ammeter is a Thomson inclined-coil instrument, connected directly in the high-voltage circuit.

Measurements were made between the various pairs of wires—*i.e.*, 1 and 2, 2 and 3, and 1 and 3. The current was found to be practically the same in each case. The loss on one of the circuits was slightly greater than that on either of the other two, on which the losses were about equal. The accompanying curve shows the measurements of current when two wires were connected and the measurement of loss; the latter measurements were made upon one pair of wires up to about 26,000 volts, and then upon a second pair. The results are given in Fig. 14.

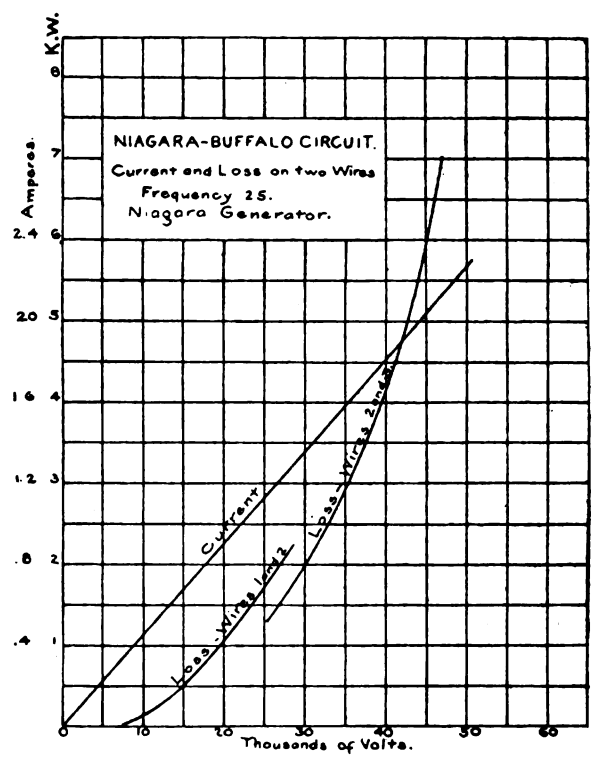

FIG. 14.

On another day measurements were made of the resistance between each wire and the ground, and corresponding measurements of loss were made by placing the high potentials between each wire and the ground. The measured loss was somewhat greater than the loss calculated by using the E.M.F. and the measured resistance. In these measurements, at voltages from 13,000 to 23,000 volts, the power factor calculated from the current and wattmeter measurements varied from about 4 to 6 per cent., so that a very small charging current in the wattmeter would produce a considerable error in the reading.

Some measurements were made upon a pair of fine wires, in which the wires were placed at different distances apart. No. 31 B. & S. gauge spring brass wire, 0·0089in. in diameter, was used. The length of the parallel wires was 744ft. They were suspended by light strings successively at 6in. apart, 14in. apart, and about 25in. apart, the distance varying from 24in. to 27in. The wattmeter readings are given in the curves in Fig. 15. The power factor of the measurements made above 100,000 volts is about 95 per cent., and is over 80 per cent. above 70,000 volts. There can be but little error in the wattmeter due to charging current in the resistance at these power factors.

The measurements on the Buffalo line were made by the writer. Those on the fine wires were made by Mr. E. M. Tingley, who conducted the tests at East Pittsburg, and rendered valuable assistance in the preparation of this paper.

POWER TRANSMISSION PLANTS IN OPERATION.

Beginning with the plant at San Bernardino and Pomona,

* Paper read before the American Institute Electrical Engineers.

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which began operation in 1892, using 10,000 volts and transmitting 30 miles, a constantly increasing number of plants have been installed operating at 10,000 or 15,000 volts. In some cases there has been little or no trouble experienced with the transmission lines, while in other cases the experiences have been less satisfactory. The principal trouble seems to have been a poor grade or an insufficient size of porcelain insulator. In other cases the insulators, sometimes porcelain and sometimes glass, have given almost perfect satisfaction.

The superintendent of a power company which has been running 15 months with about 15,000 volts, reports that they "have had absolutely no trouble whatever of an electrical nature." Some insulators were broken because they had been used as targets by small boys or hunters, but only the outer petticoats were broken, and no short-circuits occurred, although in some cases insulators were in use for months with most of the outer petticoats chipped off. The distance of transmission is 12 miles. Porcelain insulators are used.

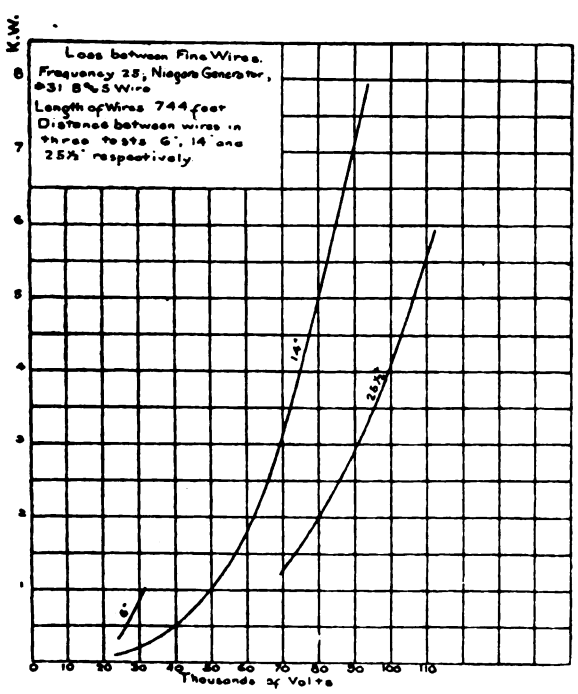

FIG. 15.

In another plant which has been in operation about a year and a half, employing 15,000 volts for a distance of nearly 30 miles, there have been but three shut-downs on account of line difficulties. These were due to the breaking of insulators at a point where the line was spiralled. In one case the repair was made in half an hour, and in the other case a few minutes' interruption to the service was sufficient for repairs.

The line is regularly patrolled, and if a defective insulator or pin is found, the generating station is notified by telephone and the line is shut down for a few moments at noon. In one case two poles were burned by a defect in the insulators on the top of each. The poles burned to the ground, leaving the line hanging clear without anyone at either the generating station or sub-station being aware of the fact.

(To be continued.)

THE LONDON CHAMBER OF COMMERCE DINNER.

The monthly dinner of the London Chamber of Commerce was held at the Trocadero Restaurant on Tuesday last. The subject for discussion after dinner was "The Progress of Electricity," and this had drawn together a good attendance of gentlemen interested in electrical matters. The dinner, which commenced at 6.30, was well and quickly served, so that there was ample time for discussion. It is usual at these dinners to allow the opener of the debate 20 minutes and the succeeding speakers 10 minutes each, so that a large number may express their opinions. Last Tuesday Mr. THOMAS F. BLACKWELL, the chairman of the council, presided, and also opened the discussion. In his remarks, Mr. Blackwell touched generally on most of the applications of electricity. Thus, in reference to telegraphy, he advocated the laying down of all-British submarine cables, so that we may have full control of the means of communicating with the Colonies. He also stated that the Chamber of Commerce in London had discussed the telephone question, and that a petition in favour of the Government taking up the telephonic work of the country had been forwarded to Parliament. Mr. Blackwell then instanced the great progress made in electric lighting during the past 20 years, and the fact that the lighting made our offices and private houses both brighter and healthier. No doubt even now the industry suffered from over-legislation, and in this respect he did not think that some of the electric light companies had been fairly treated. The speaker then spoke of electric traction and of the need in London for quicker methods of transit. The Central London Railway would confer a great benefit in this respect. Before concluding his remaks, Mr. Blackwell also referred to the process of electric engineering and of the use of X-rays in surgical work.

Mr. SIDNEY MORSE said they were fortunate in having the chairman of the council with them that evening to lend weight to their deliberations. It was a wonderful fact that, although they were discussing the means of forwarding the electrical industry that evening, no one knew what electricity was. His contention was that electricity had not received fair play in the past, but he hoped it would get better treatment in the future. It seemed to be the opinion of successive Presidents of the Board of Trade and of parliamentary committees that the science should not be encouraged, but scotched. He was afraid that, unless a great effort were made, still greater obstacles would be placed in the way of the progress and development of electricity, and the great object the London Chamber of Commerce had in view was to prevent so undesirable a purpose from being accomplished. There were now in the electric light undertaking of London alone some £11,000,000 invested, without considering the supply of electric lighting throughout the country. This fact was an indication of the great progress that had been made in spite of all difficulties, and of the enormous proportions to which the enterprise had grown. In traction, matters were worse, owing to the provisions of the Tramway Act and to the action of the municipalities. The municipal competition in tramway undertakings was most unreasonable, and he regretted to say that some times their system of accounts gave anything but a true aspect of municipal works. Both as regards rating and salaries, these works were unduly favoured in several cases that he knew of—in fact, the municipalities had the idea that all monopolies should give place to competition, and yet when they had once taken up the supply of any lighting or travelling facilities they would not allow competition at any price. In spite of this, progress had been made, but the profits of the gas companies alone exceeded the amount of capital invested in electric lighting.

Major-General WEBBER said it was with the greatest regret that he had heard that the Chamber had adopted a resolution which he was afraid would be likely to kill the telephone industry in this country. He could not help feeling that this resolution was taken without the Chamber having the fullest knowledge on the subject before it. The telephone, he claimed, was essentially a local, and not a national, industry, as quite 95 per cent. of the total messages were local in spite of the good trunk services. All the difficulties the Telephone Company had had to surmount, and which the Post Office would have to surmount if it undertook to telephone the country, were purely local, and he sincerely hoped that the Chamber would pause before finally and irrevocably committing itself to the idea of the State controlling the service. In all those countries where nationalisation had taken place the progress had not been so great as in the countries where the telephone industry had been carried on and managed locally.

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Mr. EMILE GARCKE said it was no use deluding themselves in the belief that they should be satisfied with the progress of electricity in this country. If they compared the history of the progress of the science here with that in America and on the Continent, they found that we were to-day many years behind most civilised nations. He believed the cause of this was due to that spirit of municipalisation which had been so rampant during the last 20 or 30 years. He instanced the Tramway Act of 1870 as the first sign of this tendency, and stated that this Act, which was passed as an experiment, was a complete failure. While the first lines laid down for the tramways were serviceable all was well, but after they were worn out it was almost impossible to obtain further money considering the stringent clauses of the Tramway Act. As regards telephony it was not fair to compare this country with Germany or America. Here, in London, we crowded the day's work into the limited time between 11 a.m. and 4 p.m., while in Germany the telephones would be at work from 7.30 a.m. to 6 p.m. He considered that the vacillating policy of the Government was responsible for the present state of the telephonic industry. As regards electric traction, he did not think the municipalities should have the right of veto in this matter. A municipal monopoly was the most unsatisfactory of all, as having once commenced an undertaking the authorities strongly fought advancements and improvements in all forms. As an example of the disadvantage of municipal traction, he referred to the towns of Bradford and Leeds, which were only eight miles apart, but in spite of this, one had laid down its tramways with a 4ft. 8½in. gauge, while the other was a 3ft. 6in. gauge. This entirely prevented the joining up of the two systems, whereas a company would have made them interchangeable, and provide through services.

Mr. J. S. RAWORTH referred to the delays caused by local authorities in electric lighting by the practice of obtaining provisional orders and then deferring action. As to the potentialities of electric traction, it was now usual to find that by this means the returns of a tramway were increased 2d. per car mile, while the expenses were lowered 2d., so that it made a total difference of about 4d. in a shilling. This was quite enough to provide for interest on the capital required for equipment.

Mr. C. H. W. BIGGS said that when in Sweden recently he had been impressed by the telephone organisation in that country. As regards electric traction, he thought such undertakings were better managed by companies. He was not sure, however, that in the larger towns trams running on rails were the best solution of the street difficulties. He favoured rather the improvement of the street surfaces and the use of self-propelled vehicles.

Mr. R. PERCY SELLON detailed the troubles that municipalisation of electrical undertakings had entailed from the manufacturer's point of view. It was a fact that the contractors had not made the profits which are usual in other engineering firms. This was due to the fact that they could not standardise their machines when every electric lighting committee wanted different apparatus. The lowest-tender craze was another cause for the cutting down of prices. The worst fault, however, was the want of standardisation, which hampered the manufacturer very much when competing against foreign firms. Personally, he did not fear that work would go abroad if once the radical step of standardisation could be carried out. He trusted that the resolution condemning the clause in the provisional orders for 1899 allowing corporations to manufacture, would receive the entire support of the Chamber.

A SOLICITOR from Chesterfield, whose name we could not catch, said he did not agree with the previous speakers who said that our telephone system was worse than in other countries. One must remember that in London there were some five millions of inhabitants, and that people were only too apt to compare the work of the telephone in this large city to that in towns of, say, 100,000 inhabitants abroad. He had always found the telephone of great service to him in business, and that the charges were moderate.

After one or two more short speeches the proceedings terminated by a vote of thanks to the chairman.

FORTHCOMING EVENTS.

FRIDAY, JAN. 20.

Royal Institution.—At 9 p m., "Liquid Hydrogen," by Prof. Dewar, M.A., LL.D., F.R.S.

SATURDAY, JAN. 21.

Institution of Junior Engineers.—At 3.30 p.m., Visit to the Streatham-hill Depôt of the Brixton Cable Tramway.

TUESDAY, JAN. 24.

Northern Society of Electrical Engineers.—At the Albion Hotel, Manchester, at 8 p.m., "Electric Traction," by Horace F. Parshall, M.I.C.E., M.I.E.E.

Society of Arts.—At 4.30 p.m., "Rhodesia and its Mines in 1898," by William Fischer Wilkinson, F.G.S., A.M.I.C.E.

Institution of Civil Engineers.—At 8 p.m., discussion on the papers on "The Effects of Wear upon Steel Rails," by William G. Kirkaldy, A.M.I.C.E., and "On the Micro-photography of Steel Rails," by Sir William C. Roberts-Austen, K.C.B., F.R.S., A.I.C.E.

WEDNESDAY, JAN. 25.

Liverpool Engineering Society.—Royal Institution, Liverpool, at 8 p.m., "Some Observations on the Rating of Machinery," by Oswald W. Young.

Institution of Electrical Engineers.—At 8 p.m., students' meeting. Discussion on "Systems of Electric Traction."

THURSDAY, JAN. 26.

Institution of Electrical Engineers.—At Institution of Civil Engineers, at 8 p.m., "Rules for the Regulation of the Wiring of Premises for Connection to Public Supply Mains," by J. Pigg, "The Regulation of Wiring Rules," by C. H. Wordingham, and the "Institution Wiring Rules," by R. E. Crompton.

FRIDAY, JAN. 27.

Physical Society.—At Burlington House, at 5 p.m., "The Equivalent Resistance and Inductance of a Wire to an Oscillatory Discharge," by Edwin H. Barton, D.Sc., F.R.S.E., "Exhibition of (*a*) A Dephlegmator, (*b*) A Temperature Tell-Tale," by R. Appleyard, and "On the Volume Changes accompanying Solution," by T. H. Littlewood.

Institution of Civil Engineers.—At 8 p.m., students' meeting. "King's Lynn Waterworks," by F. C. Grimley, Stud.I.C.E.

Institution of Junior Engineers.—At 8 p.m., at Westminster Palace Hotel. Lecture on "Measurements of Elasticity," by Prof. J. A. Ewing, F.R.S., Hon. M.I.J.E.

SATURDAY, JAN. 28.

Institution of Electrical Engineers.—Students' visit to the works of the Electric Welding Company, Hindon-street, Pimlico, S.W.

Institution of Junior Engineers.—Anniversary Dinner at the Westminster Palace Hotel, 7 p.m.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

134. What are the advantages and disadvantages of dust destructors in connection with central stations—T. J. A.

135. Should arc lamps for street-lighting be arranged zigzag alternately on each side of the street? Quote some of the methods of arranging them that are actually used in practice, and compare their relative merits, giving details as to distance and the current used in the lamps.—J. C. R.

ANSWERS.

Question No. 128.—In selecting meters for the measurement of current to consumers, what are the chief points to be taken into consideration?

Best Answer to No. 128 (*awarded* 10*s.*).—The following are the most important points to be considered in selecting a meter for the measurement of electric current:

1. Accuracy. The maximum error should not exceed

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2 per cent. at full load, 3 per cent. at quarter load, and 5 per cent. at $\frac{1}{10}$ load.

2. Starting current should be small. All meters should start with $\frac{1}{100}$ full load, and stop immediately the current is switched off.

3. Small series-coil drop. This should not exceed half a volt at full load.

4. The meter should not be affected by outside influences or capable of being readily tampered with, and should be provided with a dust and damp proof case (preferably iron) capable of being readily sealed. Variations of temperature, frequency, or barometric pressure must not materially affect the accuracy.

5. In the case of energy meters the shunt loss should not exceed four watts. In this class of meter there is generally a tendency to run on the shunt, especially when subjected to vibration. This must be avoided, while retaining a low starting current.

6. The meter should read direct in Board of Trade units.

7. It should be capable of being readily tested and checked by a short time test, and also easily checked *in situ*.

8. Cost of inspection and repairs should be low, and no periodic adjustments or winding should be necessary. The parts of the meter should be of a material not liable to rust or corrode, and as far as possible commutators and mercury baths are to be avoided. The weak spot in the otherwise excellent Thomson energy meter is the commutator.

9. The registration of the meter should not be affected by a short-circuit, which blows the fuses. This is far from being the case with at least one well-known type of quantity meter; a short-circuit may cause this meter to register high by 10 or 20 per cent. for some time after. In the case of mercury-bath meters a "short" is liable to throw out some of the mercury, thus introducing a permanent error.

10. First cost should be small, not exceeding £5.

11. In addition, when energy meters are used on alternating-current supply, it is exceedingly important that they should register true watts, and be unaffected by any lead or lag in the circuit.

12. A meter which can be used for both alternating and direct current is, *cæteris paribus*, to be preferred.

With reference to the question of employing energy or quantity meters, speaking broadly, energy meters will be found necessary in alternating-current stations, and it may be advantageous to employ them in certain districts in continuous-current supply where the pressure often exceeds the standard, as otherwise the excess pressure is nearly all lost to the station. Quantity meters are simpler than the former type, but generally require a larger starting current. The loss arising from this, however, may be nearly balanced by the shunt coil losses in the energy meter.—E. M.

Answer to No. 128 (*awarded* 5*s.*).—A good registering meter should possess the following qualifications: (1) small starting current; (2) accuracy within wide limits; (3) low total cost; (4) high capacity; (5) simple construction and compact form.

1. The meter should start within 1·5 per cent. of full load. If, on a small installation, it failed to record the current taken by a single lamp, when the lamp was on for several hours each day, this would mean an appreciable loss to the company at the end of the quarter.

2. The constant of a meter should not vary more than 3 per cent. within its working limits. Any of the standard types now on the market, however, such as the Ferranti, Elihu Thomson, or the Chamberlain and Hookham, can be got to register within 2 per cent. The chief variation occurs at low loads, when, for a 25-ampere meter, there is a tendency to run quicker as the current falls below one ampere; the Ferranti meter, however, being an exception to this rule, as it runs slower.

3. In dealing with the cost of a meter one must consider: (*a*) initial cost; (*b*) cost of maintenance—(1) inspection, repairs, etc., (2) energy consumed by meter. (*b*) is more important than (*a*), as a cheap meter may require more frequent inspection because of low capacity, or extra watts may be consumed in a wasteful shunt circuit. The cost of renewals and repairs always has to be allowed for, but if extra money is put into good workmanship it is generally found that the total cost will work out less than for a meter whose first cost was small.

4. Small capacity means more supervision, and the cost of maintenance is therefore increased. The great disadvantage of a meter having a small range is that no trace of a record of any previous reading remains when it is again set in working condition, therefore a meter should possess as large a range as possible, and in this case motor meters come first, as this question does not occur, their capacities being infinite.

5. The working parts of the meter should be protected from all dirt and moisture. The instrument should therefore be completely enclosed in an outer case, only leaving the necessary openings for the leads to be inserted. It could thus be kept free from all dust and damp, the meter would remain clean, and there would be less chance of a short-circuit if the whole arrangement remained dry.

The meter should be portable, and of a convenient size and weight. All such instruments should be corrected for any error due to change of temperature, and continued running should have no effect on the value of the constant. If such does occur, it may be generally attributed to the current weakening the retarding force of the meter, such as the weakening of permanent magnets after long use. It should, therefore, be noticed whether this force is of sufficient strength to remain unaffected by the passage of a current through the meter. Influence meters record very small currents, but they possess disadvantages which counterbalance this. Electrolytic meters will record very low currents, and, like influence meters, they are affected directly the current is switched on—there is no "friction at starting" to overcome. But their capacities are not large. For the above requirements motor meters offer the most convenient type.—H. M D.

Answer to No. 128 (*awarded* 5*s.*).—In selecting from the few types which there are at present in the market the following points should be taken into consideration. The instrument should be as cheap in first cost as is consistent with substantial and accurate workmanship, which is indispensable in an instrument from which so much is expected as the electricity meter. The meter should be enclosed in a strong case of cast iron or other suitable material, both dust and damp proof, and the indicating gear should be direct reading and boldly figured, so that the instrument may be easily and accurately read in the inaccessible position in which it is often necessarily fixed. Special attention should be paid to the terminals. In most existing types of meters these leave much to be desired, as most engineers know who have seen their workmen struggling to connect up a heavy cable in a confined situation. It is very desirable that the instruments should be sealed after leaving the test-room, so that it is impossible for the adjustment or registering gear to be injured or tampered with, and to this end the double sealing arrangement, primarily due to Messrs. Ferranti, should be adopted whereby the terminal chamber only is accessible to the workman.

Now that 200-volt distribution is being adopted on all sides, low starting current is of the utmost importance, and the writer believes that there are very few, if any, instruments on the market at the present time which will record the energy consumed by a 200-volt 8-c.p. lamp continuously. This is a most important point, and probably leads to a considerable loss of revenue by supply authorities.

Certain types of direct-current meters, depending upon a residual field to a certain extent for their working, are very liable to be rendered inaccurate if an abnormal current is passed through them, as, for instance, an accidental "short," and the writer remembers testing a meter of this type which he found registered 15 per cent. high at light loads due to this cause.

In most types of alternating meters a shunt coil is employed in addition to the usual series coil. Thus a certain amount of energy is wasted in shunt exciting current, besides the extra trouble and expense of "burn

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outs" and defective shunts. This is, however, a necessary evil, as those meters which only possess a series coil, and depend upon a rotary field for their working, have not sufficient "torque" to enable them to start or record accurately at light loads, and probably more loss would ensue from this cause than by using a wattmeter. A point frequently overlooked in connection with alternating supply is the fact that a good alternating-current meter should measure true and not apparent watts; at any rate that should be the case with those consumers who use motors, arc lamps, or other consuming devices of an inductive nature. Instruments of the ampere-hour class greatly over-register, while some so-called wattmeters under-register on an inductive load.

Meters of the clock type have been much improved lately, and may be depended upon to register both large and small currents with considerable accuracy, but the writer is of opinion that, although admirable for laboratory use, instruments of this type are, at the present time, too complicated, and require too much attention for successful commercial use upon a large scale.

Other points to be considered in selecting a meter are: the $C^2 R$ loss should be as small as possible, insulation resistance high—a matter much neglected—and further, that one pattern, wisely selected, should be adhered to. All those who have a variety of types and patterns of meters in use know the trouble and confusion it entails, both in the test-room and on consumers' premises, where different brackets, boards, insulators, etc., will be required for each type.—Wm. J. Sowtar.

Question No. 129.—In overhauling an engine a crack is found between the low-pressure cylinder exhaust port and the steam jacket. How would you determine the loss in steam and coal—say for a run of six hours daily? Give an example if possible.

Best Answer to No. 129 *(awarded* 10*s.)*.—The weight of steam that will escape into a space in which the pressure does not exceed 58 per cent. of the gross pressure of the steam is in 70 seconds just equal to the gross pressure of the steam upon an area equal to the area of the orifice. We will suppose the sectional area of the crack is equal to 1·2 square inches, and the steam in the jacket is 80lb. pressure by gauge, and if 1lb. of coal produces 7lb. of steam, what is the loss of steam and coal in six hours?

80lb. + 15lb = 95lb. gross pressure.

95 × 1·2 = 114lb. of steam that escapes in 70 seconds.

70 seconds : 3,600 seconds an hour :: 114lb : 5,862·8571lb. escaping in one hour.

5,862·8571 × 6 = 35,177·142lb. escaping in six hours.

35,177·142 ÷ 2,240 = 15 704 tons of steam escaping in six hours.

15·704 ÷ 7 = 2·243 tons of coal consumed in six hours.

Answer.—Loss of steam in six hours, 15 704 tons.
Loss of coal in six hours, 2·243 tons.

Telford.

Answer to No. 129 (*awarded* 5*s.*).—According to a well-known rule, the weight of steam that will escape into a space in which the pressure does not exceed 58 per cent. of the gross pressure of the steam is, in 70 seconds, just equal to the gross pressure of the steam upon an area equal to the area of the crack. In determining the loss of steam and coal, it is first of all necessary to find the area of the crack. Suppose the area of the crack is equal to $\frac{1}{2}$ square inch, and the steam in the jacket is 55lb. by the steam gauge. Assuming that 1lb. of coal evaporates 10lb. of water, the loss in steam and coal in a six hours' run is as follows:

The gross pressure of steam = 55 + 15 = 70lb.

The steam which escapes in 70 seconds = 70lb. × $\frac{1}{2}$ square inch = 35lb.

Six hours = 6 × 60 × 60 = 21,600 seconds.

Then the steam which escapes in six hours =

$$\frac{21{,}600 \times 35\text{lb.}}{70 \text{ seconds.}} = 10{,}800\text{lb.}$$

10,800 = 4·821 tons.

The loss in coal in six hours =

$$\frac{4\,821}{10} = \cdot 4821 \text{ ton.}$$

F. Bruton.

ELECTRIC LIGHT AT POPLAR.

The following extracts from Mr. Alfred Blackman's report to the Electric Lighting Committee of the Board of Works for the Poplar District will give some idea of the work which is now to be put in hand. Mr. Blackman hopes to get the specification issued in about four weeks from now.

Mr. Blackman commences his report by stating that in framing it he had constantly before him the necessity of arranging everything in such a manner that, as the undertaking grew and the demand for electricity increased, extensions could be carried out expeditiously and without interruption to the supply, or altering previously installed plant. The site selected was in all respects but one unusually favourable. It was situated in about the middle of the area to be supplied. There was water available for condensing purposes. Seaborne coal could be brought practically alongside by water. It was near the dust destructor, and the shape of the land was very good indeed. Those considerations by far outweighed the extra cost of foundations the use of the site would necessitate. So far as the engine foundations themselves were concerned, they could be made quite secure at a cost not exceeding £170 for the whole site, in addition to what they would have cost had the subsoil been good. Owing to the type of plant he proposed to use, the weight upon the foundations would be very small—the pressure of the plant upon the concrete engine foundations would not exceed 1·6cwt. per square foot distributed over the whole area of the engine bed. There were many areas in which it was very difficult indeed to decide which of the different systems available should be adopted, owing to the various considerations which tell in favour of the one system or the other being very nearly balanced, but the Poplar district was not one of them. After the most careful consideration, Mr. Blackman unhesitatingly advises the adoption of the low-tension continuous-current three-wire system, with a pressure of 460 volts between the outside wires, and supplying energy to consumers at 230 volts pressure.

Description of Proposed Generating Works.—Mr. Blackman submits two plans of the proposed works, showing the general arrangement of the plan in outline. Plan No. 1 embraces the whole of the site, and is intended to show the amount of plant the works will contain when the whole site is covered, and to give the committee some information in regard to the capabilities of the works site. In the general arrangement of the works and plant the future has been carefully considered and everything arranged so that extensions can readily take place without interfering practically at all with previously installed plant; no plant of a temporary nature is required or provided for in the execution of this scheme, but as the undertaking grows it will simply be added to. The works assume the form of one long row of engines and dynamos, one row of economisers, and one row of boilers; the construction would be commenced at one end and carried forward to completion, the buildings being extended from time to time as found necessary, and the end of the engine-room and boiler-house enclosed with a movable partition, which at each extension would be taken down and re-erected in its new position until the last portion of the building required on this site was erected, when a permanent gable would of course be built. The generating plant shown in outline consists of 14 sets of high-speed compound, vertical, surface-condensing engines, each coupled direct to a shunt-wound continuous-current dynamo. The dynamos would be two-pole machines in the case of the smaller sets and multipolar in the case of the large sets. The capacity of the 14 units of plant shown on the plan are as follows: two plants of 90 kw., two plants of 210 kw., and 10 plants of 450 kw. capacity each, making a total capacity of 5,100 kw. The whole of the generating plant the site is capable of accommodating when running fully loaded would generate, therefore, 5,100 Board of Trade units per hour, but in practice it is always necessary to hold one set of generating plant in reserve, capable of taking the place of any one of the plants running on the load, which reduces the available output of the dynamos to 4,650 Board of Trade units per hour. In order to give some indication of what this output means, it may be stated that taking the total length of the streets of the district as 61 miles, to light them all, including side streets, in the same manner as it is now proposed to light the main streets, the total consumption of electricity would not exceed 850 units per hour, which, deducted from our total works output, would leave 3,800 units per hour for sale to private consumers, or sufficient to light simultaneously the equivalent of 114,000 8-c.p. lamps, or deal with the demands of 228,000 lamps coupled to the mains. When the site is covered with plant it may be expected that the works will have an output of 4,500,000 units per annum, which, sold

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at 3d. per unit, represents an annual revenue of £56,250. The two largest municipally-owned electricity supply undertakings in the Metropolis at present are those of the St. Pancras and Hampstead Vestries, which have a kilowatt capacity of 1,850 and 1,065 respectively. Plan No. 2 shows in full black lines the outline arrangement of the buildings and plant to be erected for a commencement. The plant shown in dotted lines shows the additional plant the buildings will be capable of accommodating after the first instalment. The plant as shown consists of two 90-kw. and two 210-kw. generating plants, consisting of four high-speed engines coupled direct to four shunt-wound dynamos, as before described, and four boilers, together with a main switchboard, balancing transformer, booster dynamo, steam-pipes, hot-well, cold-water tank, pumps, economiser, etc. The buildings and chimney shaft are large enough to accommodate, without further extension, two and a half times this plant, or 1,500 kw. The works at these two stages would have a total dynamo capacity of 600 kw. and 1,500 kw. respectively, and would be capable of dealing with the demands of 32,400 and 86,400 8-c.p. lamps installed in consumers' houses, in addition to the public lighting recommended in this report.

Coal Supply.—It is proposed to use seaborne coal, probably from the Newcastle district, which should be obtained in barges alongside the dust destructor works at a cost of about 12s. per ton; the coal will be in the form of very small pieces or powder, and will lend itself well to mechanical unloading, and although this will not be necessary at the very commencement of supply, directly the work warrants it, the barges will be unloaded by means of an elevator driven by an electric motor, which will pick the fuel up out of the barge and drop it into the small iron tramway trucks, by which it will be conveyed to the works. From the commencement the fuel will be conveyed from the water's edge to the coal bunkers in the boiler-house by a light iron tramway of about 24in. gauge, which will run over the weighbridge at the entrance to the dust destructor yard and right over the coal bunkers in the boiler-house, and the ashes will be removed by the same means, and arrangements can probably be made to dispose of them along with the ashes, etc., from the dust destructor.

Boilers.—Water-tube boilers are recommended on account of their durability, quick-steaming powers, economy, and compactness. Quick-steaming powers are also indispensable in an electricity works serving an area at all liable to fogs; in many London electricity works the rate of output during a fog is heavier than at any other time, and when it is remembered that the works are liable to this sudden and severe call upon them at almost any moment throughout a considerable portion of the year, this point need not be further insisted upon. Quick steaming boilers have also a very important bearing upon the economical working of the plant; a much larger proportion of the total fuel consumed in the works than is generally supposed is expended in bringing the boilers up every day to their working pressures ready to take the load as darkness comes on. The water capacity of a Lancashire boiler is 2½ times as great as the water capacity of a water-tube boiler, and approximately 2½ times the fuel is required to bring the Lancashire boiler up to its working pressure compared with a water-tube boiler, and when it is considered that often 25 per cent. of the total fuel used is expended in raising steam every day, the advantage of having a boiler holding a small amount of water will be apparent. By the use of "double-deck" water-tube boilers twice the power can be installed per square foot of floor space as compared with boilers of any other class. By this means the same power can be put on a given area with the boilers all on one level as could otherwise be installed by placing them on two floor levels, one above the other. The maximum amount of power can thus be placed in a less expensive building than would otherwise be the case, and no fuel has to be lifted. All the boilers after the first instalment will be "double deck" boilers. The boilers will be constructed for a working pressure of 185lb. per square inch, and the steam superheated after leaving the steam-drum to a temperature of about 100deg. F. above the temperature corresponding to the boiler pressure, or to a total expenditure of 470deg. F. The boilers will be fitted with mechanical stokers; the quality of coal it is proposed to use and the absolute necessity of smokeless working renders them necessary. A certain amount of economy is also gained by their use, owing to the perfectly even firing and to the non-admission of cold air to the boiler-heating surfaces and flues, caused by opening and shutting the fire-grate door where hand-firing is resorted to.

Dust Destructor.—At the time of writing the dust destructor has not been brought up to full work; Mr. Blackman therefore has been unable to measure the temperature of the flue gases or form any opinion as to what its steam-raising capabilities may be. The works will be in a good position to take any help that can be derived from the dust destructor in the future, and can make use of what steam can be obtained without alteration to the arrangement of plant proposed in this report.

Mains.—An adequate system of distributing mains will be laid large enough to meet the demands for all time coming, and its capacity will be increased from time to time by laying new feeders between it and the works, and thus establishing new feeding points. Some five feeders and 10 miles of distributors will be put down at once.

Cost of the Electric Light to Consumers and Method of Charging.—In every case that has come under Mr. Blackman's notice the practice in fixing the price per unit to consumers has been to adopt such a price as was expected to about cover the cost of supply during the first year of the undertaking's life, it being no unusual thing for a consumer who adopts the electric light at the commencement of supply in his district to pay for his first year's consumption at the rate of about 6d. per unit, for the second year's consumption at the rate of about 5d. per unit, and in the third year 4½d. per unit or less. It would be hard to imagine a more unbusinesslike arrangement, for such a mode of procedure is calculated to greatly discourage anyone from using the electric light at the commencement of supply, with the knowledge that by waiting a year or two for prices to find their level he will escape altogether the heavy initial charges. After discussing the question fully, Mr. Blackman recommends his Council to adopt the "maximum demand" system of charging, and to fix the price for current for lighting purposes at 5d. per unit for one hour's use or less of the maximum per day, and 4d. per unit for all subsequent consumption, this charge to apply to both public and private lighting, and no rental for meters to be charged. For current used for driving motors, the price recommended is 3d. per unit for the first hour's use or less of the maximum per day, and to supply all subsequent consumption at 1½d. per unit.

Public Lighting.—The engineer strongly recommends that the whole of the streets in which the consumers' network is laid be lighted with electricity. The number of street lamps required would be 54 10-ampere arc lamps, which would be replaced at midnight with 108 32-c.p. incandescent lamps; 71 7½-ampere arc lamps, which would be replaced at midnight with 142 16-c.p. incandescent lamps; and 42 20-power incandescent lamps placed in the 24 existing gas lanterns in streets where the consumers' network is laid, but which are not of sufficient importance to justify lighting them with arc lamps.

The estimated capital cost of the work recommended in the report is as follows:

Land and Buildings.

To lands	£3,200
To buildings and foundations and chimney shaft	8,739
To cooling water tanks for condensers and pipe work between same and canal	500
To coal tramway and two iron trucks for same	350
Total	£12,789

Works Equipment.

Engines, dynamos, and condensing plant of a capacity of 600 kw.	£9,500
Boilers, superheaters and mechanical stokers, and feed-water heater, including brickwork setting for the boilers themselves, but no flues, which are included in the estimate for the buildings	4,100
Battery, battery stands, and regulating gear	2,000
Balancing transformer and booster	1,500
Works' main switchboard, not including platform, which is included in buildings	1,000
Steam and water pipes, valves, hot-well and boiler feed pumps	2,050
Overhead travelling crane for engine-room	600
Testing instruments	150
Office furniture	150
Total	£21,050

Mains and Street Work.

Consumers' network laid in streets and roads scheduled in report	£8,140
Four feeders run between works to the feeding points mentioned in report	5,713
Street and road work	2,790
Total	£16,643

Public Street-Lighting.

125 combined arc and incandescent lamp columns, erected complete	£4,850
Alterations necessary to convert 42 existing gas lamp-posts from 12-c.p. gas to 20-c.p. electric lamps	168
Total	£5,018

Summary.

To buildings, etc., including site	£12,789
To works equipment	21,050
To mains and street work	16,643
To public lighting	5,018
Add for house services, meters, etc., to end of first year's working	3,000
Add for preliminary and parliamentary expenses to date of commencing supply	2,500
Add for contingencies	1,000
Grand total	£62,000

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In the second year's operations about £2,500, in addition to the above, will be required to provide additional house services, meters, etc., for new consumers.

Mr. Blackman also gives estimates of the probable revenue during the first two years, which we have been obliged to omit. These show that the undertaking would soon pay its way.

Mr. Blackman concludes his report as follows: In order to estimate the results of the first two years' working of the undertaking, it has been necessary to assume a certain output, and this is the only factor of doubt in the whole matter. The committee, however, have it in their power, by adopting the scheme for public lighting included in this report, to make the greater proportion of the revenue on the first year's working a matter of absolute certainty, and for the rest it will no doubt be noted that I have reckoned upon obtaining a larger output for private consumption than has been represented to the committee as likely in a former report; but the conditions under which I expect to do this are vastly different, for not only will the electricity be sold at 1½d. per unit less than was proposed in the earlier report referred to, but more mains will be laid, and consequently the supply will be within the reach of more people. This report provides for the laying of 10 miles of consumers' network, as against less than eight miles in the previous report. Should this report be adopted as it stands, I feel sure that with energetic management the units I have indicated will be sold, always providing that the committee enter into some arrangement for assisting consumers over the initial cost of wiring their premises in good time before the commencement of supply, in order that the works may have a private lighting load from the very commencement of supply, and it will be necessary to arrange that any firm that may be entrusted with the wiring of consumers' premises under arrangement with the committee take all reasonable steps to obtain consumers by canvassing or otherwise. I would also suggest that the committee would do well, at the commencement of supply, to hold an exhibition, either in the new works or some other approved place, at which manufacturers of electrical plant and electric house fittings would exhibit in return for free floor space and a free supply of electricity with which to work and show off their exhibits. The exhibition, which would be free to ratepayers, might well last a week and public interest be aroused by a popular lecture with experiments given nightly in the exhibition hall. The expense of such an exhibition would be small, and in many places such a method of introducing the new light has been attended with much success. Summarised, my recommendations are as follows: that the low-tension continuous-current system be adopted with a pressure of 460 volts between the outside wires, and giving a service to consumers at 230 volts; that an adequate system of mains be laid before the commencement of supply; that from the commencement of supply consumers be charged as low a price for current as is consistent with making no loss upon the second year's working, and that no meter rents be charged; that gas be done away with for public lighting along the whole route of the electricity supply mains; that steps be taken to ascertain upon what terms an outside wiring company will wire premises for consumers free of all initial cost.

We must congratulate Mr. Blackman on his report, and still more on the fact that it has been adopted in its entirety.

ELECTRIC LIGHT CHARGES AT HANLEY.

We have received the report of the Hanley Electric Lighting Committee on the maximum demand system of charges and upon points raised by a deputation from the North Staffordshire Traders' Association to the Corporation. The report states that, in interviews between the association and the borough engineer 2½ years ago, exactly the same objections as were now brought forward were made and answered. The association consists of two parties—namely, the all-round uniform price party and those who admit the necessity for a scale of different charges. Those who asked for the withdrawal of the maximum demand system and price to be lowered all round 2½ years ago from 6d. to 5d. now ask for the withdrawal of the system and the price to be lowered from 5d. to 4d. A two years' trial of the price at 5d. converted a small profit into a small deficit, which showed signs of increasing. The committee then decided to give the maximum demand system a fair trial for the same length of time as with the price at 5d., and they think it unreasonable to expect them to abandon it before even one year is passed. If they abandoned the maximum demand system they would have to face the question of what they should do with the new customers who have had the light installed on the faith of the reduced charges for long-hour consumption. The committee then point out that no better authority should be required as to the value of the maximum demand system than that no fewer than 70 towns in the British Isles employ it. The report describes the maximum demand system as follows: The consumer is asked to pay 2½d. per unit for all the energy he consumes, and this is checked by the meter. This price is uniform to everybody for any amount, and covers the cost of distribution and generation of the current. He is also asked to pay 2½d. per unit to cover the charges incurred on the interest and sinking funds on the buildings, etc. But he is only required to pay this up to the amount of his maximum demand for the period of time per day fixed by the Council. After this he only pays for the energy supplied.

As to the uniform price in electricity, the few towns which have not adopted the Wright (or maximum demand) system have not an all-round uniform price. Bradford, though often taken as an example, has many different prices. The deputation, says the report, can scarcely have fully considered the effect of this uniform-price system. With it, all businesses using light for more than four hours per day would soon be ruined. Also, the ratepayers would not pay for street-lighting on such terms. The same applies to charges for heating and power. It might be seen by the accounts that it was not possible to make ends meet by a uniform price, even at 6d. per unit, where customers took less than an average of 1½ hours per day throughout the year. It was evident that steam could not be got up for 1½ hours per day only as economically as for three, six, or ten hours, and if it were not for long-hour consumers the cost of generation, which in 1897 was 2½d., would greatly exceed that amount. The great merit of the maximum demand system is that it tends to make all customers equally profitable, whereas, although with a uniform price it makes some very profitable, a great proportion would be unprofitable. The committee were not wedded to the Wright indicator if a better one were brought out, but they were in favour of a sliding scale of charges according to the length of time a consumer used the engines and mains. No system has met with the success of the maximum demand indicator, although many systems have been tried. This indicator is guaranteed accurate, and took no notice of lamps accidentally turned on for a less period than 15 minutes. One member of the deputation laid great stress on the fact that while he was paying 5d. per unit another man was paying less. He did, as a matter of fact, obtain the current at 2½d. as soon as he had passed the line. It was to make those who used a small amount of current pay their fair share of the interest account that this scale was devised. As to separate private plants it has not been found to be practicable to lay down a separate plant to supply electricity for 1½ hours per day at a less cost than 4¾d. per unit. It has not been done in London, where the prices are 6d. and 8d. per unit.

In comparing the accounts for the nine months ending Sept. 30, 1898, with the corresponding period of 1897, the estimated loss for three quarters was £357. The total revenue at 2½d. amounted to £337, which being half price represents the benefit derived from these consumers collectively. The revenue from the same customers in 1898 was £2,650, as compared with £2,711 for 1897. This was a diminution of £61 instead of £357. The number of units consumed by these customers in 1897 was 138,600, and in 1898 146,047, an increase of 7,447. The increase in the maximum output during 1897 was 35 kw., in 1898 it had been 80 kw. The report then advises the Council to persevere and extend the Wright system, and suggests that until at least some of the 70 towns using it have abandoned the maximum demand system, they should consider the matter as settled. The loss to the undertaking through the prolonged controversy has been estimated at £2,000. A great disadvantage under which the undertaking exists is its low first price. However, the accounts are so favourable that the committee propose that after Jan. 1, 1899, the charge for electricity should be 5d. per unit (with a discount of 5 per cent. for payment within 21 days) for all consumed in the quarter up to 150 hours of the maximum demand indicated, and 2½d. (net) per unit for all consumed beyond that amount. These prices give an abatement of 5 per cent. to consumers collectively, and the committee hope that an increased demand will result. At the end of the report an appendix is given showing the methods and prices in use in various large towns in the British Isles.

CORPORATION OF LONDON ELECTRIC LIGHTING.

ELECTRICAL ENGINEER'S ANNUAL REPORT.

The following is the full text of Mr. Voysey's report for 1897, which has just been issued. It is regrettable in view of the present situation that these reports are not made up at an earlier date, as the 1898 figures would be most useful. The report is dated Oct. 17, 1898, and reads as follows:

In accordance with my custom in the past, I beg to have the honour of laying before you a short report of the progress made in matters connected with my work as your electrical engineer and electric inspector during the year ending Dec. 31, 1897.

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The report deals with the following subjects: (1) electrical testing; (2) public electric lighting (main streets); (3) public electric lighting (side streets); (4) private electric lighting; (5) electricity streets works in relation to the public safety. The words "the company" throughout the following remarks mean the City of London Electric Lighting Company.

Electrical Testing.—Seventy-eight instruments have been submitted to me for testing. The bulk of these were meters, and were submitted by consumers who doubted the accuracy of their registrations. The tests of these meters resulted as follows: 34½ per cent. were slow; 22½ per cent. were fast; 43 per cent. were approximately correct. The maximum percentage error in the slow meters was 11·4, and the mean percentage error was 5·2. The corresponding errors in the fast meters were 15·4 and 6·4 respectively. These results are somewhat better than the results recorded during the previous year. In the course of my work in testing meters I had occasion to observe certain peculiar variations in the speed of meters of the type known as Shallenberger. I made a careful investigation of the matter, and having discovered that the cause of the variations was to be found in the generating machinery of the company, I made a number of tests to determine the exact amount of the variations under different conditions at the generating station. Several consumers having applied to the company to provide them on hire with certified meters, I was called upon by and at the expense of the company to test meters for use on the said consumers' premises, and I found the meters so submitted to be approximately correct except in two cases. I have had one application, under Clause 39 of the provisional orders, to test the electric pressure at a consumer's terminals. On terms approved by you I have carried out the testing of certain wires, fittings, and instruments, which is not provided for in the provisional orders. The testing fees amounted during the year to £72. 19s., or about 34 per cent. more than the fees in the previous year.

Public Electric Lighting (Main Streets).—The following table is a comparative statement for the years 1895, 1896, and 1897 of the interruptions and delays which have taken place in the lighting of the public electric lamps, based on the reports of the police, supplemented by those of myself:

	1895.	1896.	1897.
The total number of arc lamps in lighting on Dec. 31 was	486	493	493
The number of lamp failures reported by the police	551	609	1,306
The number of lamp failures reported by your electrical engineer	38	150	160
Totals	589	759	1,466
The sum of the figures representing for each lamp the total number of minutes during which it was reported as not alight	126,275	126.587	347,215
The average time per lamp of extinction in minutes	214	167	236·8
The total number of lamps late in starting as reported by your electrical engineer	—	4,132	98
The sum of the figures representing for each lamp the total number of minutes during which it was reported as late in starting	—	49,166	778
The average number per lamp of minutes late	—	12	7·9
Penalties inflicted on the company for failures: Reported by police	£127 19 4	£148 1 10	£315 1 0
Reported by your electrical engineer	8 17 10	9 12 3	33 15 2
Penalties inflicted on the company for lateness in starting reported by your electrical engineer	—	204 17 2	3 4 10
Total amounts of penalties	£136 17 2	£362 11 3	£352 1 0
The proportion of the total time of failure to the time of possible failure—*i.e.*, the total number of lamps multiplied by the total number of minutes during which they should by contract be lighted	0·1 per cent.	0·1 per cent.	0·27 per cent.

Dividing the failures into those affecting single lamps and those affecting groups of lamps:	1895.	1896.	1897.
The proportion of the time of single lamp failures to the total time of failure was	34 per cent.	31 per cent.	18·5 per cent.
The proportion of the time of group failures to the total time of failure was	66 per cent.	69 per cent.	81·5 per cent.
The number of occasions on which group failures occurred	7	12	24
The lamp failures and late startings were distributed among the various circuits in proportion to the following figures:			
Circuit A	6·8	4·7	8·5
Circuit B	5·2	5·9	13·3
Circuit C	9·9	11 2	7·0
Circuit D	2·2	21·0	2·8
Circuit E	3·3	24·9	14·7
Circuit F	19·3	10 8	2·7
Circuit G	17·6	5 6	21·5
Circuit H	21·3	4·2	13 0
Circuit K	3·4	5 2	6·5
Circuit L	11·0	6 5	10·0
	100·0	100·0	100·0

I regret to say that the arrangements for testing the supply of electricity to the public lamps have not yet been made. The company, who is responsible for the provision of instruments at its own expense, is now in communication with the Board of Trade as to its requirements, the instruments being subject to the Board's approval, and in view of the recent correspondence, a copy of which was forwarded to your honourable committee by the Board of Trade, I think there is no reason why the provision of the necessary instruments should be much longer delayed. It is an exceedingly important matter, because without proper arrangements for testing the duration and value of the supply of electricity to the public lamps, the means of ascertaining how far the public lighting agreements are fulfilled are quite insufficient. Comparing the year 1897 with the preceding one, it will be seen from the foregoing table that the total number of lamp failures has almost doubled, and the total time of extinction, taking the sum for all the lamps, has increased to a still greater degree. The proportion of group failures to single lamp failures has immensely increased. The former have been almost universally due to faults arising in the insulation of the cables, while the latter are usually due to defects in the lamps or carelessness of trimmers. In my report of last year I pointed out that the expense and trouble to which the company is put by the breaking down of its cables supplied the strongest incentive to the company to solve the problem. I may say that the old cable has now been replaced by a different type of cable. Much more care, it would appear, has been observed by the company in lighting the lamps at the time specified in the agreements.

Public Electric Lighting (Side Streets).—The year 1897 has not been one of very visible progress towards a decision as to the lighting of the side streets. But great progress has been made towards a settlement of the most important disputes between your honourable committee and the company as to the meaning of the public lighting agreements. As you are well aware, the points in dispute are of the utmost importance, and it must be a source of satisfaction to your honourable committee to know that you will be able to obtain a ruling of the High Court of Chancery in the matter.

Private Electric Supply.—As regards the continuity of the supply to private consumers the year 1897 shows an improvement on the preceding year, as there has not been, as far as I am aware, any occasion on which an extensive interruption of the supply has occurred. At the end of 1896 the equivalent of 247,785 lamps of 8 c.p. were connected to the company's system of supply; at the end of 1897 this number had reached 296,012, an increase during the year of about 19 per cent.

Electricity Street Works in Relation to the Public Safety.—I am glad to say that the year, as far as I am aware, has been free from any accident or injury to the public by electric shock or gas explosion arising out of the electric lighting works in or under the streets. The company has, I believe, continued to carry out or maintain the following precautions, with a view to comply with the Board of Trade regulations and secure the safety of the public: (1) the regular inspection of street boxes for the presence of gas, and the notification of escapes of gas to the gas company; (2) the plugging and packing of the ends of pipes and conduits to prevent gas coming into the boxes through them; (3) the connection to earth of arc lamp standards and brackets; (4) the protection of the arc light cables in the base of the lamp-posts over underground conveniences.

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COMPANIES' MEETINGS AND REPORTS.

EASTERN TELEGRAPH COMPANY, LIMITED.

The fifty-third half-yearly ordinary general meeting of this Company was held on Thursday, the 19th inst., at Winchester House, Old Broad-street, E.C., to receive the directors' report and accounts, elect directors and auditors, and transact the ordinary business of the Company. The report of the directors for the half-year ended Sept. 30 last states that the revenue for the period amounted to £444,012, the ordinary expenses £121,377, and for repairs and renewals of cables, etc., £41,717, depreciation of spare cable £2,523, income tax £6,965, leaving a balance of £271,430, to which is added £3,568 brought from the preceding half year, making a total of £274,998. From this balance there has been paid interest on debentures and debenture stock, £29,855; dividend on preference shares, £10,148; dividend on preference stock, £14,548; and two interim dividends of 2s. 6d. per share each on the ordinary shares, £100,000, together absorbing £154,551. After carrying £10,000 to the reserve fund for maintenance ships, £5,000 to the reserve in connection with the removal of head offices, and £70,000 to the general reserve fund, there remains a balance of £35,447, which is carried forward. The revenue includes £23,902 dividends for the half-year upon the Company's shares in other telegraph companies. The new issue of £500,000 3½ per cent. preference stock, referred to at the last general meeting, was more than fully subscribed for by the shareholders. A section of the cable from Porthcurnow to Gibraltar has been laid, and the expedition with the additional cables from Gibraltar to Malta and Alexandria left the Thames on 27th ult. The directors are arranging for the building of a new cable-repairing steamer to replace the ss. "John Pender," which has been recently sold. An extraordinary meeting followed for the purpose of considering an alteration in the Company's articles of association referring to debenture stock.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING COMPANY, LIMITED.

An extraordinary general meeting of the shareholders of this Company was held at the offices of the Company on the 16th inst., to consider the Bill for compulsory powers promoted by the Company.

The **Chairman** (Lord Rathmore) stated that the meeting was a formal one, called to comply with parliamentary standing orders, and that the main object of the Bill was to enable the Company to obtain compulsory powers for acquiring sites for generating stations and rights of way for connecting its various districts.

The resolution was carried unanimously.

LONDON ELECTRIC OMNIBUS COMPANY, LIMITED.

The third annual general meeting of the London Electric Omnibus Company, Limited, was held on the 14th inst. at Winchester House, Major S. Flood Page presiding.

The **Chairman**, in moving the adoption of the report, said the Board had been endeavouring to ascertain exactly the whole of the conditions necessary for the working of electric traction, especially with reference to accumulators. Although they believed they had a good asset in the Sola accumulator, they could not do anything with it owing to the claims made. The reputed owners of these accumulators were compelled to go to arbitration to have these claims settled. The Electrical Street Car Manufacturing Company were carrying out a considerable amount of experimental work, and had been making not only omnibuses, but cars. An increase of capital would enable them to continue to try to solve the problem. The London Electric Omnibus Company had had three omnibuses running successfully in the streets of London for three or four hours successively, but they had been unable to run one for 24 or 26 passengers continuously in competition with the existing omnibus companies. The construction of a much smaller type of omnibus had been suggested. The Board had reduced the expenditure to the very lowest limit, but they had practically come to an end of their capital.

The report was adopted after a formal vote was taken as to whether the Company should be reconstructed or should go into liquidation. The shareholders appeared to be strongly in favour of reconstruction.

The *Financial Times* of the 16th inst., from which we extract the above, published the following letter from Mr. Radcliffe Ward: "Sir,—As the question is one of universal public interest, you may consider the undernoted worth a place in your columns. That the 26-passenger type of electric omnibus meets all requirements of London street traffic is a well-established fact. My omnibuses have met the requirements of the police authorities, who licensed the first driver for electric omnibuses after examining his capabilities, driving a car designed and constructed under my supervision for working by the London Electric Omnibus Company, Limited. Now, special interest, in view of the above, attaches to the statements of the management made to the shareholders to-day reported at the general meeting of this Company in the evening papers as follows: 'Omnibuses were sent down to Wolverhampton to be overhauled, and the directors had been advised that electrical engineering was not yet sufficiently advanced to justify the firm to whom they were sent becoming responsible for the proper working, and they also recommended a much smaller type of omnibus.' The cost question is, of course, primarily a shareholder's question. But indirectly it strongly affects the public, who have so much to gain by the successful introduction of roomy electric omnibuses. The point naturally occurs on reading the above that if one firm representing one particular set and capabilities of electric appliances cannot be responsible for the working, perhaps another firm can—and this is, in fact, the case. I was able to read a letter before the meeting closed from Mr. A. E. Hodgson, of the Eclipse Brass and Copper Company, Limited, Halifax, containing the following: 'We are now in a position to supply the Schanschieff patent accumulators very rapidly in large quantities, and provided the working details are satisfactory we would undertake a contract on which could be inserted a proper guarantee as to cost of maintenance. We authorise you to communicate these facts to the directors and the shareholders of the London Electric Omnibus Company, Limited, as it may prove considerably to their advantage to know this information.' In another case when the working of 15 omnibuses, each carrying 26 passengers, was in question, Mr. Hodgson wrote as follows: 'Or if you preferred to put the working of the station into our hands and thus guarantee yourselves against any possible fluctuation in station charges, we would undertake to run the stipulated number of kilos for 20 centimes per kilo as cost of traction.' This is equivalent to about 3·2d. per mile, and shows a large economy over horse traction. The great saving is manifest from remembering that the cost for horse traction is about 5d. per mile to even a large corporation like the London General Omnibus Company, and that ½d. per mile pays them a good dividend. The question of running ordinary-sized omnibuses by electricity in the London streets is, therefore, in this position: (1) my 26-passenger omnibus, as run by the London Electric Omnibus Company, has proved its 'running' success (*vide* reports); and on the question of cost (2) there is available a sufficiently economical and light accumulator (Schanschieff's) to ensure a guarantee of cost (*vide* Mr. Hodgson's letters); and (3) this practically amounts to a guarantee of dividend, ensuring a great and popular commercial business."

POTTERIES ELECTRIC TRACTION COMPANY, LIMITED.

An extraordinary general meeting of this Company was held on the 16th inst. at the offices, Donington House, Norfolk-street, Strand, Mr. Emile Garcke in the chair, to consider a resolution for making certain alterations in the articles of association which are required by the rules of the Stock Exchange. The undertaking of this Company consists of three separate tramways—the North Staffordshire tramways, the tramways extensions (authorised under a provisional order of August, 1896), and the lines authorised under the light railways order confirmed by the Board of Trade in December, 1897. The Chairman said that the directors hoped the North Staffordshire tramways, which had been undergoing conversion to electric tramways, would be opened for traffic in a few weeks. The tramways extensions had been under construction for some time, and the electrical equipment was also well in hand. The light railways were also now under construction, but they had ample time to finish this work. The time allowed by the Board of Trade for carrying out the tramways extensions expired on the 7th prox., but they had applied to the Board of Trade for an extension of time, and this application would now be supported by the local authorities.

The resolution was carried unanimously.

YORKSHIRE HOUSE-TO-HOUSE ELECTRICITY COMPANY, LIMITED.

Report of the directors to be presented to the ordinary general meeting of the Company, to be held at the Great Northern Railway Station Hotel, Wellington-street, Leeds, on Tuesday, Jan. 24, 1899, at 3 p.m.:

The directors submit herewith a statement of the income and expenditure for the past year, and the balance-sheet showing the assets and liabilities of the Company made up to Dec. 31 last. The Leeds Corporation, in exercise of the powers conferred upon them by the Company's provisional order, gave notice on Aug. 4 last requiring the Company to sell its undertaking. As the result of negotiations, it was agreed that the sale should take effect, as regarded capital expenditure, on Aug. 31, 1898, and as regarded revenue account, on Sept. 30, 1898, and that agreement was approved at a meeting of the Company held on Nov. 21 last. The Company's capital expenditure to Aug. 31, 1898, after deducting depreciation, was found to amount to £217,420. 10s. 4d., and the purchase price is therefore to be paid, in accordance with the provisions of the Company's provisional order, by the issue of £217,420 of Leeds Corporation 5 per cent. stock, redeemable only by agreement between the Corporation and the holders of the stock for the time being. The amount of capital assets included in the accounts is merely the nominal value of the stock, the market value of which cannot at present be accurately estimated. The transfer of the undertaking was completed on Dec. 15 last. The Corporation have retained the services of the whole of the Company's staff. The shareholders will be invited, at an extraordinary general meeting to be held at the close of the ordinary general meeting, to pass a resolution for the liquidation of the Company. At the meeting to be held at a later date, for the confirmation of that resolution, the directors propose to submit the name of Mr. Grosvenor Talbot (chairman of the Company) as liquidator, and the names of the other members of the Board as an advisory committee. It will further be proposed that Mr. John Gordon, who has acted as the Company's auditor,

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be appointed to audit the liquidator's accounts. The supply of electricity by the Company on its own account having, as already stated, ceased on Sept. 30 last, the revenue account now submitted shows the result of only nine months' trading, and excludes the most profitable quarter of the year. The profit available for dividend, including £1,329. 2s. 5d. brought from the last account, and after providing £2,612. 6s. 8d. for depreciation on the scale demanded by the Board of Trade auditor, is £10,740. 5s. 10d., which the directors propose shall be appropriated as follows: to payment of interim dividend at the rate of 5 per cent. per annum on the amount called and paid up on the ordinary shares of the Company, for the half-year ending June 30, 1898, £3,671. 6s. 5d.; to payment of a dividend on the amount called and paid up on the same shares, which, with the interim dividend previously paid, will equal a dividend at the rate of 6¾ per cent. per annum for the year ending Dec. 31, 1898, £6,981. 9s. 8d.; to balance to carry forward, £87. 9s. 9d.—total, £10,740. 5s. 10d. The number of lamps connected to the Company's mains increased during the nine months ending Sept. 30, 1898, from 49,150 to 65,328 (35-watt lamps). The directors desire to express their hearty appreciation of the work done by the staff during the existence of the Company, more especially by Mr. Green, the secretary, and Mr. Harold Dickinson, the engineer, who have held their positions since the commencement, and whose ability and disinterested services have been of the greatest value in developing the undertaking. The directors would also recognise the conspicuous care and skill exercised by Mr. Robert Hammond, consulting engineer, in designing and superintending the construction of the works, as well as his valuable efforts in establishing the Company and obtaining the provisional order for supply of electricity in Leeds. The retiring directors, Mr. Grosvenor Talbot and Mr. Robert William Eddison, being eligible, offer themselves for re-election.

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1898.

Dr.	£	s.	d.
Coal, including carriage, etc.	702	19	4
Oil, waste, water, and engine-room stores	162	7	5
Salaries and wages of engineers and workmen	1,854	18	9
Repairs and maintenance	614	10	7
Rents, rates, and taxes	176	2	2
Directors' remuneration	375	0	0
Salaries of secretary and clerks, stationery and printing, law expenses, and general charges	1,001	13	2
Insurances	94	19	7
Depreciation	2,612	6	8
Balance carried to net revenue account	6,306	9	2
	£13,901	6	10

Cr.	£	s.	d.
Sale of current, rental of meters and other apparatus, etc., after providing for discounts and bad and doubtful debts	12,720	3	7
Rents receivable	1,148	19	9
Transfer fees	5	5	0
Students' instruction	26	18	6
	£13,901	6	10

GENERAL BALANCE SHEET.

Dr. Capital and Liabilities.	£	s.	d.
Capital account—amount received as per last account	131,992	0	0
Received during the year	37,252	0	0
Total amount received	169,244	0	0
Amount due to bankers (Wm. Wms. Brown and Co.) (As security for this they hold the Company's mortgage debenture for £10,000)	26,012	5	3
Sundry creditors	7,788	2	8
Net revenue account — balance brought forward from last year ... £1,329 2 5			
Profit for the year ... 9,411 3 5			
10,740 5 10			
Less interim dividend paid July 20, 1898, £3 548. 18s. 10d.; income tax thereon, £122. 7s. 7d.; and income tax on dividend now recommended, £232. 14s. 4d. ... 3,904 0 9			
	6,836	5	1
Reserve fund account—balance at credit thereof	8,000	0	0
	£217,880	13	0

Cr. Assets.	£	s.	d.
Amount due from the Leeds Corporation in payment for the Company's undertaking, to be satisfied by the issue of 5 per cent. stock	217,420	0	0
Interest accrued thereon	460	13	0
	£217,880	13	0

Enlargement of Premises.—We are informed by Mr. G. Braulik, of 217 and 218, Upper Thames-street, E.C., that in consequence of increasing business he has been compelled to very considerably enlarge his present premises in Upper Thames-street, where extensive and well-appointed showrooms are being fitted up, which will be ready shortly.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Stirling.—The Burgh Commissioners invite tenders for mains, full particulars of which appear in our advertisement columns. Tenders by Jan. 30.

Sunderland.—The Corporation are prepared to receive tenders for various works, full particulars of which appear in our advertising columns. Tenders by 27th inst.

Belfast.—The City Electric Committee are prepared to receive tenders for the supply and erection of plant, full particulars of which appear in our advertising columns. Tenders by Feb. 2.

Buxton.—The Urban District Council invite tenders for work in connection with their electric light station in Buxton, particulars of which appear in our advertising columns. Tenders by Feb. 6.

Glasgow.—The Corporation invite tenders for providing and erecting generating plant at one or other of their new electricity works. Further particulars appear in our advertising columns. Tenders by Jan. 21, 1899.

Govan.—The Commissioners invite tenders for boilers, engines, dynamos, etc., for electric lighting. Specifications, etc, may be obtained from Mr. W. Arnot, C.E., 79, West Regent-street, Glasgow. Tenders by 23rd inst.

Lowestoft.—The Mayor and Corporation of the borough of Lowestoft are prepared to receive tenders for the supply and erection of various plant, all details of which appear in our advertisement columns. Tenders by Feb. 6.

Ealing.—The Urban District Council invite tenders for the supply and erection of two 500-h.p. steam alternators and one 150-h.p. steam dynamo-alternator, full particulars of which appear in our advertisement columns. Tenders by Jan. 30.

Bradford.—Tenders are invited by the Bradford Corporation for an installation for electric lighting at the Hammerton-street destructor. Specification may be obtained at the Electricity Department, Town Hall, Bradford. Tenders by Feb. 1.

Brussels.—The Compagnie Générale de Traction Electrique invite tenders for the supply of 10,000 ko. galvanised iron wire and 9,000 porcelain insulators, 3,600 bronze posts, etc. Conditions may be obtained on payment of 10d. at the Company's Offices, rue de Meridien No. 6, Brussels.

Bucharest.—Tenders are invited by the Posts and Telegraphs Department for 3,000 ko. steel wire of 2mm. diameter and 94,500 iron wire of 1·8mm. to 5mm. diameter; also for bronze wire, which must contain silica, as follows: 10,000 ko. (1·5mm.), 2,000 ko. 3mm.). Tenders for the first lot by Jan. 22, and for the last by Jan. 28.

London, N.—The Tottenham Urban District Council invite designs for a refuse destructor to be erected within their district. Three premiums of £25, £15, and £10 will be awarded for the three best designs, in order of merit. Designs to be sent by 12 noon on Feb. 7. Particulars may be obtained upon application to Mr. P. E. Murphy, engineer to the Council, Coombes Croft House, 712, High-road, Tottenham.

Christiania.—The Secretary of State for Foreign Affairs has received a dispatch from her Majesty's Consul-General at Christiania, stating that tenders are invited by the Norwegian State Telegraph Administration for the delivery of about 140,400 porcelain telegraph and telephone insulators. Tenders must be received at Christiania by 12 noon on Feb. 26. A copy of the specification, conditions, etc., may be examined on personal application at the Commercial Department of the Foreign Office, any day between 11 a.m. and 5 p.m.

London.—The London County Council invite tenders for the manufacture, delivery, and erection complete of four gas-engines, with starting appliances, at the proposed Victoria-embankment electric lighting station, in the parish of St. Martin-in-the-Fields. Persons desiring to submit tenders may obtain the drawings, specification, form of tender, and other particulars at the Engineer's Department, County Hall, Spring-gardens, S.W., upon payment of £2. This amount will after the Council or its committee has come to a decision upon the tenders received, but not before, be returned to the tenderer, provided he shall have sent in a bona fide tender and not have withdrawn the same. Tenders will be received up to 10 a.m. on Jan. 31.

London, N.—Tenders are invited by the Metropolitan Asylums Board for the execution of the following works in connection with the proposed electric light installation at the Northern Hospital, Winchmore Hill, N.—viz.: (1) switchboards, booster, and connections; (2) battery; (3) electrical mains; (4) steam, exhaust, feed, and drain pipes; (5) wiring and fittings. Specifications, etc., which have been prepared by Messrs. Burstall and Monkhouse, engineers, of 14, Old Queen-street, Westminster, S.W., can be obtained at the office of the Board, Norfolk House, Norfolk-street, London, W.C., on deposit of the sum of £2. 2s. in respect of each section, which will be returned to bona fide tenderers who return the specifications and conditions of contract. Tenders by 10 a.m. on 25th inst.

London.—The London County Council invite tenders for the manufacture, delivery, and erection complete of four continuous-current dynamos, one motor-generator, two switchboards with switches, measuring instruments, and other work required for the proposed Victoria-embankment electric lighting station, in the

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parish of St. Martin-in-the-Fields. Any person desiring to submit a tender may inspect the drawings and obtain the specifications, forms of tender, etc., on application at the Engineer's Department, County Hall, Spring-gardens, S.W., and upon payment of £2. This amount will, after the Council or its committee shall have come to a decision upon the tenders received, but not before, be returned to the tenderer, provided he shall have sent in a bona fide tender and not have withdrawn the same. Tenders by 10 a m. on Jan 31.

Shanghai.—The Shanghai Municipal Council invite tenders for a concession for constructing and working about 23 miles of electric tramways on the trolley system in the streets of Shanghai. The special attention of tenderers is drawn to the fact that the tender (if any) recommended by the Council will require ratification by the ratepayers. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 being deposited with Messrs. Pook and Co., which sum will be retained by the Council, and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China (telegraphic address Dynamo, Shanghai; "ABC," fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Tramway Concession," must be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, and received by 12 noon on March 15.

Shanghai.—The following resolution in reference to the telephone system in Shanghai was passed at the last annual meeting of the ratepayers of the Foreign Settlements at Shanghai, north of the Yang-king-pang: "Resolution VIII.—That the Council be and is hereby authorised to enter into negotiations with the China and Japan Telephone Company or any other company, and in its discretion grant a franchise with a view to the community being supplied with an adequate and efficient telephone service at a fixed maximum charge." In accordance with the above resolution the Shanghai Municipal Council invite tenders for a concession for a period of 30 years for the exclusive right of establishing and working a telephone system in Shanghai. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 sterling being deposited with them, which sum will be retained and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China. Telegraphic address, Dynamo, Shanghai (ABC, fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Telephone Concession," to be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, by 12 noon on March 31.

BUSINESS NOTES.

Personal.—Mr. George G. Scurfield, of Sunderland, has been appointed assistant engineer at Carlisle.

Stratford.—The electric light failed suddenly on Wednesday night, but was restored in about an hour's time.

Cleethorpes.—The Council intend to obtain a provisional order to provide electricity for lighting and other purposes.

Garston.—The District Council have agreed to transfer their electric lighting to the British Insulated Wire Company.

Coatbridge.—The Scottish House-to-House Electricity Company, Limited, are constructing draw boxes on the pavement of various streets.

Chorley.—The Corporation intend to oppose the Lancashire Electric Power Bill. The Rural District Council have referred the matter to a committee.

Bexhill.—The Urban District Council have now sealed their consent to the British Electric Traction Company to lay tramways from Kewhurst to St. Leonards.

Halifax.—A satisfactory trial trip on the tramway extension to Salterhebble was made on Monday. The Board of Trade inspection was expected to take place during the week.

Barnet.—The Urban District Council have transferred its provisional order for electric lighting to the North Metropolitan Electrical Power Distributing Company, Limited.

Coventry.—The City Council have unanimously approved of the action of the Parliamentary Committee in presenting a memorial to oppose the Leicestershire and Warwickshire Electric Supply Bill.

Hampstead.—The directors of the Electric Supply Company, Limited, have notified the payment of the dividend on the 5 per cent. cumulative preference shares for the period ended Dec. 31, 1898.

Paignton.—The directors of the Paignton Gas Company have under consideration a scheme of electric lighting for the district. It is stated that they will shortly make a proposal to the District Council.

Wellingborough.—The engineer to the Leyton electric lighting and refuse destructor works has inspected sites here for the purpose of reporting upon the possibility of constructing similar works for Wellingborough.

British Electric Traction Company.—An issue has been made by this Company of 20,000 6 per cent. cumulative preference shares of £10 each at £12 per share, through the Electric and General Investment Company.

Islington.—The Electric Lighting Committee of the Vestry is considering a letter from the Vestry of St. Pancras with regard to the supply of electric current to the premises of consumers situate on the border line of Islington and St. Pancras.

Electric Construction Company, Limited.—The transfer books of this Company for the ordinary shares are closed until Jan. 31 (inclusive) for the payment of the second half of the dividend of 6 per cent. per annum, declared on July 21 last.

Globe Telegraph and Trust Company.—The directors of the Globe Telegraph and Trust Company, Limited, announce a quarterly interim dividend of 3s. per share on the preference shares and of 1s. 9d. per share on the ordinary shares.

Brecon.—Steps are being taken to put down plant for the electric lighting of the town. Colonel John Morgan, the mayor, has signified his intention of laying down the plant at his own cost. It is estimated that this will practically mean a gift of £6,000.

Farnborough.—At a special meeting of the Council held on Wednesday letters from the Power and Traction Company with reference to the light railway and with respect to the electric lighting order, together with the draft proposed deed of transfer, were considered.

Beckenham.—At last week's meeting of the Urban District Council tenders for supplying the necessary materials, machinery, etc., for electric lighting were submitted and referred to the surveyor with instructions to prepare and send to members a tabulated statement of the same.

Gloucester.—Mr. W. O. E. Meade-King, Local Government Board inspector, held an enquiry on Wednesday at the Guildhall into an application by the City Council for authority to appropriate funds from the sale of corporate property for the purchase of the site for the electric light works.

Glasgow.—The Clyde Trust have decided to light Glasgow harbour with electricity. The work will necessarily be a very extensive one. The supply will be taken from the Corporation of Glasgow for the north side of the river, while the Trust will lay down a plant to supply the south side.

Grimsby.—The Town Council have decided to apply to the Local Government Board for consent to borrow £43,500 for the carrying out of necessary works for electric light and power. A committee which was selected two years ago has now been reappointed to consider the erection of a destructor.

Newcastle.—The Tramways Committee of the Corporation have visited Bradford, Halifax, and Leeds in order to inspect the electric tramways. Last week they proceeded to Brixton to inspect the cable tramway, and also viewed the working of the refuse destructor at Shoreditch, which is utilised for electric purposes.

Birstall.—The introduction of the electric light was advocated at the recent meeting of the local Chamber of Commerce. If Birstall and Batley were united, both towns could be cheaply supplied from the same works. It was suggested that a requisition from the residents in the district should be obtained asking the Chamber to act in this matter.

Chatsworth.—Upon the occasion of the recent county ball given by the Duchess of Devonshire, a large addition to the regular lighting at Chatsworth was made by Messrs. Drake and Gorham. Several hundreds of additional lights were fixed in the ballroom, orangery, statue gallery, and other parts of the building, and the effects produced were much admired.

Radcliffe.—The Council have applied to the Local Government Board for permission to borrow £16,000 for electric lighting purposes. The consulting engineer has made enquiries and found that three firms are willing to take over a concession respecting electric traction from the Council on equitable terms, and he has advised the Council to accept the best offer.

Canterbury.—Mr. N. Staniland has been appointed electrical engineer to the Town Council at a salary of £200 per year. The following staff is proposed: assistant electrical engineer, £104; two junior electricians, £104; engine-driver and fitter, £95; one stoker, £85; lamp trimmer and cleaner, £52; lad, £13; jointer, £100; assistant, £52; clerk, £52; office boy £13.

Bristol Tramways Company v. National Telephone Company.—This action was in the list of non-witness actions for hearing on the 17th, before Mr. Justice North, in the Chancery Division of the High Court of Justice. Mr. Justice North acceded to an application for an adjournment, and the case will accordingly not be in the paper for hearing before Jan. 24.

Catalogue.—We have received from Messrs. Peirson and Co. a catalogue of their high-class steel and iron work. The list includes steel roofs, railway bridges, steel columns for various purposes, fire-proof floors, etc. Illustrations are given of various works which the firm have undertaken. It will also be found useful for reference as giving the sizes and weights of girders, bar iron, etc.

Twickenham.—The District Council are corresponding with Edmundson's Electricity Corporation with regard to the latter's application for an order authorising them to light Twickenham and Teddington by electricity. Amongst the points under consideration are the question of charge per unit for energy to (*a*) private consumers and (*b*) public lamps, and the terms of purchase by the Council.

Airdrie.—The members of the Town Council recently visited Coatbridge to view specimen electric light lamps which the Scottish House-to-House Company, Limited, suggested as suitable for the lighting of the streets of Airdrie. An agreement is being prepared showing the terms upon which the company will light

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the principal streets of the burgh in the event of the Council resolving on not doing so themselves.

Central Africa Telegraph.—The Brussels correspondent of the *Daily Chronicle* states that M. Mohun, who left Antwerp last August in charge of an expedition to connect Lake Tanganyika and Nyangwe by telegraph, has arrived at the former place with a full complement of men and stores. The telegraph line runs in a north-easterly direction. The Congo telegraph has now reached Lukolela, nearly 500 miles from its starting point at Boma.

Wood Green to Strand Railway.—The Bill of the Great Northern and Strand Railway Company provides for the construction of an electric railway in two tunnels from the Great Northern Company's Wood Green Station *viâ* Islington to the Great Northern Company's King's Cross Station, and from thence *viâ* Southampton-row, High Holborn, to a point in the Strand near the Law Courts. The capital is £2,400,000 in shares and £800,000 in debentures.

Salford.—At Wednesday's meeting of the Town Council it was stated that the prospective adoption of electric traction and the constantly increasing demand for the electric light had made the erection of a new generating station necessary. It was proposed that Messrs. Lacey, Clirehugh, and Sillar be appointed consulting engineers for a term of three years at a sum of £500 per annum. The discussion was afterwards adjourned to a meeting to be held on Wednesday next.

Electric Heating Apparatus.—We are given to understand that the English Industrials, Limited, 55, Market-street, Manchester, have bought from Messrs. Hummel and Helberger, of Munich, the sole rights for the United Kingdom and the Colonies of their patent electrical heating apparatus, and are now manufacturing the various specialities in connection therewith. It is claimed that the efficiency of these apparatus, which are in great demand, is about 97 per cent.

Annual Dinner.—The Langdon-Davies Electric Motor Company's annual dinner was held on Saturday last, the 14th inst., at the Bridge House Hotel, London Bridge. Mr. A. Soames (managing director) occupied the chair, supported by Mr. W. Langdon-Davies (engineer), and Mr. W. S. Davidson (works manager). About 50 sat down to a most enjoyable repast, the duties of stewards being admirably performed by Messrs. F. Hugden and R. Wilson.

Hastings.—A cheque for £58,000 has just been handed over by the town clerk to the secretary of the Hastings Electric Light Company, this being the price the town has had to pay for the company's undertaking as it stood at the time of the initiatory stages of the negotiations. As the increased business of the company has resulted in an outlay of a few more thousands of pounds for extension, the town will also have to pay that amount before entering into full possession.

Wrexham.—The Cobden Flour Mills Company, Limited have just completed in their mill an electrical installation of 500 16-c.p. lamps. The whole plant was supplied and erected by W. Sillery, electrical engineer and contractor, Wrexham, and gives entire satisfaction. There has been installed one spare dynamo, and another dynamo is added for day load. The same firm have also laid down an installation of 100 16-c.p. lamps at Messrs. Davies Bros.' terra-cotta works, Marchweil, Wrexham.

Carlisle.—The following scale has been fixed for rebates to consumers of electricity both for lighting and power: lighting up to 1,000 units, 5½. per unit; above 1,000 and under 3,000 units, 4¾d. per unit; and over 3,000 units, 4½d. per unit. Power: up to 50,000 units per annum, 2d. per unit; and above 50,000 units per annum, such terms as may be agreed upon between the consumers and the Corporation. Mr. Burnett has taken over his duties as electrical engineer to the Corporation from the New Year.

Bournemouth.—Sir George Meyrick, the owner of the Bournemouth East Cliff frontage, having given his consent to the formation of an undercliff drive between Bournemouth and Boscombe piers, a modified plan has been approved for the scheme. The cliffs will be cut away to a natural slope and held by a big retaining wall. An electric lift from the top of the cliffs to the shore is projected opposite Meyrick-road, and one at another point between that and Boscombe. Electric trams are proposed along the lower drive.

Birkenhead.—The Town Council have decided to apply for a license to supply electricity for lighting and other purposes to the townships of Bidston-cum-Ford and Noctorum, which are outside the borough boundary. Practically all the houses along the route of the proposed mains have applied for electricity. The promotion of the Tramways Bill in Parliament, providing for the municipalisation of the tramways and the working of an electric system, has also been formally approved by the requisite majority of the Council.

Walsall.—At a special meeting of the Town Council on the 16th inst. it was decided to oppose the South Staffordshire Tramways Company's Bill. The total number of consumers supplied on Dec. 31 last was 136. The total units generated at the station during the month of December was 34,668. The total output from the main generators was 32,986 units. The total units from the transformers was 26,236. The total units registered on the meters was 21,621. The machinery has been run for 417 hours during the past month.

Southwark.—The action of the Vestry's Electric Lighting and Dust Disposal Committee in refusing the request of the County of London and Brush Provincial Electric Company, Limited, to change the system of the supply of electrical energy has been approved by the Vestry. The committee found that the company desired to change the system laid down in the Southwark Electric Lighting Order, 1892, and the regulations of the Board of Trade of May 7, 1895, to a system of two-phase alternating currents, to which request the committee did not deem it advisable to accede.

Whitechapel.—With reference to the application made by the Vestry to the County Council to borrow the sum of £60,500 in order to carry out that portion of the work of erecting an electric lighting installation in the district as contemplated by the report of Mr. Wright, the electrical engineer, we note that the London County Council will be asked to defer the repayment of any instalment of principal until after a period of five years from the date of the loan. The report of the Electrical Committee on the subject of the erection of a new destructor was submitted on Monday last.

City and South London Railway Company.—The accounts of the City and South London Railway Company for the half-year ended Dec. 31 show that after providing for the debenture interest and the full dividend on the 5 per cent. preference shares, there remains enough to allow the payment of a dividend on the consolidated ordinary stock at the rate of 2 per cent. per annum, carrying forward a balance of £1,420 to the new account. The dividend for the corresponding period last year was at the rate of 1¾ per cent. per annum, the balance carried forward being £1,511.

Lowestoft.—A meeting of the Lowestoft Town Council was called for Tuesday evening to discuss the promotion of an electric tramway for the borough by the East Anglian Light Railway Company. The Special Light Railway Committee's report, which was adopted, contained various amendments to the clauses in the company's Bill, the principal of these being one to secure power to purchase at the end of seven, fourteen, or twenty-one years, at sums equal to 10 per cent., 5 per cent., and the times of the annual profits in the undertaking, and another requiring the widening of part of the High-street.

Sunderland.—The Town Council have agreed, in addition to their resolutions referred to in our last issue, to confirm the promotion of a Bill in Parliament (1) to enable the Corporation to acquire the tramways in the borough and in the urban district of Southwick, and to work them and their other tramways by mechanical and electrical traction; (2) to empower the Corporation to construct new and additional tramways; and (3) to empower the Corporation to supply electric energy in Southwick urban district, and to extend the area of supply under the Sunderland Electric Lighting Order, 1891.

Crosby.—The movement for establishing a system of electric tramways in Crosby, Waterloo, and Seaforth, to connect with the Overhead Railway Company, and also to be worked by this company, has resulted in several schemes for the further development of Crosby and Blundellsands being taken into consideration. A new road is at the present time being made. This will soon be followed by the further extension of two others and the formation of a private park. In addition, there are plans for erecting something like 90 houses in Crosby, while land in the neighbourhood of College-road will be shortly developed.

Electric Lighting in Brazil.—We are informed that the San Paulo Gas Company have decided to at once erect an electric light plant for the supply of current for lighting and power. They have already entered into an agreement to light the new railway stations in course of erection in San Paulo. The gas company has decided upon this because of the strong position they occupy in San Paulo with the new concession for 30 years, and being in a position to raise the capital without difficulty. The company's consulting engineer has been instructed to prepare the plans and specifications and obtain tenders for carrying out the work with the least possible delay.

Edinburgh.—At a recent meeting of the City Council, the Lord Provost moved a motion to the effect that the Lord Provost's Committee should take steps to have inserted in the new parliamentary Bill a provision empowering the Corporation to form, out of the revenue of the electric lighting undertaking, a special fund for the purpose of meeting substantial renewals of plant and machinery, which should be in addition to the statutory reserve fund; but an amendment that the matter be remitted to the Electric Lighting Committee to present to the Council a report on the necessity for laying aside a sum either by renewals fund or otherwise for renewals, was carried.

Appointments Vacant.—The Southport Corporation invite applications for the appointment of a mains superintendent; the Corporation of Worcester require two improvers as switchboard attendants by Jan. 23; the Borough of Ashton-under-Lyne are about to appoint a second assistant engineer; the Corporation of South Shields require an electrical tester, able to test meters, transformers, and cables, at a salary of 35s. per week; a mains electrician is wanted for the high-tension works at the Torquay Corporation Electricity Works; the Great Indian Peninsula Railway Company require an assistant telegraph superintendent; and a draughtsman with good mechanical and electrical knowledge is advertised for by the city electrical engineer, Bradford. Full particulars of these vacancies will be found in our advertisement columns.

Opposed Bills.—Memorials alleging non compliance with the standing orders in respect of Bills deposited for consideration during the ensuing session have been received at the Private Bill Office against each of the National Telephone Company's Bills from the Corporations of Glasgow and Edinburgh; from the Vestry of Hammersmith and others in regard to the Kensington and Notting Hill Electric Lighting Bill; and from the Metropolitan Electric Supply Company, Limited, in regard to the St. Marylebone Vestry Electric Lighting Bill; against the Lancashire Electric Power Company's Bill by the Corporation of Warrington and

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the Urban District Councils of Ormskirk, Lathom and Burscough, Stretford and Dukinfield; from the Corporation of Loughborough in opposition to the Leicestershire and Warwickshire Electric Supply Company.

St. Luke's.—At the fortnightly meeting of the Vestry on Tuesday it was resolved to withhold the consent of the Vestry to the application of the Smithfield Markets Electric Supply Company, Limited, to the Board of Trade for a provisional order for the supply of electricity to the parish, and to authorise the solicitor to present objections to the order and to take all the necessary steps in the matter. A special committee of eight members was appointed to report upon the desirability of the Vestry's applying for a provisional electric lighting order, and empowered to secure the requisite technical and professional assistance in the matter. The following were appointed on the committee: Mr. Enos Howes, J.P. (chairman of the Vestry), Mr. A. Pond, Mr. G. Standring, Mr. S. H. C. Rumball, Mr. E. Miller, Mr. W. Elven, Mr. Basterfield, and Mr. G. Whitehead.

Liverpool.—The electric tram system was added to by the opening of the new route to Prince's Park on Monday. This necessitated the putting on the service of 12 new cars constructed on the American plan. It is understood that in a short time the Tramways Committee may take steps to obtain the speedy running of electric cars to other districts in the city. The penny stage system with regard to the ordinary horse cars is said to work satisfactorily. At a recent meeting of the Tramways Committee it was decided to recommend that the Corporation should proceed with the work of laying tramlines along Smithdown-road for electrical traction, and that a car shed be constructed by day labour at a cost of £11,000. It was unanimously decided that Mr. C. R. Bellamy should be appointed general manager of the tramways at a salary of £800 per annum, rising by £100 a year to £1,000. The appointment, of course, is subject to confirmation by the Council.

Southampton.—The Corporation have agreed to adopt the overhead system of electric traction for their tramways, and to double the line wherever practical. The committee summarised their recommendations as follows: (1) Electric traction by the overhead trolley system, as already adopted by the Council; (2) double all lines where possible; (3) punctual service of cars on each route at intervals of five minutes, and from the junction to Floating Bridge at intervals of 2½ minutes; (4) retention of outside-seat cars throughout the system; (5) provision of additional headway through the Bargate by lowering the roadway to give an effective height of 15ft. 6in.; (6) protecting trolley wire under the Bargate; (7) provision and equipment of overhead wires and trolleys, and electric equipment throughout the entire system; (8) provision of stock of 20 motorcars, with running sheds; (9) the estimated cost of the above, complete (exclusive of lowering road under Bargate), £63,297.

Weston-super Mare.—The Urban District Council have given notice that, with the consent of the Board of Trade, they propose to transfer their powers, duties, liabilities, and works to a company, to be registered under the Companies' Acts, 1862 and 1898, entitled the Weston-super-Mare and District Electric Supply Company, Limited, or other suitable name. We note that the company may be required to sell the undertaking to the Council at any time within six months after the expiration of 10½ years from Dec. 31, 1899, and within six months after the expiration of any subsequent period of two years. At the expiration of 42 years from the date of the transfer, and within six months of every subsequent period of five years, the Council may require the company to sell the undertaking upon the terms of Section 2 of the Electric Lighting Act, 1888. The rent for the first year is not to exceed the sum of £453. 18s. 1d., and there is no other pecuniary consideration, except the payment of the costs of the Council not exceeding £100.

Stirling.—At a recent meeting of the Lighting Committee the Convener stated that he had been in communication with a number of other towns where the system of free wiring had been adopted, and the replies he had received were to the effect that the arrangement was found to work very satisfactorily. He had instructed the clerk to write Prof. Kennedy for his opinion on the subject, but no reply had been received. Consideration of the matter was postponed until the reply of Prof. Kennedy had been received. It was stated that the Lighting Committee had not been able to come to terms with any of the proprietors between Burghmuir and the St. Ninians-road as to obtaining wayleave through their property, and that it might be necessary therefore to have the cable for Pitt-terrace and Melville-terrace carried up the Craigs. The offers to supply the electric lighting plant have been forwarded to Prof. Kennedy for adjudication. The terms of the Public Works Loan Board for an electric lighting loan are regarded as very satisfactory.

Walton.—The Urban District Council have adopted a report of the Electric Lighting Committee as to the Walton and Weybridge electric lighting provisional order, in which it is emphasised that the order, as drawn, constituted the district of the Council with the district of Weybridge as one lighting area. The statutory powers of pre-emption which each Council would possess could therefore only apply to so much of the installation as happened to be within the area of the purchasing Council, and it might thus happen (as it probably would) that the generating station would be in Weybridge, and that therefore all that the Council could acquire would be the mains in the Council's area, necessitating the erection of a new generating station before those mains could be utilised. The only alternative would be that the two authorities would join together and carry on the undertaking by means of a joint committee. But to this there were very many objections. Considering all the facts of the case, the committee recommended that the approval to the provisional order should be withheld.

City Lighting.—At last week's meeting of the Court of Common Council, a resolution of the Wardmote of Aldersgate against the purchase, at a premium, of the undertaking of the City of London Electric Lighting Company, and in favour of the establishment of a competing supply, was referred to the Streets Committee for consideration and report. Mr. Brooke-Hitching objected to the matter being referred to the Streets Committee, and announced his intention of moving at an early date that all resolutions affecting the electric lighting of the City should be referred to a special committee. During the debate which ensued, the public lighting of the City came in for some severe criticisms, the bad lighting of portions of Broad-street, Bishopsgate, and Threadneedle-street being specially commented upon. A question was raised as to the advisability of charging the City of London Electric Lighting Company for the privilege of having their cables laid across the City bridges. There exist at present wayleaves granted under agreements of 21 years, but the Corporation has the power to terminate them upon giving three months' notice.

Paddington.—At a meeting of the Vestry on Tuesday a report was received from the Electric Lighting Committee recommending that the opinion of counsel be obtained as to the powers of the Metropolitan Electric Supply Company under existing Act to lay down mains through the parish for use in other parishes or otherwise. The Chairman of the Electric Lighting Committee said that the company intended to lay down five large cables through their streets, each cable having the pressure of 10,000 volts. After a lengthy discussion the question was referred to the Electric Lighting Committee with powers to act. The joint committee of members of the Works and Legal Committee recommended that with regard to the Baker-street and Waterloo Railway Bill that they were unanimously of opinion that the erection of a generating station within the parish of Paddington would be most objectionable, and that the Bill be opposed. They recommended that the Central London Railway Bill be not opposed, and that with regard to the North-West London Railway Bill that, subject to all proper protection clauses being inserted in this Bill and that the use of the streets be kept open and unimpaired, no opposition be offered to the scheme. The report, after a short discussion, was unanimously adopted.

Hanley.—At a meeting of the Town Council on the 17th inst. it was decided, in consequence of the resignation of Mr. Sutherland, joint engineer with Mr. Cowell, to appoint the latter gentleman Corporation electrical engineer, at a salary of £250 per annum; that Mr. Lobley continue to act as engineer for capital expenditure in connection with the electrical undertaking, and consulting engineer on revenue account; and that two junior assistant engineers be engaged for the electricity works at £80 a year each, rising by £10 a year to £100. It was also resolved, on the advice of the engineers, that in future any new distributing mains required in the district outside the compulsory area be arranged for a pressure of 200 volts at consumers' terminals, and that existing mains be converted from 100 volts to supply 200 volts as may be convenient. A letter was read from the Local Government Board sanctioning the borrowing of £4,000 for the purposes of electric lighting, and the thanks of the Council were tendered to Mr. Woodall, M.P., for obtaining an extension of the period for the repayment of the loan from 10 to 20 years. It was also resolved that from the 1st inst. the charge for electricity shall be 5d. per unit (with a discount of 5 per cent. for payment within 21 days) for all consumed in the quarter up to 150 hours of the maximum demand indicated, and 2½d. (net) per unit for all consumed beyond that amount.

St. Marylebone.—The agenda for the meeting of the Vestry yesterday contained a report from the Electric Lighting Committee recommending that a petition be presented to Parliament against the Central Electric Supply Company's Bill, in order that the Vestry may be in a position to protect the interests of the parish, and that the solicitor be instructed accordingly; also a notice of motion that the Electric Lighting Committee be instructed: "(1) To enquire and report whether the Metropolitan Electric Supply Company has power to sell, and, as vendor, can make a good title to that part of its undertaking which is situated in or supplies with electricity the parish of St. Marylebone, including the benefit of any provisional orders and confirming Acts, and whether the Vestry can legally purchase; and what is comprised in the Company's undertaking, so far as it is situated in or supplies, or was intended and is adapted to supply, St. Marylebone, and whether what is specified or referred to in the report of the committee is wholly separate (or capable of being wholly separated, and, generally, by what work and at what approximate expense) from that part of the company's undertaking which is not situated in or used for supplying St. Marylebone. (2) If the company has power to sell and make a good title to what is, or can, at small expense be made a wholly separate, independent, and exclusive undertaking for the supply of St. Marylebone with electricity, then, before report, to enter into a provisional contract with the company in the name, and on behalf, but subject to the approval of the Vestry, for the purchase of the benefit of such part of the company's provisional order, works, and undertaking, including a covenant not to compete with the Vestry, and not to use any part of its purchased or added plant (or to do so, subject to such limits, and on such terms as may be agreed, at a price to be hereafter agreed on between the company and the Vestry, or in default of agreement to be settled by submission of both parties to an arbitration under the Arbitration Act, 1889, or

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as may be otherwise agreed). (3) The committee to be at liberty to employ such experts or obtain the benefit of such professional advice as they may consider necessary for the purposes of this reference to the committee."

New Capital.—Among the new capital created in the second half of 1898 we note:

	Authorised.	Issued.
Aron Electricity Meter—6 per cent. preference.	£125 000	£125,000
Ordinary	125,000	125,000
Blackheath and Greenwich District Electric Light Company—ordinary	150,000	148,800
Bright's Light and Power—7 per cent. preference	100,000	50,000
Ordinary	100 000	100,000
5 per cent. debenture stock	100,000	50,000
Brisbane Tramways Company—5 per cent. first mortgage debentures	—	167 900
British Columbia Electric Railway Company—5 per cent. nominal cumulative preference	120,000	120,000
British Electric Traction Company—5 per cent. debenture stock	100,000	100,000
Brompton and Piccadilly-circus Railway	600,000	600,000
Canadian, British, Columbian, and Dawson City Telegraph Company—ordinary	300,000	—
5 per cent. mortgage debenture stock	225,000	225,000
Chelsea Electricity Supply Company—4½ per cent. debenture stock	—	40 000
Copper Corporation of Chili—ordinary	200,000	105,000
6 per cent. mortgage debentures	50,000	50,000
Eastern Telegraph Company—3½ per cent. preference stock	—	500,000
Edison and Swan United Electric Light—4 per cent. debenture stock	—	150,000
Edmundson's Electricity Corporation—4½ per cent. first mortgage debenture stock	75,000	75,000
Hampstead Electric Supply Company—5 per cent. preference	100 000	100,000
Ordinary	100,000	100,000
New St. Helens and District Tramways Company—5 per cent. preference	100,000	80,000
Ordinary	50,000	50,000
Potteries Electric Traction Company—5 per cent. preference	200,000	200,000
Ordinary	200,000	200,000
Telegraph Manufacturing Company—5 per cent. preference	100,000	100,000
Ordinary	100,000	100,000
United River Plate Telephone Company—5 per cent. debentures	200,000	48,267
Wenlock Electrolytic Company—ordinary	120,000	120,000

Hammersmith.—At the meeting of the Vestry on Monday a report was submitted on the Kensington and Notting Hill Electric Lighting Bill, which is promoted by the Kensington and Knightsbridge Electric Lighting Company and the Notting Hill Electric Lighting Company jointly, to acquire lands and to erect and work generating stations. The preamble of the Bill, *inter alia*, states that it will conduce to the convenience of those who use electrical energy in the respective areas of supply—*i.e.*, Kensington and Notting Hill—that the companies jointly should be authorised to acquire certain lands in the parish of Hammersmith belonging to the Vestry of the parish of St. Mary Abbotts, Kensington, and also certain land in the same parish belonging to the Hammersmith and City Railway Company, and thereon to erect generating and transforming stations, and to supply therefrom electrical energy to their respective distributing stations within their respective areas of supply, and for that purpose to lay down electrical mains from the last-mentioned lands to connections with their several distributing stations and mains within their respective areas of supply. It is proposed to empower the joint companies to construct a subway from the western end of Hunt-street under the Hammersmith and City Railway and the West London Railway into the lands they propose to acquire. The committee suggest that as neither the width of the proposed subway nor the depth it will be under the railway can be ascertained from the plans and sections supplied, more definite information on these points should be given. It appears to them that the roadway in Hunt-street must be somewhat lowered in order to get a proper gradient, and they are of opinion that there seems to be a reasonable opportunity for obtaining the long-wished-for communication between Latymer-road and Wood-lane, and advise the Vestry that, whilst petitioning against the Bill to obtain the necessary *locus* for protective clauses, to instruct them to use every endeavour to see that the subway is of sufficient width and height for the accommodation of the traffic, and dedicated to the public use, and to take all the necessary steps for protecting the Vestry's interests generally. The following is a summary of the memorial sealed by the Vestry objecting to the Kensington Vestry electric lighting order: The Hammersmith Vestry have already laid down cables and wires within the main thoroughfares, and constructed a central generating station at a cost of £66,000, and are about to expend a further sum of £56,000 in extensions. The Vestry object to the breaking up and disturbance of the streets and roads of the parish for the purpose of laying pipes, wires, and other apparatus. The Kensington Vestry's proposal to erect what is called a destructor for burning or otherwise disposing of the refuse from the parish of Kensington is considered most objectionable. The memorialists also point out to the Department that a Bill has been deposited by the Kensington and Knightsbridge Electric Lighting Company and the Notting Hill Electric Lighting Company jointly to acquire compulsorily part of the same land which has recently been acquired by the Kensington Vestry for the purpose of enabling the two companies to erect further generating stations. This is contrary to the usual practice, and almost without precedent, and it will be extremely inconvenient and might result in endless litigation hereafter if the Board of Trade granted the proposed order to the Kensington Vestry and Parliament afterwards granted the Bill to the two electrical companies to deal with the same land. In a report submitted to the Hammersmith Vestry on Wednesday, the electrical engineer, Mr. G. G. Bell, expressed the opinion that a large saving of time and cost would be effected by the Vestry employing a main-laying staff, and laying its own mains. He estimated the profit at about 3d. per yard. The Vestry decided that the proposal be tried in six important roads, the cost being estimated at £13,000.

PROVISIONAL PATENTS, 1899.

JANUARY 9.

462. **Improvements in arc lamps and lanterns.** Edward John Shaw, Astral Works, Hatherton-street, Walsall.

465. **Improvements in electric ceiling-roses, fuse and junction boxes, and wall sockets.** James Whitcher, 120, High-street, Cowes, Isle of Wight.

485. **Improvements in telegraphic relays.** Robert William Paul, 44, Hatton garden, London.

490. **Improvements in electrical relays and transmitters.** Herbert Watson Sullivan, 19, Great Winchester-street, London.

503. **Improved advertisement frames adapted for the rooms of travellers' hotels and provided with an electrically-actuated clock with an alarm if desired.** Elie Belzon and Paul Royer, 52, Chancery-lane, London. (Complete specification.)

513. **An improved electro-mechanical system for providing additional security for safes, vaults, and similar receptacles for the storing of valuables.** Henry F. Freed, Isaac Freed, David Key Clink, and George Judd Reed, 40, Chancery-lane, London. (Complete specification.)

514. **Improvements in electric arc lamps.** The Davy Electrical Construction Company, Limited, and John Leman Eckersley Daniel, 40, Chancery-lane, London.

516. **Improvements in telegraphic receiving and translating instruments.** Alexander Muirhead, 323, High Holborn, London.

517. **Improvements in type-printing telegraph apparatus.** Charles Denton Abel, Birkbeck Bank-chambers, Southampton buildings, Chancery-lane, London. (Siemens und Halske Aktiengesellschaft, Germany.)

JANUARY 10.

537. **Improvements in pressure-regulating apparatus for electric mains used chiefly in connection with storage batteries.** John Somerville Highfield, Wolseley-road, St. Helens.

540. **Improvements in methods of operating electromotors and controllers and switches connected therewith.** Peter Valentine McMahon, 195, Clapham-road, London.

571. **Improved electric arc lamp clutch and feed mechanism.** Henry Vincent James, Westhill, Higher Broughton, Salford.

580. **Telephone system.** David Henry Wilson, 46, Lincoln's-inn-fields, London. (Complete specification.)

582. **A method of operating electric tramcars, etc., where a combined or alternate fixed line conductor and accumulator traction is used.** John Dugdill, Firs House, Failsworth, near Manchester.

626. **Improvements in or connected with telephonic instruments.** Archibald Laidlaw Baird, 55, Chancery-lane, London. (Thomas Barnet, New South Wales.) (Complete specification.)

633. **Improvements in printing telegraphs.** Frederick Hachmann, Charles Pfeifer, and Casper Ernst, 22, Southampton-buildings, Chancery-lane, London. (Complete specification.)

635. **Improvements in electrical appliances for controlling the supply of gas to burners and effecting its ignition from a distance.** Carl Franzen, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

JANUARY 11.

655. **An improved locking and releasing device for electrical switches.** Frederick Percy Cox, 10, St. George's-crescent, Liverpool.

656. **An improvement in electrical switches.** Frederick Percy Cox, 10, St. George's-crescent, Liverpool.

672. **Improvements in continuous-current electric dynamos or generators for train-lighting purposes.** Herbert William Wilson, The Grange, Wendling, East Dereham, Norfolk.

690. **Improvements in means for forming eyes on wire and other ropes especially applicable to span wires for overhead conductors in electric tramway systems.** Edward Henry Tyler, 77, Chancery-lane, London.

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657. An improved electrical fuse holder. Frederick Percy Cox, 10, St. George's-crescent, Liverpool.

699. Improvements in and relating to electric furnaces for the production of calcium carbide and other substances. Tinker and Holliday, Limited, and William Cardno, 55, Chancery-lane, London.

710. Improvements in or relating to apparatus for electrically controlling mechanical movements. Pierre Emmanuel Emile Raverot and Pierre Frédéric Léon Belly, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JANUARY 12.

764. Hollow or recessed punches used in connection with Wheatstone's automatic telegraphy or any other systems of automatic transmission. Joseph William Willmot, 41, Tufnell Park-road, Holloway, London. (Complete specification.)

JANUARY 13.

813. An improved electrical signalling and telegraphic apparatus. Johann Christian Schäfer, Eduard Renz, and Paul Lippold, 24, Luisen-strasse, Berlin. (Complete specification.)

825. Improvements in electrical measuring instruments. Arthur Frederick Harris, 57, Acre-lane, Brixton, London

864. Improvements in electric arc lamps. Wallace James Lambert Sandy and Thomas Geer, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JANUARY 14.

993. Improvements in telephone exchange switchboards. August Eckstein and William Armstrong Guthrie, Peel Works, Adelphi, Salford.

906. An improved magneto-electric generator and automatic pull and circuit closer. George William Thomas Shrubshall, 36, Eccleshourne-road, Thornton Heath, Surrey.

918. Improvements in enclosed electric arc lamps. William James Davy, 40, Chancery-lane, London.

925. Rotary converters for single-phase alternating currents. Max Deri, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

934. Method of and apparatus for electrically transmitting orders, signals, or indications from one place to another. Alfred Upton Alcock, 46, Lincoln's-inn-fields, London.

SPECIFICATIONS PUBLISHED.

1897.

24262. Electric firing apparatus for ordnance. Vickers, Sons, and Co., Limited, Dawson, and Buckham.

30259. Method or methods for controlling a mechanism or mechanisms by means of electric or electromagnetic waves of high frequency. Wilson and Evans.

30846. Method or methods for controlling a mechanism or mechanisms by means of electric or electromagnetic waves of high frequency. Wilson and Evans.

30923. Electric elevators. Leigh. (Sprague.)

1898.

525. Electric signalling. Thompson.

933. Electrolytical condensers and electric current-directing devices. Pollak.

1140. Electromagnets for electric traction. Leigh. (The Gesellschaft zur Verwerthung elektrischer und magnetischer Stromkraft (System Schiemann und Kleinschmidt), Ad. Wilde und Co.)

1557. Clockwork-operated mechanism for switching electrical current. Scull.

2021. Electrical log recording instrument for the cabin. Jensen. (Patentktiebolaget Svea.)

2417. Electric circuit breakers. Bouchet. (Date applied for under International Convention, July 2, 1897.)

2485. Electric arc lamps. Oliver.

3507. Electric meters. Evershed and Vignoles, Limited, and Evershed.

4621. Electric arc lamps. Spooner. (Vassir.)

8179. Means for electrically lighting railway carriages. Dick.

19110. Method of suspending curtains, electric lamp wires, and other articles. Ogden.

19688. Mechanism of electrically-illuminated devices for automatically making and breaking electric circuits used in such electrically-illuminated devices. Richardson, Jevons and Gent.

22081. Means for adjusting the reluctance of magnetic circuits. The British Thomson-Houston Company, Limited. (Thomson.)

22545. Automatic telephone exchanges. Thompson. (The Strowger Automatic Telephone Exchange.)

23563. Electric arc lamps. The British Thomson-Houston Company, Limited. (Hartham.)

23958. Electric measuring instruments. The British Thomson-Houston Company, Limited. (Thomson.)

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1899.	Corresponding week 1898.	Increase or decrease.	Total receipts for half-year. 1899.	1898.
		£	£	£	£	£
Birmingham Tramway	Jan. 14	3 754	3,458	+ 296	—	—
Blackpool and Fleetwood Tramroad	,, 13	113	—	—	280	—
Bristol Tramways and Carriage Co.	,, 13	2 556	2,365	+ 191	—	—
City and South London Railway	,, 15	1,107	1,085	+ 22	3,286	3,259
Dover Tramways	,, 16	151	108	+ 43	306	225
Dublin U.T., elec. cars	,, 13	555	551†	+ 4	1,016	1,018†
Dublin S.D. Electric Tramways	,, 13	605	422	+ 183	1,115	759
Halifax Corporation Tramways	,, 11	238	—	—	7,356*	—
Liverpool Overhead Railway	,, 15	1,337	1,361	- 24	—	—
South Staffordshire Tramways	,, 13	629	609	- 20	1,086	1,151

* Since June 29, 1898. † Including horse cars.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	21-22
Bournemouth and Poole Electric Supply, Limited, Ord.	10	12½-2½
—— 4½ per cent. Cum. Pref	10	10½-11½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	17-18
—— 6 p. c. Cm. Pf., 30,001-40,000 (all paid)	10	13-13½
—— 5 per cent. Perpetual Debenture Stock	100	119-121
Brush Electrical Engineering Limited, Ordinary	2	1⅞-2
—— Non. Cum., 6 per cent. Pref.	2	2⅛ 2⅜
—— 4½ per cent. Debenture Stock	100	111-115
—— 4½ per cent. 2nd Debenture Stock	100	101-104
Callender's Cable Company, Debentures	100	110-113
—— Ordinary	5	9½-10½
Central London Railway, Ordinary	10	9½-10⅛
——	8	7⅞ 8¼
—— Pref. Half-Shares	3	3½-4
——	5	4-4½
Charing Cross and Strand	5	11½-12½
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	8½-9½
—— 4½ per cent. Debentures	100	113-115
City of London, Ordinary	10	22-24
—— ,, 90,001-100,000	10	21-23
—— 6 per cent. Cumulative Pref.	10	15½-16½
—— 5 per cent. Debenture Stock	100	125-130
City and South London Railway, Consolidated Ordinary	100	68-70
—— Ordinary	3	3½-4
—— 4 per cent. Debenture Stock	100	133-135
—— 5 per cent. Pref. Shares	10	14½-15½
—— ,, ,, '96	10	14-15
County of London and Brush Prov. Elec. Light Co., Ord.	10	12½-13½
—— ,, No. 30,001-40,000	10	12-13
—— 6 per cent. Cum. Pref.	10	14½-15½
Crompton and Co.	3	2½ 2¾ xd
—— 5 per cent. Debentures	—	91-96
Crystal Palace District, Ordinary 5 per cent. Stock	100	125-130
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2½-3
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	97-99
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5-5½
Electric Construction, Limited	2	2½-2⅝
—— 7 per cent. Cumulative Pref.	2	3-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	103-105 xd
W. T. Henley's Telegraph Works, Ordinary	10	23-24½
—— 7 per cent. Preference	10	18-19
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9-10
—— 7 per cent. Preference	5	9½-10½
Imperial Tramways, Limited	6	16½-17½
India Rubber, Gutta Percha, and Telegraph Works	10	21½-22½
—— 4 per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	13-14
London Electric Supply, Ordinary	3	3-3½
—— 6 per cent. Pref.	5	6½-6⅝
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	102-104
Metropolitan Electric Supply, Limited, Ord., No. 1-62,500	10	18½-19½
—— ,, ,, No. 62,501-85,000	4	11½-12½
—— 4½ per cent. First Mortgage Debenture Stock	100	115-119
National Telephone, Ordinary	5	5½-6
—— 6 per cent. Cum. First Pref.	10	14-16
—— 6 per cent. Cum. Second Pref.	10	13-15
—— 5 per cent. Non. Cum. Third Pref.	5	5½-5⅝
—— 3½ per cent. Deb Stock, Red.	100	99-102
Notting Hill Electric Lighting Company, Limited	10	17-18
Oriental, Limited, 1879	1	1½-1⅝
—— £5 Shares	5	7½-7⅞
—— £4½ Shares, New	4½	6¼-6⅝
Oriental Telephone and Electric Company	1	1-1⅛
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6-6½
Royal Electrical Company of Montreal	1	150-155
—— 4½ per cent. First Shares Mortgage Debentures	100	105-107
South London Electric Supply, Ordinary	3	3 3½
St. James's and Pall Mall, Limited, Ordinary	5	17-18
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	37-41
—— 5 per cent. Bonds	100	103 105
Waterloo and City Railway, Ordinary	100	108-111
Westminster Electric Supply, Ordinary	5	16-17

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NOTES.

Institution of Mechanical Engineers.—We are asked to call attention to the fact that the address of this institution is now Storey's-gate, St. James's Park, Westminster, S.W.

A Curious Lightning Effect.—An extraordinary accident is reported to have recently happened to the Johannesburg mail train. During a heavy thunderstorm a flash of lightning struck the engine, with the result that the electric staff used on the engine was partly fused and rendered useless. The train was shortly afterwards brought to a standstill.

Electrical Concerts.—The number of concerts in connection with electrical engineering which are to be held to-night renders the choice of where to spend the evening exceedingly embarrassing. Thus, there is the Electro-Harmonic concert at St. James's Hall, the smoking concert of the Electrical Engineers (Royal Engineers) Volunteers, at Holborn Restaurant, at 8 p.m., and the sixth annual Bohemian concert of the Telephone Athletic Association at the Westminster Town Hall, at 7.30. Mr. W. E. R. Gaine will preside at this last function, for which an excellent programme has been prepared.

Museum Lighting.—Prof. Ray Lankester, director of the Natural History Departments of the British Museum, South Kensington, states that arrangements have been made for the supply of the electric light to the museum. It will be introduced first into the offices, studies, and workshops, and afterwards into the public galleries. We wonder if the last two conversaziones of the Institution of Electrical Engineers has hastened this decision. It will be remembered that on each occasion the entrance hall and galleries adjoining have been brilliantly lighted by electricity, the wires and lamps being fixed up temporarily.

Ozone Purification.—One of our contemporaries contains a note on "Ozone Purification Humbug," which we are not sure if it is meant to be considered sarcastic or not. It reads as follows: "Among the advocates of the charms of ozone, prepared most cheaply by means of alternating currents, E. Andreoli has justly acquired a reputation, for he has succeeded in constructing very simple and effective ozone generators. At the same time he has more than once protested against unfair puffing of ozone, and he exposes now, in the *Electricien* of Dec. 24, again an impudent puff of the Electric Refining Company of Philadelphia, which papers have copied seriously."

Restricted Competition.—We regret to see that the consulting engineer to the Vestry of Fulham has recommended the committee that, in issuing specifications for the engines and mains required in their electrical works, it would be better to write to seven or eight of the best firms in England than to advertise for tenders. We understand that he is to report fully on the matter to the committee, but we trust that in this instance his advice will not be followed. If tenders in answer to an advertisement are received from a firm which the engineer has reason to know is incompetent to carry out the work satisfactorily, there is every reason for not accepting such a tender. The other course of restricted competition in the present state of the industry is unfair both to the manufacturer and to the Vestry.

Two-Rate Metering.—The General Electric Company, of America, has recently introduced a Thomson recording wattmeter for a two-rate system of supply. This meter, which is connected with a clock, can be arranged to give different rates of charging at any desired hours. The general idea is similar to that, devised many years ago by Mr. Gisbert Kapp, and used on the Bristol mains. In the present case the clock is self-winding, and two independent dials indicate the amount of electricity used at the high rate and at the low rate respectively. The argument has been raised against this system that it is exceedingly difficult to obtain business during the average light load of the central station. This argument has been proved in several cases to be wrong. A curve is published by our contemporary showing how much the load can be improved during the daytime, and also after midnight, when is required by newspaper and printing establishments.

London's Telephones.—The following motions are to be submitted to a joint conference of delegates from the Corporation of London and the London County Council (the meeting is to take place at 3 p.m. on Wednesday next, Feb. 1): (1) that a joint application should be made for a telephone license for the London telephone area, in accordance with the resolution passed by the Court of Common Council on Nov. 17, 1898—viz., "that application be made for a license to establish a telephone service in conjunction with the London County Council and other local authorities within the London telephone area"; (2) that the London telephone service should be managed by the London County Council and the Corporation of London; (3) that this conference recommends a joint application to the Postmaster-General for the telephone license, in accordance with the foregoing resolutions; (4) that these resolutions be submitted to the various authorities represented at this conference for their confirmation.

French Telegraphs.—It is well known that in France the telegraph system is not well organised, and in many cases prepaid replies become absolutely worthless on account of the time taken in replying. We have one case in mind in which we wired from a small place on the coast of France to Paris, and after waiting six hours for a reply without one arriving, we had to make other arrangements to those we had intended. The *Electrical Engineer* of New York gives an amusing story of an American gentleman who, on arriving at Havre, cabled to Washington and telegraphed to Paris. He then proceeded to Paris, and on arriving he found that, although there was a reply awaiting him from Washington, the telegram to Paris had not arrived, and was not delivered until a hour after he arrived. The French telegraph service is evidently conducted on steady lines, and we should say that each office takes plenty of time over the transmission of its messages. By so doing they at least halve the average value of the telegram sent.

Presentation.—An interesting gathering was held in one of the car-sheds of the London United Tramways Company at Chiswick in the small hours of Sunday morning, when Mr. J. Clifton Robinson, the managing director, was presented by the staff with an illuminated address, and Mrs. Clifton Robinson with a diamond pendant and diamond earrings, in celebration of their silver wedding. The address was signed on behalf of the London United Tramways Company by Messrs. G. E. Cummings (private secretary and treasurer), F. Freshwater (superintendent), A. G. Buxton (assistant superintendent), W. Jenkins (foreman of depôts), William Hutchings, Thomas B. Holliday, E. P. Whitmoor, H. Hooper, A. E. Green, and R. Smith. It was also signed on behalf of the Middlesbrough, Stockton, and Thornaby Electric Tramways by Messrs. G. R. Holmes (resident engineer), by Alfred J. Linnell (assistant engineer of the Bristol Electric Tramways), Fred. Groves (manager of the Reading Tramways), and J. R. Dix (general manager of the Corris Railway).

A New Alternate-Current Wattmeter.—Dr. H. Behn-Eschenburg, the electrical engineer of the Oerlikon

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Company, has recently introduced a new wattmeter on the principle of the d'Arsonval galvanometer. The fixed magnet is energised by the main current, and the moving coil taking current from a shunt across the mains. The axis of the moving coil is perpendicular to the plane of the horseshoe fixed magnet. The shunt consists of an inductionless resistance, one end joined to one main, the other to two resistances in parallel; of these, one is inductionless and completes the circuit directly to the other main, and the other is inductive and completes the shunt circuit through the moving coil. The object of the small inductive resistance inserted in series with the moving coil is to balance the effect of the hysteresis in the main circuit. The latter produces a phase difference of about 5deg., and by suitably adjusting the inductance of the shunt circuit, according to calculations given in the paper, a similar phase difference is created in the shunt circuit and the effect of hysteresis balanced at any frequency.

Micro-photography of Steel Rails.—In Sir Wm. C. Roberts-Austen's paper on this subject, read before the Institution of Civil Engineers last week, a statement was given of the principles which guided micro-photography of steel rails. The most generally useful information as to the structure of a steel rail was obtained by treating a highly-polished surface of the section with an infusion of liquorice in water, which stained the pearlite a dark tint and left the ferrite unacted on. The most convenient magnification was between 100 and 150 diameters. Normal rails were thus shown to consist of patches of pearlite set in ferrite, and although the structure was common to all rails the ratios of the areas differed widely, the amount of carbon increasing with the area of the pearlite. Micro-photographs were appended to the paper to illustrate the influence of manganese on the structure of the steel. If the ferrite was arranged in large, enclosed polyhedrons, the temperature to which the rail was raised before rolling was too high. The strength and intensibility increased as the size of the grain diminished; and closely interlocking ferrite and pearlite was said to be the condition which most favoured the prolongation of the life of the rail.

National Telephone Company's Bills. — The memorials which have been presented to the Examiners of both Houses against the passing of the National Telephone Company's Bills through the standing orders stage allege that the notices given by the company of their intended application to Parliament were defective, insufficient, vague, and misleading. It is alleged that the notices were not published in the manner prescribed by the standing orders in newspapers circulating in the cities and districts affected by the Bills, whilst the notices that were given in the London, Edinburgh, and Dublin *Gazettes* contained no intimation of some of the principal provisions in the Bills. In support of this allegation, it is pointed out that the notices did not indicate any intention on the part of the company to authorise the Railway and Canal Commissioners to consent to the laying of wires through districts whose road authorities had refused to grant their consent; nor was any notice given of any intention to resort to the procedure of the Railway and Canal Traffic Acts. The proposed powers to the Railway and Canal Commissioners will, it is pointed out, practically repeal express statutory provisions in force in various districts, yet no notice was given, as required by the standing orders, of any intention to repeal those enactments.

The Education of Workmen.—Mr. Arthur A. Hamerschlag recently read a paper before the American Institute of Electrical Engineers on the education of electrical apprentices and journeymen. In this he pointed out how much the loss of the old apprenticeship system in the training of our mechanics is to be deplored. The great tendency nowadays is to subdivide labour to such an extent that the mechanic who can investigate and repair breakdowns is likely to be seriously missed. The author also explains that for every single opening for the electrical engineer, such as are prepared by the colleges and universities, there are 100 vacancies for skilled journeymen. He also says that the skilled journeyman of the average class receives more remuneration than the average so-called electrical engineer. Mr. Hamerschlag recommends the establishment of schools for workmen in which sufficient information will be given to enable them to understand the general principle and practical applications of the electrical science. He refers to one or two such schools which have been doing good work in America, amongst which the New York Trade School has some 6,000 graduates on its list. We think the idea worthy of further consideration on this side, where the subdivision of labour is not, up to the present, carried quite as far as in America.

The Mysteries of Electricity.—The verdict of the coroner's inquest on the death of Mr. S. Pugh was given last week, and can only be accepted on the assumption that electricity being incomprehensible its effects cannot be predicted. The deceased was an engine driver in the service of the City and South London Railway Company, and he was found dead on his engine at Stockwell Station on the morning of the 10th. At the opening of the inquest the doctor said that death was due to shock followed by sudden stoppage of the heart's action. As the man was a healthy man, the doctor concluded that death was due to the electric current. The railway company then objected that the deceased could not possibly have obtained an electric shock on the engine, and the inquest was adjourned for further medical advice. Three doctors examined the body and found no signs whatever of an electric shock, but the first doctor adhered to his decision. The jury subsequently agreed with this first doctor, but said that they did not know how the shock was caused. They also wisely expressed no opinion as to whether the shock was sustained accidentally. If the facts given by the company's officials are correct, we think the verdict an unreasonable one. It is well known that with a 500-volt shock considerable damage is done to the skin if contact is maintained for any prolonged length of time, and some scorching should have been evident in the present case.

Institution of Mechanical Engineers.—The fifty-second annual general meeting of this institution is announced for Thursday and Friday, Feb. 9 and 10, when the meeting will be held at the institution's new home at Storey's-gate, St. James's Park. The chair will be taken each night at half past seven. The business of the meetings consists of the election of the president, vice-presidents, and members of the council. After this the following papers will be read and discussed as far as time permits: "Fifth Report to the Alloys Research Committee: Steel," by Sir William C. Roberts-Austen, K.C.B., D.C.L., F.R.S., hon. life member (Thursday); "Machinery for Book and General Printing," by Mr. William Powrie, member; and "Evaporative Condensers," by Mr. H. G. V. Oldham, associate member. In this last paper, which will be of considerable interest to electrical engineers, the author, after pointing out the advantage of using evaporative condensers where a large supply of cooling water is not available, discusses the action going on in evaporative condensers. He then refers to the action of steam and water as they pass through the apparatus, the method of jointing tubes, water seal, etc. The principal designs of

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air condensers in use during the last 26 years are then described, and special attention is given to the most recent types. The application of fans to increase the efficiency of evaporative condensers is discussed, as well as the best arrangements for connecting the condenser to the engine and the necessary pumps.

The Campbell Surface Contact System.—The 1898 boom in electric traction in England has brought to notice a number of contact systems for electric tramways, etc., which have as yet not been tried in practice. In America, the rush of new systems still claims the attention of the technical Press, but we regret to find that those recently noticed are less practical than we could wish. The last one brought before us is described in the *Electrical Engineer* of New York, and is the invention of Mr. George P. Campbell. In this, a small conduit, 9in. by 6in. in cross-section, is used. At the bottom of this conduit a live contact rail is placed, and a small trolley with four wheels makes connection between this and the sectional contact rails at the road surface. This running connector is held in place by grooves, and is supposed to be drawn along by electromagnets on the car, which have to transmit the tractive effort through the sectional conductor. This in itself would be the cause of much waste in eddy currents in the sectional conductor, and at high speeds it would be exceedingly difficult to transmit enough force to keep the running contact-maker under the car. In the event of the car over-running the contact-maker a live section would be exposed, which would be extremely dangerous to the public. The running wheels on this connecting carriage bottom are so small that they will run at very high speeds if the car is to have a reasonably rapid schedule. For instance, in the illustration given wheels are shown which would have to revolve at 1,600 revolutions per minute if the car was going at 15 miles per hour.

Electromagnets.—The American *Electrician* calls attention to the following problem which frequently confronts the electrical designer—*i.e.*, given a magnet of known shape, size, excitation, and magnetic material, what is the pull upon an armature of known materials and dimensions at a specified distance? There is, says our contemporary, absolutely no reliable data on this subject. Surely Prof. Silvanus P. Thomson's Cantor lectures have been overlooked. Still, the matter of leakage enters into this problem so intricately that it is impossible to apply any mathematical formula, either rational or empirical. It is frequently the case that data of the most approximate character in this direction would be very welcome, and this it should not be impossible to experimentally obtain. In connection with this subject, it seems wise to suggest a series of experiments with a number of magnets with known dimensions, beginning with those of very minute size and proceeding upward to the largest size that would ever be used in electromagnetic mechanism, where the function is to exert a tractive force. The experiment would not be particularly expensive. It would be somewhat tedious, but the results would be of incalculable value. With a single set of magnets the attraction of armatures of various shapes and sizes could be measured, and also the attraction of these magnets under the influence of alternating currents. The tabulated results giving magnetising forces, saturation of the cores, the dimensions of the magnets, and the pull at various distances, would constitute a valuable contribution to engineering data, and place the profession under a very great debt of gratitude to the author.

Light Railways in London.—On Friday last the question of the future action of the Board of Trade with reference to light railways came before Sir Courtenay Boyle on the objection of the Great Western Railway Company to the confirmation of the order of the Light Railway Commissioners, who had sanctioned the making of an electric railway between Hanwell and Uxbridge. Mr. Pope, Q.C., at the hearing, raised the point whether, under the Light Railways Act, such a project could be sanctioned, inasmuch as the Act said that where the proposed undertaking was of such magnitude as to seriously affect an existing railway it ought to go before a parliamentary committee. This was really an extension of the tramway system into the country, and should come under the Tramway Act, so that people interested could oppose it before parliamentary committees, if necessary. On behalf of the London United Tramways Company, it was argued that the Light Railways Act would be utterly useless, and would stop all the light railway projects throughout the country if they had to go through such an expensive machinery as Parliament. The main idea in instituting the Light Railway Commissioners' Court was to allow these light railways to be carried out cheaply without the heavy preliminary costs of parliamentary procedure. Sir Courtenay Boyle said the Board of Trade had considered this matter very carefully, and they had come to the conclusion that this might reasonably be considered an undertaking under the Light Railways Act, and therefore the case must proceed on that understanding. Sir Courtenay Boyle also said, in answer to the opposition of the Middlesex County Council, that he must hold that the company was under an obligation to carry both goods and passengers. The *Financial News* reports that the decision of the Board of Trade was reserved.

Waves in the Ether.—The *Times résumé* of the progress of science in 1898 contains the following interesting paragraph on waves in the ether, in which the author points out that before the time of Hertz's brilliant discoveries the only vibrations in the ether with which we were acquainted were those produced by the natural oscillations of atomic electrical charges, and made evident as ultra-red, visible, or ultra-violet radiation. Hertz showed us how to manufacture electrically other ether waves of wave-length a million times greater than those which give rise to visible light; and since his time numerous investigators have sought to produce Hertz waves of continually smaller wave-length. In Italy, Lampa has succeeded in generating Hertz waves of about 4 mm. in wave-length. Other investigators, attacking the problem from the other side, have endeavoured to sift out from ordinary dark heat radiation the shorter wave-lengths and leave the longer ones. This last year, Drs. H. Rubens and E. Aschkinass have achieved the feat of filtering out from an heterogeneous radiation the waves of very great wave-length existing in the radiation of an Auer burner. This they accomplished by repeated reflections from rock-salt or sylvine. They have thus obtained invisible radiation or ether waves having a wave-length one hundred times greater than those which give rise to the sensation of red light, but at the same time of only one-hundredth part of the wave-length of the shortest known Hertz waves. There remain about five octaves of as yet unknown radiation to be produced, but when this is done we shall know how to create the whole of the vast gamut of ether waves lying between the ultra-violet light, found by Schumannto to have a wave-length of one ten-thousandth of a millimetre, and Hertz waves of many metres in length.

Unreasonable Opposition.—The agenda of the Camberwell Vestry meeting this week discloses that they are taking a somewhat obstructive policy with respect to the London Electric Company's work. This company has written to the Board of Trade asking for the consent of

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the Board to the use of the extra high pressure of 6,600 volts. The company also state that it wishes to supply two-phase current for lighting and power purposes from low-tension concentric mains in that portion of the Camberwell district where power is likely to be required. The frequency used will be 50. The recommendation was forwarded to the Vestry for consideration, which suggested that the Board of Trade be asked not to consent to these two proposals. No reasons are given, and we fail to see what reason there can be for the opposition. At the same meeting the application for the compulsory purchase of lands by the County of London and Brush Provincial Electric Light Company will come up for consideration. In this case the committee recommends that, unless the promoters agree to the insertion of a clause providing that the generating station to be erected in Camberwell shall only be for the purpose of supplying electrical energy in the area authorised by the Camberwell Order of 1896, and that no works or other expenses proposed to be authorised by this Bill shall be chargeable to the Camberwell Order of 1896, or shall be taken into consideration in estimating the amount of compensation to be paid to the company when the undertaking is purchased by the Camberwell local authority, the Vestry should oppose every stage of this Bill. It seems to us that this last requirement is unreasonable, as the company in question should not be prevented from working its numerous districts in the most economical way, and in the way which will tend to supply the electricity at the least possible price.

Progress of Electric Traction in Germany.—The *Elektrotechnische Zeitschrift* publishes a statistic table and article from which some interesting figures may be deduced relative to the progress of electric traction in Germany during the past year. Naturally, the figures are not quite up to date, but they may be taken as representing with sufficient accuracy the position holding good on Sept. 1, 1898, when it appears that the generating stations supplying energy for traction purposes numbered 68, as compared with 56 in the corresponding month of 1897. Further, the lines opened for traffic totalled a length of 1,220 miles, against 850 miles, while the capacity of the generating machines installed amounted to 33,333 kw., compared with 24,920 kw. Thus the several increases were to the extent of 21·4 per cent., 43·0 per cent, and 33·8 per cent. respectively. It should be mentioned, however, that the capacity of the generating plant given above does not include accumulators, the employment of which for parallel working with the generator has recently found considerable favour in Germany. The total capacity of the accumulators already installed for such purpose amounts to 5,118 kw., so that generating machines and accumulators together are capable of an output of 38,451 kw. It is also interesting to note that the overhead trolley system still is used most generally, while the conduit system has only been employed over some short lines in Berlin and Dresden. On the other hand, the so-called mixed system of working—that is, partly by means of trolley wires and partly with accumulators charged during the passage of the car over the sections provided with trolley wires—is extending in the larger towns. In conclusion, it may be added that amongst the lines already opened for traffic are included numerous light railways for the conveyance of goods as well as passengers.

To Thaw Klondyke.—The Graburn and Blaney Canadian patent of the Graburn electrical thawing process has, we gather from our New York namesake, been sold by the inventor, Mr. Nelson Graburn, of Montreal, to the Electrical Thawing Syndicate, Limited, London, England, for £7,000 and one-quarter interest in the company. The patent is intended to be used in countries like the Klondyke, where mining operations are carried on during a large portion of the year under considerable difficulties, owing to the ground being frozen hard to a considerable depth. It provides for specially constructed dynamos and electrodes, the latter being placed against the walls of the shaft, with a space of from 5ft. to 6ft. of ground intervening: so that when the current is turned on, it has to cross the face of this space to complete the circuit, and the ground contained therein forming a resistance to the passage of the electricity, heat is generated and the ground thawed. By the bonfire system of thawing in a temperature of zero or lower, it is stated that upwards of 85 per cent. of the heat generated is lost in the atmosphere, whilst heat generated by the above electrical process can be absolutely controlled and applied in such a manner as to utilise its full force and effect. It is also claimed that by the electrical system it is possible to thaw out 1ft. of frozen earth per hour, as against 1ft. in 24 hours by the bonfire system. Several electrical experts who have examined into the system are said to be satisfied as to its practicability and efficiency. It seems to us that there is no doubt that in a case like this the fuel is used to better advantage than by the direct action on the frozen ground. It is more economical in heating up a boiler which should drive dynamos, by means of which even electric radiators might be used to thaw the ground. If covered over with a heavy blanket all the heat from these would go downwards, and the thawing would, in our opinion, be more rapid.

The Future of the Punkahwallah.—A correspondent to *Indian Engineering* writes as follows on the punkah question: "With the advent of electrical power in Calcutta, the question naturally arises as to whether the punkahwallah is to go. I am afraid it will be a long time before the punkahwallah will be superseded even in Calcutta, in spite of the fact that electricity will be practically laid on in all the main thoroughfares, for the reason that to instal the power into the several buildings will be expensive, and it will be only those houses that adopt the electric light that will use this motive power for punkahs. The rotary fan appears to be the fan that will supersede the punkah, so say those who know nothing about the matter, and I beg to differ from them. The punkah proper will never be superseded by the rotary fan, for the following reason. The rotary fan is not so efficient an air distributor as the punkah is, and it takes considerably more power to work one rotary fan than it does to pull half-a-dozen decent sized punkahs. Now if we take an ordinary electric rotary fan with a 5ft. sweep of blades, making from 180 to 200 revolutions a minute, it will consume 100 watts, or $\frac{1}{7}$ h.p. practically. With this power the air distributed by a fan of the kind in question would be too concentrated, and it would require fully two or three of them to give favourable results in an ordinary sized room, and taking the cost of power at nine annas per unit, it is very evident that the fan bill per month would be considerable. On the other hand, a consumption of 12,000 foot-pounds a minute would pull nearly every punkah in a large office if properly arranged. Under these circumstances, no one who had a large house, or no public building or hotel would discard the punkah for the rotary fan. With electricity as the motive power, and laid on in the house the same as gas, the cost of pulling punkahs in a private residence would be insignificant. All that would be necessary would be motors wound in such a way that they would be suitable for the work they had to do and an efficient electric punkah-pulling machine."

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The Highland Water-Power Scheme.—The Fort William Burgh Commissioners have held a special meeting to pass resolutions in favour of the Highland water-power scheme, which will shortly come before Parliament. In this respect the Scottish authorities have given another instance of their good sense. Instead of hampering the electric enterprise, as is being done in too many places in England, the Fort William authorities recognise the great value to the community of the industries which will follow the introduction of cheap power. Provost Young, who presided over the meeting last week, gave some useful information which cannot be obtained from merely reading the Bill. He explained that the object of the promoters was to utilise the vast water power of the Central Highlands by the construction of embankments and the raising of the water-levels of Loch Ericht and the lakes of the Blackwater. The waters thus impounded would be led by canal and tunnel westwards across the country to Kinloch Leven, where a fall of about 1,100ft. would be obtained, and the value of that power, which at present was allowed to run to waste, was estimated at about 37,000 e.h.p., as against 350ft. of pressure and 7,000 h.p. delivered at the Foyers Aluminium Works, where a large number of workmen were at present employed. The capital of the Highland Water Power Company was to be £1,700,000, and they had agreed to acquire 400 acres of land at the head of Loch Leven upon which to erect power-houses, works, dwelling-houses, piers, and other necessary buildings. The other speakers who supported the resolutions in favour of the scheme also dwelt on the large amount of employment which it would give to the inhabitants. One of these pointed out that there was no limit to the number of industries which might be established throughout the Highlands when the water-power scheme was in full working order. We have always held that the establishment of the aluminium works at Foyers has been of immense benefit to the inhabitants of the district, in spite of the opposition which it met with at first, and the scenery of the district has not been spoilt. We are sure that the same kind of opposition may be expected in connection with the Highland water-power scheme, and we hope that the Foyers experience will be of service in the matter.

Dust Destructor Work.—At the meeting of the St. Pancras Vestry, Mr. Thornley, chairman, submitted an elaborate adjourned report from Mr. Bellamy, accountant to the Vestry, upon a return presented by Mr. Morley, the superintendent of the refuse destructor, as to the collection of house refuse from the east and west divisions of the parish during the six months ended September, 1898, as compared with the cost of the work executed during the corresponding period of 1897. He said that from this it would be seen that for the 12 months ending Michaelmas, 1897, 15,569 tons of refuse were disposed of at a cost of £3,500. For the 12 months ended Michaelmas, 1898, no less than 19,768 tons had been similarly disposed of at a cost of about £3,350. In other words, this meant that if the cost of disposal per ton now in force had been applicable in 1897, instead of costing the parish £3,500, as it did then, the quantity of refuse destroyed would only have cost £2,600. This was in the face of the fact that during the 12 months ended Michaelmas, 1898, the work had been seriously hampered in consequence of the reconstruction of cells, etc. If this had not been so it would have been easy to have consumed in 12 months nearly 80 per cent. more than was actually destroyed, and if the destruction had been carried on for seven days a week, as was the case previously to the committee taking this work in hand, the ultimate result would then have been nearly a 100 per cent. increase. A source of income which had been discarded up to the present lay in the enormous resources they possessed for generating electricity by the mere destruction of this refuse. It was difficult even to estimate what this particular branch of revenue might produce, but as soon as the Electricity Committee provide the necessary apparatus it would then be possible to ascertain something definite in that direction. A member then said the utilisation of the heat from the destructor for the manufacture of electricity was not worth five minutes' consideration. With regard to this last statement, the Shoreditch Vestry have found the destructor very valuable in the generation of electricity, and we should recommend the gentleman in question to study the results obtained from it. The fact remains, however, that the St. Pancras destructor has broken every promise in this direction, but the reason for its failure to generate steam in the first year is apparent to any engineer viewing the works.

Massachusetts Institute of Technology.—The prospectus of this Boston institute has been sent to us. We note that the usual course for students in either electrical engineering or physics extends over four years. This is no inconsiderable portion of a lifetime, but as the first year's course is only partially technical, and general educational subjects are introduced even up to the third year, no doubt the student can cut off a year of ordinary school life. We are particularly pleased with the programme for the fourth year. During the last term of his course every student who is a candidate for a degree spends a large portion of his time in the preparation of a thesis upon some electrical subject. This is always of the nature of an experimental research, investigation, or test of some kind, and may be either purely scientific or technical in its character. A list of the titles of these in electrical engineering and physics is given for each year since 1870, and the following extracts from the subjects treated in 1898 will give an idea of their variety and extent: "Variations of Stray Power in a 35-kw. Generator"; "An Electro-Chemical Recorder for Sudden Rushes of Current"; "An Investigation of the Disruptive Effect upon Air at Different Pressures of Alternating Currents of High Potential and Low Frequency"; "A Method for the Determination of Thermal Conductivity"; "A Test of a Municipal Electric Lighting Plant"; "A Study of the Efficiency of an Electrical Plant under Varying Conditions"; "An Investigation of the Cause of Distortion of the Current in a Transformer Primary"; "A Test of 40in. Boston Cupola and Forge-Blower"; "A Method for the Harmonic Analysis of Alternating-Current Waves"; "A Test of the Quarter-Phase Generating Plant of the Quincy Market Cold Storage Company, of Boston, Mass."; "A Study of Disruptive Tests of Insulation"; "An Analysis of Stray Power of Two Similar General Electric Company's Generators"; "An Efficiency Test of 600-kw. Induction Potential Regulator at Carborundum Works, Niagara Falls, New York"; "An Investigation of Phenomena occurring in Three-Phase Power Transmission"; "A Test of the Candle-Power of an Enclosed Arc Lamp"; "Tests of a Rotary Converter"; "An Investigation of the Stray Field of Various Dynamos and Motors"; "A Study of the Field of a Three Phase Induction Motor"; "An Investigation of a Small Single-Phase Synchronous Induction Motor"; "The Vortex Theory of Atoms"; "The Effect of Dissociation on the Colour of Solutions." Many of these theses have been printed in the technical Press, and have come under our notice. We commend the general idea to Prof. W. E. Ayrton as worthy of adoption at the Central Institution.

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THE PRACTICAL TESTING OF ELECTRICITY METERS FOR CENTRAL STATIONS.

BY C. A. L. PRUSMANN, A.I.E.E., ASSISTANT ELECTRICAL ENGINEER, BRADFORD.

(*Continued from page 40.*)

Handling.—On the arrival of the meters from the manufacturers, they should immediately be taken charge of by the storekeeper, who should see them unpacked, and examine them externally with a view to the detection of any damage in transit. After taking down full particulars as to the numbers and capacities of the different makes of meters, he should hand them over to the meter department. All unpacking and packing of meters should be done by the storekeeper's department, away from the meter-room, as straw and paper are most objectionable materials to have lying about in the test-room. However much care is bestowed on the unpacking of meters, litter and dirt cannot be altogether prevented. On receiving the meters from the storekeeper, those in charge of the meter department should label each meter with a brass or zinc plate, on which is stamped the corporation number of the meter, and, further, words to the effect that the meter is corporation property. Several types of plates are given in Fig. 3.

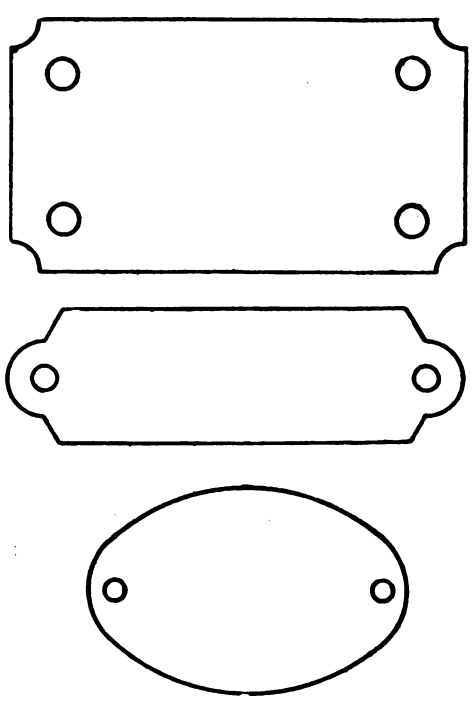

FIG. 3.

The plates themselves are affixed to the meters in a conspicuous part by means of screws, and it will be found the best plan to have the holes for these screws drilled and tapped from a template when the meter is at the makers. After the labels are attached to the meters, the meters should then be arranged on shelves, the same make being together, and also those of the same capacity. A proper system in this respect often saves a vast amount of trouble and annoyance. There will, of course, be a proper place for them in the storeroom on the shelves specially reserved for meters "awaiting testing," and before any meter is removed, all particulars relating to make, type numbers, and capacity should be carefully entered in the books kept for the purpose. A full description of these and other books necessary in the meter-room are given herewith. The meters are now ready for examination and testing, and are left stored away until the time when the testing tables and circuits are at liberty for the respective batches. After the meters have been tested they are ready for use on the circuit. A word here must be said as to the order in which the meters are used. It sometimes happens that a meter gets at the back of a number of other meters of a more recent date. The result is that it may be weeks before the meter is fixed on circuit. As far as possible it is advisable to put meters on the circuit in the same order as they are received at the works.

Book-keeping.—In this section it is proposed to deal with a system of meter department books. Too much importance cannot be attached to the departmental book-keeping. It is essential that it should be as nearly perfect as possible, if anything like method and order are to be preserved. Before we proceed to enumerate and describe the books actually required, it may be advisable to consider what must be at the basis of any system. First, it is absolutely necessary to be able to trace the history of any consumer's meter, or meters, during the whole of the period the consumer has been connected to the supply mains. Secondly, it must be possible to ascertain easily the number of meters which may be at the maker's under repair, and all data relating thereto. Thirdly, all particulars relating to the tests made on meters must be readily at hand if required. Fourthly, it should be possible easily to trace any meter—where it is installed, or where elsewhere it has been sent.

We will now proceed to describe the several books necessary for use. The order observed in the description corresponds with the usual course and progress of a meter through the department—viz., receiving, testing, fixing on circuit, returning from circuit, sending away for repairs, and, finally, returning from repairs.

Books: Meters Received (Fig. 4).—Little need be said in reference to this book, as it is sufficiently simple to be self-explanatory. Having entered the meters in the "meters received book," the next booking which takes place is after they are tested, and the tests require to be registered. Of course the meters which fail to pass the standard tests are simply marked defective, a label particularising the defect being attached. Incidentally we may here mention the test-books. These, of course, will be found to differ for different types of meters used, but they will be fully dealt with when the testing of the different makes of meters is described. Assuming, therefore, that the meters have passed the required tests, and are entered in the test-books, a white card, of which a specimen is given below, is then affixed to the meter (see "meter outwards" card, Fig. 5). The meter is now stored away on its proper shelf in the storeroom, until it is required for use on the circuit. When this time arrives, the white card is removed from the meter, and the "meter outwards" book entered up therefrom. This book is printed on white paper, corresponding to the white meter card, and is made in duplicate with perforated holes, so that one half may be detached and handed over to the accounts department; the other portion is kept by the meter department (see Fig. 6, "meter outwards" book). After being in use for some time, meters have to be removed from the circuit in consequence of defects of one sort or another having developed in the ordinary course of wear and tear. The meter is brought back to the department, and particulars of what is wrong are entered on a "meter inwards" card (Fig. 7) (pink pasteboard), from which card the "meter inwards" book (Fig. 8) is duly posted. This book, like the "outward" book, is arranged in duplicate, the one half being sent to the accounts department. The meter is then stored away with the card attached, awaiting examination. When subsequently overhauled it may be found in good condition, and in that case it is again ready for the circuit. The pink card on the meter is replaced by a white card, and the former, duly filled in recording the meter to be in good condition, is then filed away. If, however, the meter is found to be defective, so that it necessitates returning to the makers, the pink card is filled in to that effect. When actually returned to the makers the pink card is removed, and a label describing the defect substituted. This then completes the cycle which a meter normally may take. The books described above should be properly indexed for ready reference, so that all particulars relating to any meter may be easily found. These index books are two in number, and are designated "meter index book" (Fig. 9) and "consumer's meter book" (Fig. 10). It will now be instructive to take a case by way of illustration and see how the books work. First, let us suppose it becomes necessary to trace a particular meter—say, corporation No. 100. Turning this number up in the meter index book, we shall find recorded therein the maker's number, the capacity of the meter, and

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202 CITY OF BRADFORD METERS RECEIVED. ELECTRICITY WORKS. 202

Name of Maker.	Type of Meter.	Corporation Number.	Maker's Number.	Size.		Date Received.		Date when on Circuit.		Remarks.
				Amps.	Volts.					

FIG. 4.

Front Side.]

B. C. E. W.

Meters—Outwards.

Corpn. No...... *Maker's No.*.....*Amps* .....*Volts*.....

Maker..... .....*Constant*.....*Reading*.....

Page in Test Book..... .....

I hereby certify that I have examined and Tested this Meter and find it to be in good condition.

(*Signed*) .....

Date.....*1899.*

This Form to be attached to Meter before it is issued.

[*Reverse Side.*

B. C. E. W.

Meter fixed at

Name .....

Address .....

.....

Date.....*1899.* *By*.....

This Form to be filled in by Meter Fixer and Returned to Meter Department.

Noted

(*Signed*) .....

FIG. 5.

599

B. C. E. W.

DAILY REPORT OF METERS.

Outwards.

.....*1899.*

To Mr.....

Please note that the following Meters were Installed on above date.

Meter No.	Maker	Size.		Constant	Reading	By whom fixed.	Remarks
		Amps.	Volts.				

Signed..... .....

FIG. 6.

January, 1899. 399

CITY OF BRADFORD.—ELECTRICITY DEPARTMENT.

DAILY REPORT OF METERS.

Inwards.

..... 1899.

To Mr..... , Town Hall.

Please note that the following Meters or Indicators were Removed on above date.

Corporation Number.	Maker's Number.	Maker.	Size.		Constant.	Reading.	Cause of Removal.	By whom Removed.	Remarks.
			Amps.	Volts.					

Signed.....Chief of Meter Dept.

FIG. 8.

Front Side.]

B. C. E. W.

Meters—Inwards.

Corpn. No......*Maker's No.*.....*Amps*.....*Volts*.....

Maker..... *Constant*..... *Reading*.....

Removed from..... *Cause of Removal*..... ....

Name.....

Address .....

Date.....*1899.* *By*..... .....

This Form to be fixed to Meter at time of Removal.
The Meter to be returned to Meter Department.

[*Reverse Side.*

B. C. E. W.

I hereby certify that I have examined and tested this Meter and find it to be in.....*condition.*

(If in bad condition, state defect below.)

.....

.....

.....

(*Signed*)

.....

Date.....*1899.*

FIG. 7.

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also the pages in (1) the "received" book, which gives maker, type, corporation number, maker's number, capacity, date received, date when fixed on circuit, and remarks; (2) test book; (3) the "outwards" book, stating meter numbers, maker, capacity, constant, reading when fixed, by whom fixed, date fixed, and remarks, such as what class of circuit meter is used on. Two more columns are necessary for consumer's name and address, but owing to this making the book somewhat long, it may be found preferable to simply write the name and address under the meter particulars—this, though taking up more room as regards the breadth of the book, is no great disadvantage, as it is rarely required that more than four meters are to be entered in one day; (4) the "inwards" book, showing meter numbers, maker, capacity, constant, reading when removed from circuit, by whom removed, cause of removal, date of removal, and remarks, such as what class of circuit the meter has been removed from—the name and address of consumer being written under these particulars, as in the "outwards" book; (5) the "repairs" book (Fig. 11), showing maker, type of meter, corporation number, maker's number, capacity, date returned to maker, date returned to corporation, cost of repairs chargeable to, and nature of defect. In the second place, let us suppose it becomes necessary to find particulars of a certain consumer's meter. The consumer's meter book is referred to, and opposite the consumer's name is found the corporation number of the meter, and the pages in "outwards, test, and inwards" books, and from these references all particulars are easily obtained. In addition to those already enumerated above we may mention the meter readers' books. These simply consist of books of such a size as to be conveniently carried in the pocket. The names and addresses of the consumers are entered in such a manner as to facilitate the work of meter reading. It is advisable to have the books so arranged as to admit of readings being taken and entered every month, and to make each book complete for one year. How often meters are read during a twelvemonth will differ largely, of course, with different corporations, but it is a great point in favour of monthly readings that a check is thus kept on meters stopping or becoming defective. An excellent plan, and one which amply justifies itself in practice, is to have a man permanently employed testing the meters on circuit, for starting current, insulation resistance, and general reliability. It is surprising how many meters will be found to have high starting currents when they have been in use for any length of time. With almost every type of meter at present employed there is the greatest need to adopt some form of severe periodical inspection and testing, particularly in view of the starting currents of meters increasing in value with time. This, with the higher-voltage lamps, now so much in vogue, and consequent smaller currents employed, becomes a matter for very serious consideration. How to obtain the full revenue from those consumers burning one or two lamps throughout

150 CITY OF BRADFORD INDEX TO METERS. ELECTRICITY WORKS. 150

Corporation Number.	Maker's Number.	Size.		Folios in the undernamed Meter Books.				
		Amps.	Volts.	Received.	Test.	Outwards.	Inwards.	Repairs.
2534								
2535								
2536								

FIG. 9.

A. CITY OF BRADFORD CONSUMERS' METERS. ELECTRICITY WORKS.

Name.	Address.	Folios in undernamed Books.	
		Outwards.	Inwards.

FIG. 10.

201 CITY OF BRADFORD METERS REPAIRED. ELECTRICITY WORKS. 201

Name of Maker.	Type of Meter.	Corporation Number.	Maker's Number.	Size.		Date Returned		Cost to be borne by	Nature of Defect.
				Amps.	Volts.	To Maker.	To Corporation.		

FIG. 11.

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the day is always most important. Every station engineer will recognise in this connection the importance of maintaining in thorough working and efficient order the meters employed on the circuit. If, then, a system is adopted of periodically inspecting the meters, some appropriate form of book for this work becomes necessary. A similar book to the one employed by the meter readers may be used, the headings being so arranged as to provide columns for such particulars as: starting current in 8-c.p. lamps, insulation resistance, date inspected, general remarks, etc. The meter-reading books, as a rule, are sent on to the accounts department, from which the consumers' accounts are sent out.

This, then, completes the books of the department. Many of the details given above can be altered to suit individual cases, but, at any rate, the books we have enumerated may form a basis on which to build up a useful and efficient system of book-keeping.

(To be continued.)

THE CONTACT RESISTANCE OF CARBON AND COPPER BRUSHES.

Prof. E. Arnold contributes an article to the *Elektrotechnische Zeitschrift* in which he discusses the contact resistance of carbon and copper brushes and the heating of commutators. A short digest of the same may prove of interest. The writer tabulates the losses caused by the heating of a commutator under four headings:

1. Loss through contact resistance between commutator and positive or negative brushes.
2. Loss through sparking.
3. Loss through eddy currents induced in the commutator bars.
4. Loss through mechanical friction.

Continuing, he points out that in order to determine loss 1, it is first of all necessary to know the contact resistance. To ascertain this he carried out some experiments with a machine generating 100 amperes at 110 volts pressure when running at 855 revolutions per minute, the results of which are given in graphic representation with the article. It should be added that the machine had been in use some time previous to the experiments, its commutator having assumed a brown colour. In the first experiment carbon brushes were employed, care being taken to obtain good contact at the bearing surfaces, which latter measured $1{\cdot}5 \times 2 = 3$ square centimetres. The contact resistance proved dependent on the bearing pressure, the circumferential velocity of the commutator, the current density under the brushes, and the conditions of the brush and commutator surfaces. Further, the number of laminations, weight and spring of the brush-holders, vibration of the machine and want of truth of the commutator also influence the contact resistance. The experiments also disclosed the interesting fact that the contact resistance decreases rapidly with increasing density of current relative to the higher velocities. Prof. Arnold ascribes the probable cause of this phenomena to a more even contact promoted by particles of carbon, which at the higher temperatures corresponding to the increased velocities are more easily rubbed off, since, as is well known, a blackening of the commutator occurs with high current densities. Further experiments with a smooth polished commutator strengthened this view.

With a constant current density the resistance increased at first with the revolutions, but then decreased again. The maximum resistance corresponded to two and five amperes per square centimetre with the machine running at about 750 revolutions per minute. Subsequently the commutator was polished, but, both when slightly oiled and unoiled, greater resistance, with the same constant bearing pressure—*i.e.*, 190 grm. per square centimetre—was found than in the first experiment.

The experiments with copper brushes were carried out under similar conditions. Each brush possessed a contact surface of 2·75 square centimetres, while a constant bearing pressure of 125 grm. per square centimetre was maintained. Just as with the carbon brushes, the contact resistance decreased with increasing density of current, though in lesser degree. The maximum resistance corresponded to about 250 revolutions per minute, while the maximum with the lighter carbon brushes was only reached at about 750 revolutions per minute. Copper brushes possess a much longer period of vibration than carbon brushes, being consequently unable to follow the quick vibrations of the commutator at high speeds. The weight of the carbon brush-holders, with brushes complete, amounted to 195 grm., and that of the copper brush-holders, with brushes, 685 grm.

According to these experiments, the contact resistance of carbon brushes relative to the usual current densities of eight to five amperes per square centimetre, and a circumferential velocity of 6m. to 12m., may be taken at 0·15 to 0·25 ohms per square centimetre, and that of copper brushes under similar conditions at 0·005 to 0·015 per square centimetre.

Continuing, Prof. Arnold points out that loss of energy through sparking can only come into question if the commutating E.M.F. be too high or too low. If the current density remains constant this loss is nil.

Loss through eddy currents is brought about by the movement of the commutator through a stationary magnetic field excited by the current flowing to the brushes. The larger this current and the cross-section of the commutator bars, the greater will be the heating through eddy currents. Where possible, the current allowed per bar should not exceed 500 amperes.

In order to ascertain the loss arising through friction of the brushes, the bearing pressure of the same, the peripheral velocity of the commutator, and the friction coefficients must be known. A bearing pressure of 100 grm. may be regarded as light, and one exceeding 250 grm. as heavy. Carbon brushes require to bear somewhat more heavily than copper brushes. The friction coefficient between brush and commutator may, if both are in good condition, be taken at 0·3 for carbon brushes and at 0·2 for those of copper.

Let P denote the bearing pressure of all the brushes in kilogrammes, v the peripheral velocity of the commutator in metres per second, and Q the friction coefficient, then the loss in watts

$$= 9{\cdot}81 \,.\, P \,.\, v \,.\, Q.$$

Further, if W represent all the losses occurring in the commutator in watts, and A the cooling surface of the same in square centimetres, the temperature increase may be determined from the formula—

$$T = \frac{300 \,.\, W}{A\,(1 + 0\,1\,v)}.$$

In conclusion, the author gives a couple of examples, from which he deducts that the losses occurring at the commutator when combined with carbon brushes are not inconsiderable, which fact demands attention on the part of the designer, who should allow in his calculations for the heating of the commutator, especially when heavy currents are to be dealt with.

THE CONDUIT SYSTEM OF ELECTRIC TRACTION IN WASHINGTON.

The following brief description of the conduit system of electric traction established by the Capitol Traction Company in the city of Washington is abstracted from a very fully illustrated account in the *Electrical World* of New York. The big fire which destroyed the cable equipment of this company's lines in 1897, caused the directors to consider the question of whether they should use the cable system again or replace it by an electrical system. It was finally decided to instal an electric system, and to use as far as possible the old cable conduits. The cable conduit—18in. wide by 38in. deep—was fortunately made of concrete, plaster lined, and without any inside metal sheathing. Entrance to it was obtained by means of manholes at

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intervals of 31½ft., running from the slot rail to the outer track rail, as shown on the right-hand side of Fig. 2. The conductor rails for the new electrical work are of steel, T-shaped, 4in. by 2in., weighing 23lb. to the yard, and having the conductivity of 300,000 circular mils of copper. They

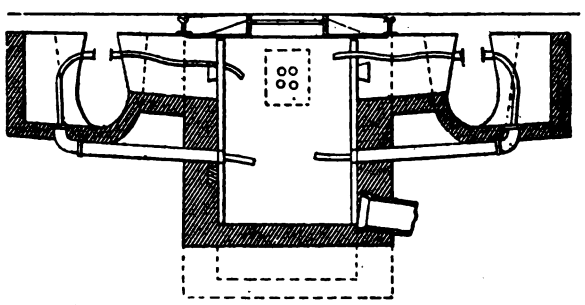

FIG. 1.—Draw-in Manhole, showing Taps to Conductor.

were cut into 31ft. 6in. sections to span the distance between these manholes, in which the insulating supports for the outer rail were placed. To hold the other conductor rail a small handhole was put in immediately across the slot from the manhole, as shown at the left-hand side of Fig. 2, and to give an intermediate support at the middle of the

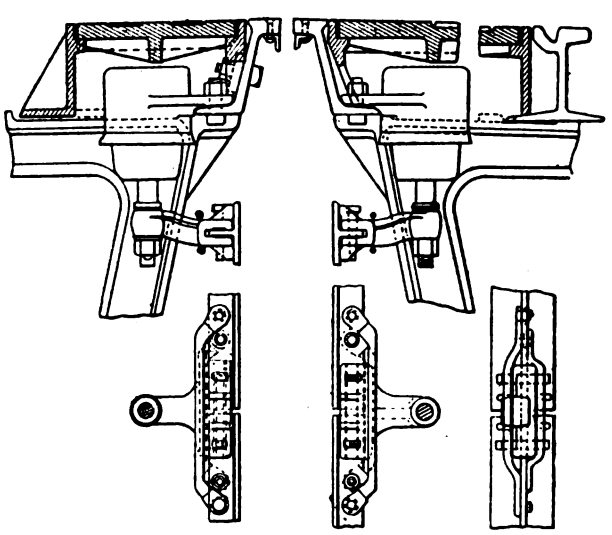

FIG. 2.—Insulating Support and Bond of Conductor Rail

rail length, a pair of similar handholes was put in midway between manholes. The conductor rails were inserted through slot hatches, which were placed at intervals of about 800ft.

The porcelain insulators are supported, as Fig. 2 shows, by cast-iron caps with ears, which are bolted to the foot

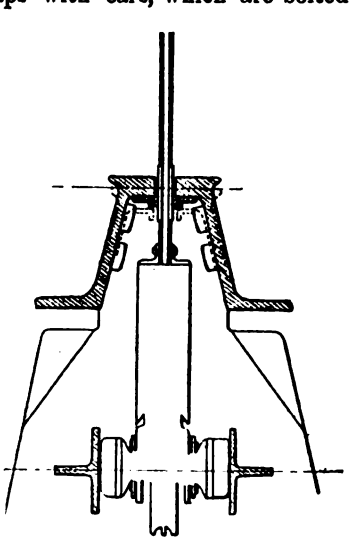

FIG. 3.—Slot Rails, Conductor Rails, and Plow.

flanges of the slot rails. The holes for these bolts were made by punching machines as soon as the excavations for the handholes had been made. The two holes in the web of the slot rail for the attachment of each cast-iron handhole frame were made by a specially-designed drill let into the excavation, and backed up against the track rail. Knock-down frames were then placed in the excavations, making an inside form for the concrete shells of the handholes, which are 5in. in thickness, internally plastered with cement mortar.

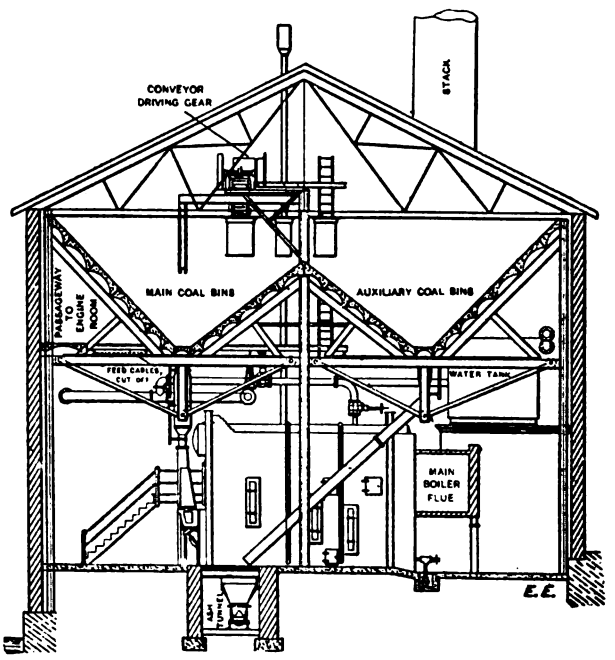

FIG. 4.—Vertical Section of Boiler-Room and Overhead Coal-Bunkers.

To prevent the water entering the slot from trickling down the sides and dripping over the conductor rails, which are 6in. apart, the upper flange of the slot rails in such a road must be fitted with a downwardly projecting lip, from which all water will drip off and fall between the conductor rails to the bottom of the conduit. There was, of course, no such lip on the old cable rails, and rather than replace them, bedded as they were in good asphalte paving, it was decided to rivet steel 1in. by 1in. angle sections to them in the manner clearly shown in Fig. 2. The old track was used again, and the joints were improved by being converted into cast welded joints, which has very much improved the running of the trams. It was found, however, after the electric system had been in operation for some time, that it was advisable to put down heavier rails, which was accordingly done. As a ground return is not

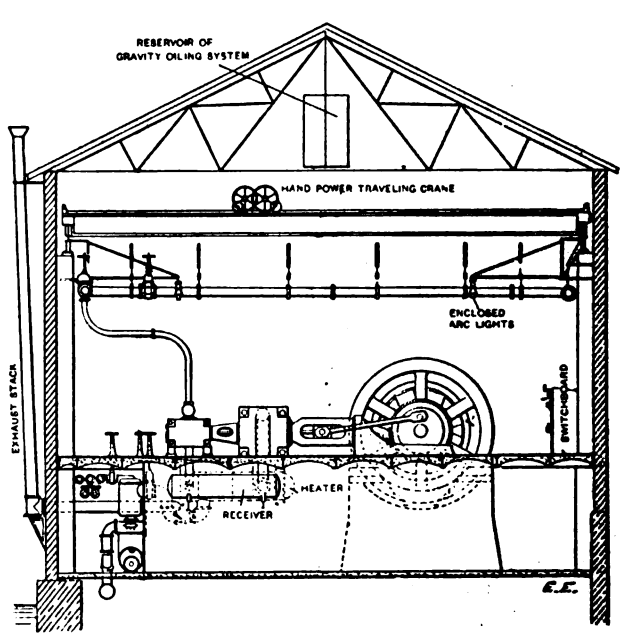

FIG. 5.—Vertical Section of Engine-Room and Condenser-Basement.

used, both the positive and negative feeders are insulated. There are thus 20 lead-covered cables for the 10 feeders, each with a cross-section of copper of 1,000,000 circular mils, insulated by saturated paper $\frac{3}{16}$in. in thickness, and protected by a $\frac{1}{8}$in. lead sheath. They are drawn in through

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manholes running across the two tracks, spaced at intervals of about 400ft., one of which is shown in Fig. 1.

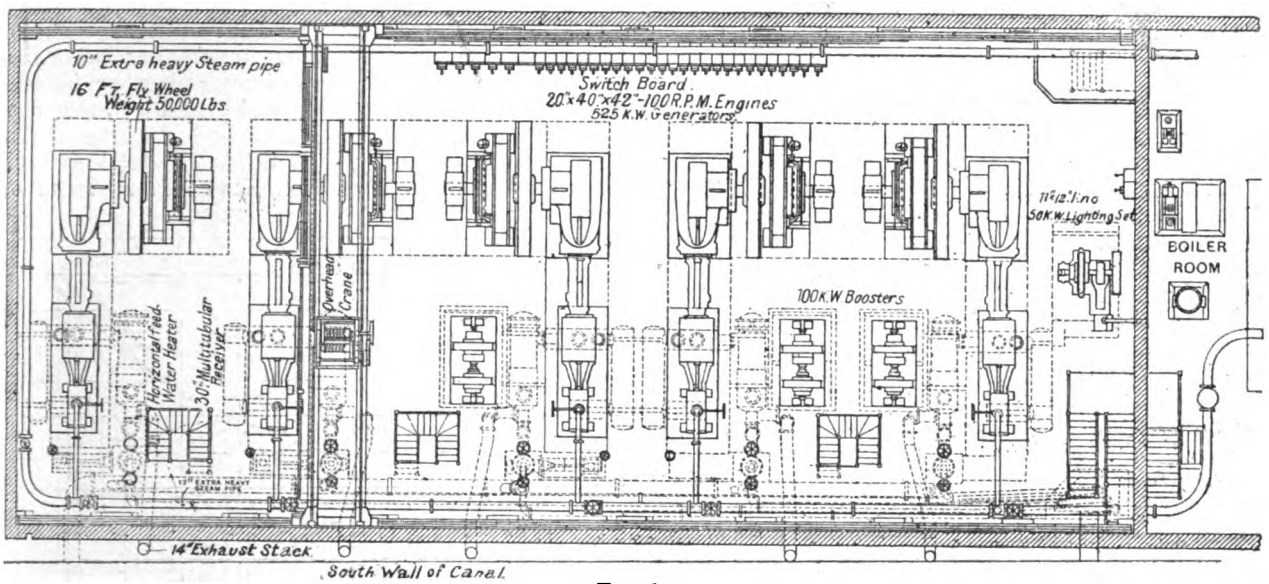

FIG. 6.

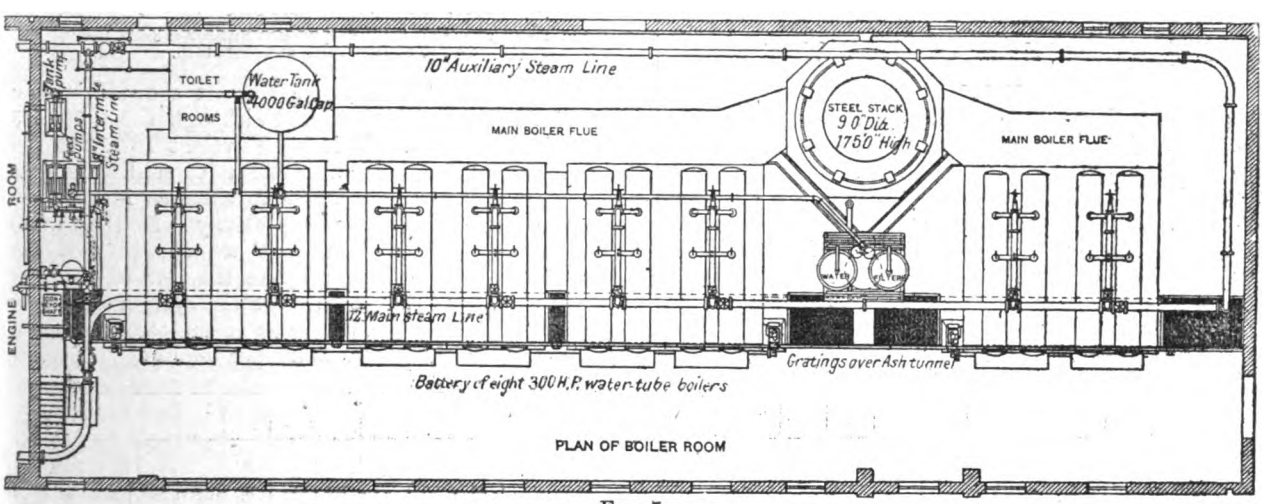
10" Auxiliary Steam Line
TOILET ROOMS
Water Tank 4000 Gal Cap
STEEL STACK 9'0" Dia. 175'0" High
MAIN BOILER FLUE
MAIN BOILER FLUE
12" Main steam Line
Gratings over Ash tunnel
Battery of eight 300 H.P. water-tube boilers
PLAN OF BOILER ROOM
ENGINE ROOM

FIG. 7.

The work on the power-house was very rapidly organised, as the running of the lines had to be proceeded with after the fire without any delay. In spite of this the plant

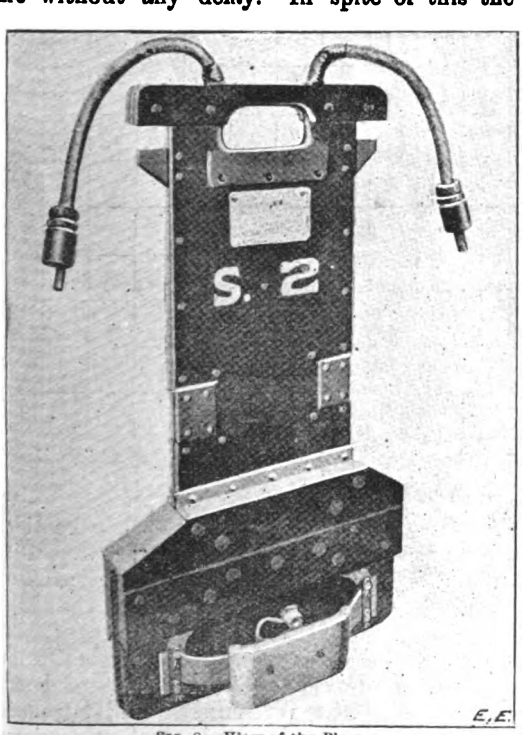

FIG. 8.—View of the Plow.

presents a very well designed arrangement, as will be seen from Figs. 4, 5, 6, and 7. One of the most interesting parts of the equipment is the arrangement of coal storage and supply. Bituminous coal is brought directly to the plant on canal boats, holding about 120 tons each. Standing apart from the main building, toward the west, is the coal-unloading tower of steel-frame construction, covered with corrugated-iron sheathing. This tower has a boom projecting over the canal, by which tubs holding 1,000lb. each take the coal up from the canal boats and dump it into a receiving hopper, which, in turn, dumps it into the weighing hopper, from which it passes down into a crushing equipment. The bucket hoist and crusher are both driven by one 30-h.p. 500-volt motor.

From the crusher the coal is dropped into the buckets of a pan and bucket conveyor. The conveyor consists essentially of two $\frac{5}{8}$in. steel cables, to which are clamped, at intervals of a foot, attachments carrying axles, the wheels of which are lubricated with graphite and run on 20lb. steel rails with a 2ft. gauge, each axle carrying a pan and pivoted to it a bucket. This is on the upper horizontal run, the cables in this case being on top of the conveyor, the interlapping pans below fitting closely into each other, the buckets hanging downwardly from them. On the under horizontal run, which is in the ash tunnel below the boilers, the cables are underneath the conveyor, the pans forming over them a continuous trough into which material may be discharged from the hoppers regardless of the position of the buckets, and which protect the cables from the material handled. As the conveyor turns up in the vertical run the material is slipped out of the pans into the buckets, which in this position fall against the pans, and when the conveyor turns over from the vertical into the upper horizontal run, the pans swing free with their loads. The driving mechanism consists of a 15-h.p. motor geared down through triple reduction gears to a heavy sprocket wheel, under which run the cables, the clamps on which fit into pockets in the wheel rim, the

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teeth adjacent to these pockets insuring an absolute drive. The conveyor dumps the coal into W-shaped bins over the boiler-room, clearly shown in Fig. 4. These bins are of simple construction, and built to have a very low depreciation and also to keep any corrosive material in the coal away from the ironwork.

As regards rolling-stock, about 60 motorcars are run, and both trucks and bodies are new. Short cars with bodies only 18ft. long are used, and run with trailers. The plough, an idea of which can be obtained from Fig. 8, consists of the usual steel plate enclosing copper straps and running down through the ¾in. slot with an enlarged wooden section carrying on outward-bearing springs the cast-iron shoes. The shoes are bevelled at the ends to prevent their catching on the joints in conductor bars and on parts of the switch gear. The plough-hanger in the truck is ingeniously arranged, so that in case of derailment or a misplaced switch the plough will fall off after travelling part way across to the side frames of the truck, and drop into the conduit sufficiently to clear the motors. This prevents, in case of such an accident, the plough from becoming wedged and twisted in the slot, which requires its cutting out by cold chisels and the shutting down of the line for some time.

THE SHOREDITCH ELECTRICITY WORKS.

The accounts of the first complete year's working, up to June 24, 1898, of the Shoreditch electrical department have now been passed by the Board of Trade. We have been favoured with a copy of these accounts, and reproduce below the revenue account and the statement of electricity generated and sold, etc. These show that for the rapid acquirement of a handsome balance Shoreditch is far ahead of any other municipal works, even if the steam obtained from the refuse destructor is charged as it should be for sake of comparison with other places. The curve of lamp connections given in Fig. 1 shows how rapidly consumers have been found in Shoreditch. At the end of the financial year now being considered there were some 29,000 8-c.p. lamps or their equivalent connected, but during the winter months that number was much smaller. This increase in connections since June augurs well for the second year's accounts. Fig. 2 shows an average winter's load curve, and from it the value of the large motor load can be seen. The square block between 8 a.m. and 1 p.m., and again from 2 p.m. to 4 p.m., is almost entirely due to the use of motors, which are supplied at very low rates. When it is remembered that no coal is used in the station until the output reaches 300 kw. or over, the value of a dust destructor will be duly appreciated. Thus the motor load with the present system of accounts is supplied with energy that does not cost the department anything for steam. We understand from Mr. Russell that the applications for motors for driving furniture and other factories still keep coming in, and that the day load will, therefore, be even more valuable during 1899.

Coming to the accounts, we find that the total expenditure reaches £90,082. In this the cost of the dust destructor does not appear. The revenue account shows that only £432. 15s. 9d. was spent on coal, although some 705,503 units were generated. This is equivalent to ·147d. per unit generated, or ·202d. per unit sold. This is an exceptionally low figure, due to the free steam from the refuse destructor, and probably if the whole energy was obtained from coal we should find the cost per unit sold to be more like the Oxford figure of ·63d. per unit, as in that town the same system of supply is used. This would give the value of the steam supplied by the destructor at about £920 per annum. The other costs at Shoreditch come out as follows when considered per unit sold: oil, waste, and stores, ·065d.; water, ·101d.; wages, ·518d.; and repairs, ·034d. This gives a total works' cost of only ·911d. per unit. Even with the addition of the charge for steam from the destructor, estimated as above, the total works' cost is only 1·32d., which is lower than that for any of the old-established works of London, with the exception of the Westminster and St. James's Companies. To get such low figures in the first year's work is quite phenomenal.

The net revenue account for the year shows that, after paying the interest and instalment for repayment of loans,

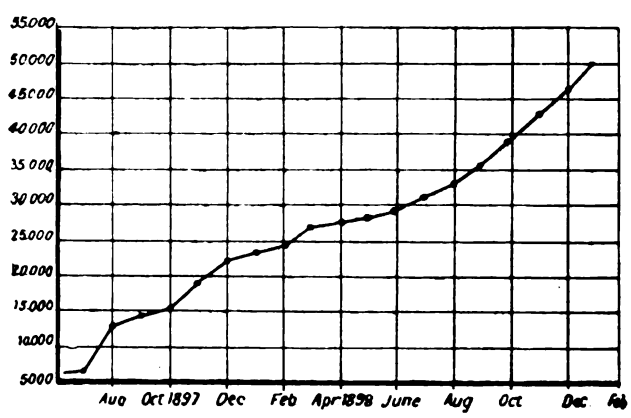

FIG. 1.—Diagram showing the Equivalent Number of 8-c.p. Lamps Connected to the Mains at Shoreditch.

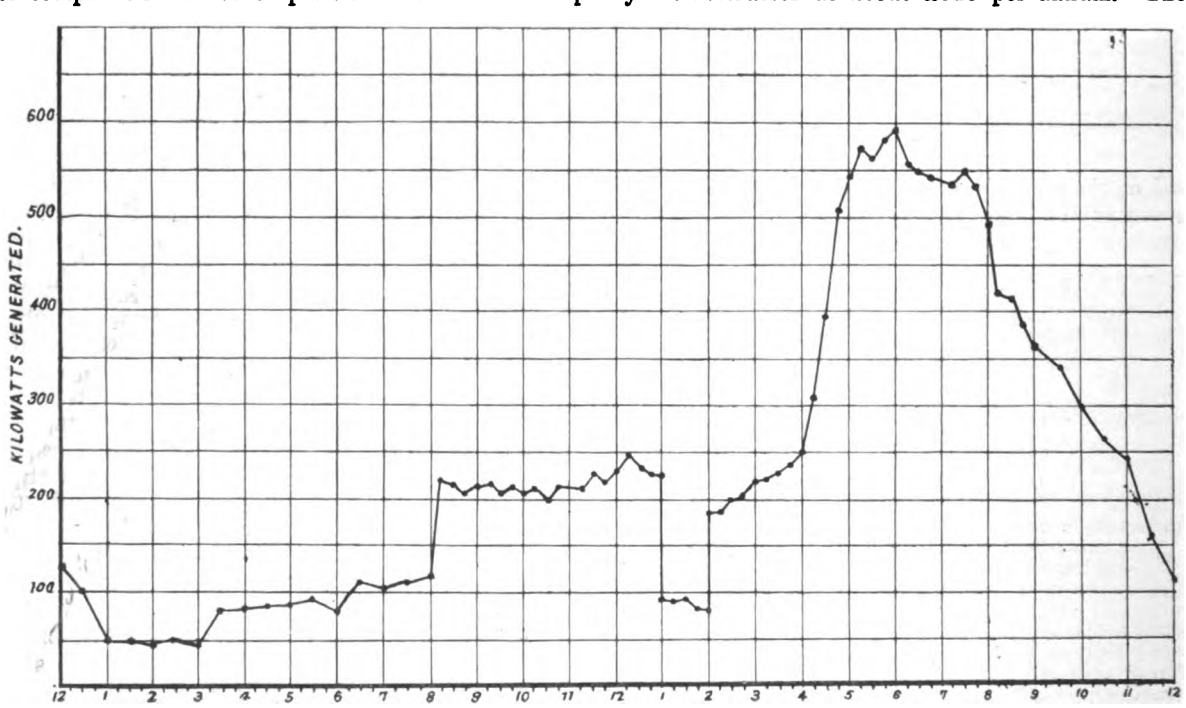

FIG. 2.—Load Curve of the Shoreditch Electricity Works for January 10, 1899.

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a balance of £3,184. 9s. 11d. remains to the credit of the department. Thus, even if the payment of the dust department for electricity is allowed, and a corresponding expenditure for steam obtained is included as estimated above, the balance still stands at over £2,260. The question of the inter-departmental accounts must be carefully gone into, and we trust that in the next balance-sheet it will be possible to obtain more exact information. Shoreditch electricity works have been spoken of as over-advertised, but in this case there has been ample fire behind the smoke, or, rather, behind the dust.

REVENUE ACCOUNT, YEAR ENDING JUNE 24, 1898.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£432	15	9			
Oil, waste, and engine-room stores	121	13	5			
Water	217	11	3			
Wages at generating stations	1,110	3	1			
Repairs and maintenance	65	4	2			
				1,947	7	8
Distribution of Electricity.						
Wages and other remuneration to linesmen, fitters, labourers	83	14	4			
Repairs, maintenance and renewals of mains of all classes, including materials and laying the same	16	18	6			
				100	12	10
Public Lamps.						
Attending and repairs	205	0	10			
Renewals of lamps	116	11	7	321	12	5
Rents, Rates, and Taxes.						
Rents, rates, and taxes				33	10	3
Management Expenses.						
Salaries—engineers' department	145	16	8			
Accountant and clerical staff	228	19	11			
Stationery, printing, and general establishment charges	210	14	7			
				585	11	2
Special Charges.						
Insurances, etc.				226	0	3
Total expenditure				3,214	14	7
Amount carried to net revenue account				5,826	6	1
				£9,041	0	8

Cr.	£	s.	d.
Sale of current per meter at per B.T.U.	6,078	7	11
Sale under contracts	15	0	0
Public lighting	2,160	14	2
	8,254	2	1
Sale of current to destructor	536	5	8
Miscellaneous receipts	250	12	11
	£9,041	0	8

Dr. NET REVENUE ACCOUNT.	£	s.	d.
Interest on mortgage and instalments of principal	2,641	16	2
Balance carried forward	3,184	9	11
	£5,826	6	1

Cr.	£	s.	d.
Balance brought from revenue account	5,826	6	1
	£5,826	6	1

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		705,503
Quantity sold { Public lamps	103,714	514,200
{ Private consumers by meter	410,486	
Quantity used on works, lifts, motors, trolleys, fans, field coils, etc.		153,052
Total quantity accounted for		667,252
Quantity not accounted for		38,251
Number of public lamps		67
Total maximum supply demanded (kilowatts)		408

POPLAR ELECTRIC LIGHTING.

We had not space in our last issue to refer to more than the main report prepared by Mr. Alfred Blackman on the electric lighting of the Poplar district. This report is supplemented by another two reports, in the first of which a careful comparison is made of the advantages and disadvantages of steam and gas plants for electric lighting. Under this head, Mr. Blackman has collected a good deal of useful information, and concludes that, while the cost for gas-driven plant is less than that for the complete set of steam-engines, boilers, and dynamos, the up-keep expenses are likely to be higher, and on the score of reliability the steam plant is a great advantage. He, of course, refers to the fact that the Belfast Corporation has not extended its system of using gas-engines for driving dynamos, and he also compares the works' cost when using liquid fuel and coal, and concludes that at the present price astatki coal will be a cheaper fuel for Poplar. In the matter of loans Mr. Blackman advocates the deferment of the annual repayment of capital until the central station has had a few years of actual working. This view we share with him. He also proposes in the second report extensions of the mains which will bring the total area of distributors up to at least 16 miles, and we are glad to note that this has been accepted by the Council, so that the works will start with a network which will extend the length and breadth of the Poplar district. The last report refers to the system of charges and to the estimated balance-sheet at the end of the first year's working. The proposed system now is to charge 5d. per unit on the first hour's consumption per day on the maximum demand, 4d. per unit for the second hour, and 3d. per unit for all hours after. This will give the inhabitants of Poplar very cheap light, and will, we are sure, hasten the time when the electric light undertaking in Mr. Blackman's charge will be a great success.

INSTITUTION OF ELECTRICAL ENGINEERS.

The Regulation of Wiring Rules.

BY C. H. WORDINGHAM, MEMBER.

The question of the conditions necessary to be attained in order to provide for safety from fire and reliability in the utilisation of electrical energy for various purposes has attracted a very large amount of attention from the earliest days of the industry, and numerous sets of rules and regulations have been promulgated from time to time. Many different authorities have taken upon themselves to issue these rules, and, inasmuch as there are various conflicting interests in an installation of electric light or power, and as each authority is determined to abide by its own particular rules, the difficulties of the wiring contractor are many and great. In consequence of this, and for other reasons, there is, at the present time, a very widely diffused feeling that there should be some definite standard set of rules by which everyone will agree to be bound.

In considering this matter it is important to recognise that there is an essential difference between the rules necessary to secure efficient and safe wiring and those, equally necessary, to secure a satisfactory utilisation of the public supply of electrical energy. The former will, practically speaking, be independent of the system of supply. The latter will vary greatly with the nature of the distribution adopted by the supply company, and also to some extent with the local conditions existing in the town in which the supply is given. It does not appear to the author that this fact has been sufficiently generally recognised. It would appear to him quite possible, and undoubtedly most desirable, to draw up a set of regulations for wiring and fittings which should be of universal application; but so far as the public supply authorities' regulations are concerned, it will be necessary either to draw up a single model set of regulations which can be modified for every particular case, or several standard sets of regulations to suit different systems of supply which might possibly meet with general acceptance. In all probability, however, the former would be the more likely to meet with success.

It is important to consider, when framing regulations, what power exists to enforce them. This point was fully discussed by the author in a paper read at the 1896 convention of the Municipal Electrical Association.* It was then shown that the power given in the Electric Lighting Acts is extremely unsatisfactory, and does not by any means give the undertakers a sufficiently strong hand to

* See *Proceedings* Municipal Electrical Association, p. 30: "The Control by Municipal Authorities of Consuming Devices, and the Wiring connecting them to Mains."

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deal effectively with wiring contractors, and the course adopted by Glasgow was advocated by the author for imitation by other towns. Since then the same powers have been sought and obtained by Manchester, and there should be no difficulty in similar powers being obtained in all cases where municipal authorities are the undertakers. The course referred to is to obtain a special Act to make the regulations in question. In the case of Glasgow this formed part of the Glasgow Buildings Regulations Act, 1892. In the case of Manchester it formed part of the omnibus Act known as the Manchester Corporation Act, 1897, Section 40. It might be somewhat difficult for existing companies to obtain similar powers, but the experiment would be well worth trying.

To consider first the question of wiring regulations properly so called. There are several excellent sets of rules in everyday use, but the author ventures to think that those issued by this Institution are the best that have yet been produced. They are the outcome of the most careful deliberation, and no one rule was drawn up until it had been most thoroughly discussed by men actually engaged in the work affected. Indeed, it may be said without any hesitation that these rules represent the unbiassed opinion of electrical engineers at the present time as to the best means of securing safety from fire and efficient utilisation of energy. It is greatly to be regretted, however, that no matter how good the rules may be, they, in the existing state of things, can only be suggestions, and when individuals have drawn up other regulations which they have found to work well in practice, and with the details of which they are thoroughly acquainted, they are extremely loth to adopt "suggestions." The only possible way in which uniformity can be attained is by first of all thoroughly thrashing out the whole question at one or more meetings, in which all the parties interested are adequately represented. When this has been done, it should be possible finally to decide upon a set of rules which will cover the whole of the points raised in the discussion, and then, if every person will abide loyally by the decision arrived at, the desired result will be attained; but it is futile to hope for this unless persons will sink their own individual preferences, and it may be their own *amour propre*.

It is not the author's object in this paper to enter into the question of particular regulations. He had the honour of forming one of the committee that drew up the Institution rules, and he might fairly say that these rules are, in his opinion, as good as can be drawn up at the present time; but a few words may not be out of place on the general question of enforcing rules when made and agreed upon. There is, in the author's opinion, great necessity at the present time for the proper supervision of fittings used in connection with electric lighting and motive power. By fittings it is intended to imply such apparatus as fuses, switches, ceiling roses, wall sockets, lampholders, etc., not ornamental electroliers, brackets, etc., which are after all only metallic casing for wiring. Quite recently the author has introduced into Manchester a system of testing and registration of such fittings. It has only been in operation for a few weeks, but the results are eminently satisfactory. It is found that all makers of repute welcome the action taken, that they are anxious to submit samples, and that they see the value of the certificates and the advantages that will accrue to them by the official recognition of their wares. At the same time, while the manufacturers are benefited, wiring contractors derive great convenience from being no longer in doubt as to what fittings will or will not pass inspection, and, further, consumers have the satisfaction of knowing that the apparatus fixed on their premises has been certified by an unbiassed authority.

It has long been the practice to test and stamp fittings intended to be used in connection with the supply of water, but, so far as the author is aware, no attempt has hitherto been made to apply this system to electrical fittings. The treatment necessary in the two cases differs materially, for whereas in an ordinary house but few taps are required in connection with the water supply, the same house would require a large number of electrical fittings, hence it is not possible to attempt actually to test and certify every individual fitting. The course adopted by the author, therefore, is to require manufacturers to submit in duplicate samples of the fittings they propose to supply in Manchester. One of the duplicate samples is then subjected to certain tests, and if it fail to pass, the two samples are returned to the manufacturer; if, on the contrary, it conformed to the regulations, the second sample is preserved and kept for reference, so that it may be seen by any contractor or consumer, and a certificate is issued stating that the article in question has been tested and found to conform to the regulations, and may be used. This certificate remains in force for one year, but may be renewed from year to year without further tests. It would be tedious to enter into all the regulations affecting this registration, but members desirous of further information will find a copy of the rules in the Institution library, and the author will be happy to forward a copy to any member desiring to have it.

The author was led to take the step in question very largely in consequence of the extreme difficulty, amounting almost to an impossibility, which exists in defining the conditions necessary in such articles as switches and fuses to ensure safety. This fact was very strongly impressed upon the members of the Institution committee when drawing up the wiring rules, and at the author's suggestion it was thought that instead of specifying a given length of break, height of cover, etc., it would be far preferable to specify certain conditions which a given fitting should fulfil. In Manchester the tests specified for a fuse are that, when duly fitted up, with its cover in position and connected to mains giving the pressure for which it is intended, it shall break the circuit when those mains are short-circuited through it with a fuse wire corresponding to its rated capacity placed between its contacts. In carrying out these tests the fuse is tested in three positions—namely: (1) with the base horizontal; (2) with the base in a vertical plane, the fuse wire being horizontal; (3) with the base in a vertical plane, the fuse wire being vertical. For switches, the conditions specified are that a switch when used in the ordinary manner shall be capable of breaking a current 50 per cent. in excess of that for which it is rated at a pressure 50 per cent. in excess of that at which it is intended to work. In addition to these tests there are other tests to insure that the parts are properly proportioned to prevent heating. It may seem that the tests set forth are unduly severe. As a matter of fact, the better class of fittings are found to conform to them with ease, and therefore on this score there can be no objection to the tests.

It may be said that so far the subject has been considered chiefly from the central-station point of view, and that reference has not been made to consulting engineers. Undoubtedly they are in a different position, but, on the other hand, they are in a much stronger position than undertakers not possessing special powers, because the contractor working under their supervision is working to a definite specification under which large powers are given to the engineer. In the author's opinion it would be a considerable boon to consulting engineers, and would tend greatly to uniformity in practice if some central authority—which, seeing that the Board of Trade is probably out of the question, should certainly be this Institution—were to undertake the testing of fittings in a somewhat similar manner to that adopted for local work by the author. It should not be a matter of extreme difficulty to establish a small testing station for the purpose, and it could readily be made self-supporting, for manufacturers would doubtless be prepared to pay a substantial fee for the testing and registration of their fittings if the certificates issued carried the weight of the Institution behind them, for they would greatly enhance the value of their wares. Were such a body as the Institution to undertake this work, consulting engineers would feel every confidence in specifying certified articles, and they would feel assured that their clients would obtain satisfactory apparatus.

The author is aware that fittings are not the only things demanding attention. There is the question of the best kind of insulation to employ for the conductors and the best kind of casing, but these matters are fully dealt with in the Institution rules, which are so drawn as to admit

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every existing system the efficiency of which has been demonstrated in practical work. We may therefore leave the subject of wiring regulations, and pass on to that of regulations made by undertakers for the efficient supply of energy to the installations of consumers connected to their mains. Systems of distribution may be divided broadly into two-wire and multiple-wire, each class being further subdivided into continuous current and alternating. The most widely employed system of distribution at the present time is the multiple-wire, and perhaps the more important subdivision of this is that in which continuous current is distributed, for there can be little doubt that the use of this will largely extend in the near future. Now, for multiple-wire distribution it is essential that the balancing of the circuits should be good, and for this reason it is most important that contractors should be required so to split up their circuits that they may be evenly divided between the various pairs of mains. For practical purposes it may be said that the three-wire system will be the most widely used, and therefore contractors should be required to divide their installations into two approximately equal circuits when a certain demand is exceeded. In Manchester this limit has been fixed at a low figure—namely, 12½ kw.—but the author ventures to think that the results attained by proper balancing entirely justify the slight inconvenience which may be said to be experienced in consequence by the contractor. As a matter of fact, this inconvenience with modern good wiring is not great, for it has become the practice to effect the subdivision in any case, and to limit greatly the number of lamps on a single circuit. Therefore in practice the only hardship is the provision of two small main switches and fuses instead of one large one. Again, in order to secure efficient balancing it is important that as far as possible all motors should be supplied from the two outer conductors. For this reason the author has required in Manchester that all motors exceeding 2½ kw. shall be wound for 400 volts. In practice there is no great hardship in this, and the result to the central-station engineer is that he is practically supplying all his motive power on the two-wire system at 400 volts. Consequently, so far as motors are concerned, he has no trouble as to balancing. In every system of distribution, whether two-wire or multiple-wire, it is important to guard against sudden rushes of current, and, therefore, it is important to draw up rules with regard to the gradual starting of motors. This involves special switch gear and interlocking arrangements between switches, but the difficulties are such as can be readily overcome. In the case of large photographic or stage arc lamps it is necessary to take similar precautions, and, of course, in the case also of charging batteries or working electric furnaces.

Another important point which will require different treatment according to the system of supply is in connection with the earthing of one of the conductors. In the case of a continuous-current supply on the multiple-wire system of distribution, it does not appear to the author desirable to allow any portion of the consumer's wiring to be directly connected to earth whether the middle conductor of the system be insulated or not. There is much to be said in favour of the middle conductor being earthed at the central station and something against it, but the reason against earthing one conductor of the consumer's installation are extremely cogent, the most important being that although on the whole the balancing on the network may be extremely good, there must of necessity in some streets be a considerable local want of balancing, causing heavy currents to flow through the middle wire. If then there be two consumers separated by a few hundred yards, both having one conductor earthed, and if there be a heavy current flowing down the middle wire and causing a fall of potential of several volts along that wire, there will then be currents set up in the earth from the earth conductor of one consumer to that of the other, and the result may be serious electrolytic troubles—worse, in fact, than might arise from an improperly bonded tramway return. This reason alone appears sufficient to the author to preclude a system of wiring which requires the earthing of one conductor in a consumer's installation. The same objection does not apply with equal force if the distribution be effected by means of alternating currents, though in this case trouble may be anticipated if an earth return be used on the local telephone service. The author desires it to be understood that it is on these grounds alone that he deprecates an earth return system of wiring; for isolated installations there is much to recommend it, and also in cases in which the system of supply is a high-pressure one and each consumer is supplied from his own alternating-current transformer.

From what has been said it will be seen that the regulations comprised in this second group are of a totally different nature from wiring regulations proper, and the contention that they cannot be made absolutely uniform will probably be thought justified. The matter is one that affects chiefly central-station engineers, though, of course, the views of contractors, and particularly of manufacturers, should be given due weight to. It would be most useful if some general consensus of opinion as to the best rules for given systems of distribution could be obtained. The matter has received the attention of the Municipal Electrical Association for some time past, and a committee of their council is at the present time drawing up a model set of rules for the use of municipal stations. It is greatly to be desired, however, that a general set of rules acceptable also to the engineers to companies should be decided upon.

At last night's meeting of the Institution of Electrical Engineers the following were the candidates balloted for.

Members.—O. W. Brain, 51, Philip-street, Sydney; W. G. T. Goodman, Tramway Construction Branch, Public Works, Sydney.

Associate Members.—M. Feetham, 22, South-street, Thurloe-square, S.W.; D. A. Hamilton, 162, Osborne-road, Forest Gate.

Associates.—J. D. Allan, 5, Swallowfield-road, Charlton, S.E.; F. J. Edgar, R.I.E. College, Cooper's Hill, Staines; J. A. Foster, 18, Daleham-gardens, Hampstead, N.W.; H. B. Harvey, 38, Grainger-street West, Newcastle-on-Tyne; T. E. Herbert, Engineering Department, Postal Telegraphs, Manchester; R. E. Holdom, 16, Lichfield-road, Cricklewood; E. A. Johnstone, 11 and 12 Brookman's-buildings, Adelaide; W. D. Kilroy, East-meon, Ryde, Isle of Wight; R. V. Macrory, borough electrical engineer, Londonderry; T. R. Renfree, King's College, Strand, W.C.; E. J. Saner, 6, Butler-street, Stoke-on-Trent; H. J. Tomlinson, 20, St. Mary's-road, Peckham, S.E.; A. C. Unbehaun, 11 and 12, Brookman's-buildings, Adelaide.

Students.—G. L. Drury, 112, Rathgar-road, Dublin; H. A. Nott, Electrical Works, Cheltenham; C. E. Wells, Merrion, Ashby-road, Loughborough; H. T. Wilkinson, Reepham, Lincoln.

FORTHCOMING EVENTS.

FRIDAY, JAN. 27.

Institution of Civil Engineers.—At 8 p.m., students' meeting. "King's Lynn Waterworks," by F. C. Grimley, Stud.I.C.E.

Institution of Junior Engineers.—At 8 p.m., at Westminster Palace Hotel. Lecture on "Measurements of Elasticity," by Prof. J. A. Ewing, F.R.S., Hon. M.I.J.E.

Electro-Harmonic Society.—At 8 p.m., smoking concert at St. James's Hall Restaurant, W.

Electrical Engineers (R.E) Volunteers.—At 8 p.m., smoking concert at Holborn Restaurant, W.C.

Telephone Athletic Association.—At 7.30 p.m., Bohemian concert at Westminster Town Hall, S.W.

SATURDAY, JAN. 28.

Institution of Electrical Engineers.—Students' visit to the works of the Electric Welding Company, Hindon-street, Pimlico, S.W.

Institution of Junior Engineers.—Anniversary Dinner at the Westminster Palace Hotel, 7 p.m.

TUESDAY, JAN. 31.

Institution of Civil Engineers.—At 8 p.m., adjourned discussion on papers on "The Effects of Wear upon Steel Rails," by William G. Kirkaldy, A.M.I.C.E., and "On the Micro-photography of Steel Rails," by Sir William C. Roberts-Austen, K.C.B., F.R.S., A.I.C.E. And time permitting, J. A. Jones, M.I.C.E., will read a paper on "The Waterworks of the Madras Presidency."

WEDNESDAY, FEB. 1.

Society of Arts.—At 8 p.m., paper on "The Cost of Municipal Enterprise," by Dixon H. Davies.

Institution of Electrical Engineers.—At 8 p.m., students' meeting. "Safety Fuses," by Sydney Ransome.

THURSDAY, FEB. 2.

Institution of Civil Engineers.—At 2.30 p.m., students' visit to the Millbank station of the London Hydraulic Power Supply Company.

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THE
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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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THE TELEPHONE SERVICE.

The above is the title given to three articles which have appeared in the *Times* during the past few days. We offer no apology for returning to this subject, although it has been quite recently referred to in these columns. The *Times* articles are supplemented by a letter from General Webber. If we understand General Webber aright, he has somewhat changed his opinion, and in our view the change is in the right direction. It may be useful to indicate briefly the trend of the conclusions in the above contributions to the telephone controversy. The value of the *Times* articles is in giving a brief historical sketch of the rise and progress of telephony from 1877 to the present time. Unless our recollection is wrong, the first prominent discussion of the discovery of the telephone was by Lord Kelvin (then Sir W. Thomson) at the Glasgow meeting of the British Association, at which time and place an early form of telephone was shown. This form was not practical, or, rather, was not practical from the commercial point of view. The *Times* correctly states that Messrs. Preece and Fisher brought over the first pair of practical telephones in 1877, and that the discoveries of Hughes in 1878 made commercial telephony practicable. It has always been a mystery to us why the negotiations with the rival concerns, before the amalgamation of the Bell and Edison interests alluded to in the *Times*, came to naught. Telephony became of commercial interest and the Government took fright, entered into litigation, and obtained judicial authority to the effect that telephony was really telegraphy. Again came a further example of "Government ineptitude and blundering," the result of which was to make telephonic service in this country dear, if not inefficient. An agreement was made to confer licenses, the licensees to pay 10 per cent. on the gross income as a royalty. The Government got its royalty and business men had to pay it, for 'tis certain that the rent to the telephone companies was fixed so as to give them good profits before this tax was added to their charges. Certainly the Post Office, in a kind of indolent way, tried to establish an exchange or two. These exchanges might have been made exceedingly successful if they had been allowed to work in an ordinary business way. The policy pursued by the Government has been altered from time to time, with the corresponding result that with each relaxation of rules telephonic expansion has occurred. In 1892 the question of nationalisation was raised in Parliament, with the result that the Government eventually took over the trunk lines. But throughout the system has been both dear and inefficient. Business men, seeing what was done elsewhere, commenced an agitation for municipalisation, in which Glasgow took a very prominent part. This agitation led once more to the appointment of a committee, which, as our readers know, reported in favour of "effective competition." The *Times* thus summarises the mistakes of the Post Office:

"(1) It refused to acquire the patents when they first came out; (2) it adopted a policy of impeding and

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harassing the companies in developing the enterprise; (3) it favoured the idea of unlimited competition, which failed; (4) it acquired a portion only of the companies' undertakings—namely, the trunk lines—instead of the whole of such undertakings; (5) it has always refused to let the companies have adequate powers for running wires, although two committees of Parliament have recommended that such powers be conferred; and (6) it is now contemplating a reversion to the old policy of obstruction, coupled with an unfair competition."

General Webber's contention is that 95 per cent. of the telephone business is local, and that the work is not national. The weight of opinion is against him, and seeing the probable rejection of his previous suggestion, he formulates the following scheme:

"It is (*a*) to give due notice to the National Telephone Company that the nation will, under the terms of the license, buy their undertaking in 1904; (*b*) at the same time to carry a Bill through Parliament appropriating twelve millions during the next, say, six years; and (*c*) to appoint a commission, directly under the Treasury, charged with the distribution of the funds, the general control of the expenditure, and the guidance of the Department charged with the business in the paths of the policy laid down by Parliament. In such a Bill as this the public should be safeguarded by a mandate (1) that the MINIMUM average local exchange subscription must not exceed five pounds per annum; (2) that subscriptions may be classified regionally within the same areas, and also by 'time' or 'talk.'"

We do not know how far Mr. A. R. Bennett agrees with these views of General Webber, but if he is in accord with them it would seem that there is but little opposition to nationalisation. It has always seemed to us that the local area to be served by one or a series of local exchanges was not and could not be coincident with the municipal area, so that municipalisation meant either one central body having control or a combination of interests, and combination pointed to nationalisation against municipalisation. Our point, however, always has been that if telephony is telegraphy under another name, and that telegraphy is a Government monopoly, then Government alone was the proper controller of telephonic work.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTRICITY AS AN EXACT SCIENCE.

SIR,—I have read Mr. J. J. Fahie's letter under the above heading—p. 82 of your last issue—and fear that I must plead ignorance as to your esteemed correspondent's object in writing.

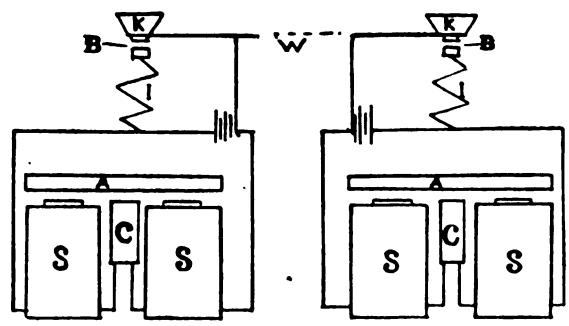
It surely cannot be that he would have us think him omniscient, and it would be equally absurd to suppose that he wishes us to look upon him as a competent critic of anything which he has not read.

Further, it is not conceivable that he fears I shall bulk too largely in a field whereof he is undoubtedly the central ornament. Alas, no, I must abandon even that flattering thought, and continue, unless Mr. Fahie will, of his courtesy, come to my assistance, vainly seeking for light.—I beg to remain, Sir, the author of that "work of supererogation," of which but one-sixth part has yet been published,

HOWARD LITTLE.

SIMPLE SIGNALLING THROUGH A SINGLE WIRE.

SIR,—The method of signalling detailed below has as its basis the utilisation of the Hertzian waves which are produced on the breaking of any circuit in which current is flowing, in this case preferably one in which some amount of self-induction is present. Referring to the diagram, on



either of the Morse keys, K, being worked in the usual way for the transmission of messages, minute, but not necessarily visible, sparks are produced at B on breaking of circuit, and the Hertzian waves from this point, being transmitted along the single wire, W, actuate the coherer, C, at the far end, thus completing the circuit of a sounder, S. The sounder armature, A, is arranged to beat on the coherer, which may be of the metal filings type, and in this way break its own circuit, and so become again sensitive to further signals. For further efficiency in the working of the above method, a self-induction, I, is included in the key circuit for the purpose of intensifying the production of waves at B. The contacts at B are preferably of copper. The superiority of this metal for the purpose required above—viz, that of wave production—becomes soon evident in the course of experiment.—Yours, etc.,

J. A. COLQUHOUN.

[We cannot understand the working of Mr. Colquhoun's system, and think he should give some records of actual tests. In the first place, it does not seem at all probable that Hertzian waves would be formed, and that one circuit would necessarily affect the other if there were such waves present. The sounder armature, automatically breaking up the coherer, is a very useful idea, but the arrangement of the two closed circuits with a single wire between them seems to require explanation.—ED. *E. E.*]

ELECTRIC LIGHTING OF A LARGE RAILWAY STATION.

Passers by that portion of the Pancras-road which lies on the west side of the Midland Railway Company's main line immediately entering St. Pancras Station, will have noticed recently a somewhat low building, with offices facing the street, the interior of which is illuminated by a mass of electric light. This building covers an area of some 20,000 square yards, which not long since was covered with houses and streets of a very unenviable character. At an enormous cost all these dens have been swept away, great improvements in streets and footways effected, and some of the finest blocks of buildings suitable for artisans erected in the place of those demolished, all at the cost of the Midland Railway Company, and all for the purpose of establishing in its place probably one of the finest coal depôts in the world. At present the lower level is in operation, but very shortly the upper portion will also be in full swing. This lower portion, as may be imagined, obtains very little light from above, consequently the entire space has to be artificially lighted.

For this purpose some 104 10-ampere arc lamps have been installed, and it is by their aid that the work of this large coal depôt is now being carried on from 6 a.m. to 6 p.m. Hydraulic lifts—two of which are in operation—

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lower the loaded trucks down from the upper to the lower level, and in like manner raise the empty ones. This goes on chiefly during the night. During the daytime the lower level may be said to be practically entirely in the hands of the coal merchants and hauliers.

Extending along the west side of both levels is a traverse road, the purpose of which is to transfer the trucks from one road to another. These traverse roads are to be worked by the aid of electricity, and this would have been in operation now had the traversers themselves been forthcoming. They, however, like many other engineering works, have been thrown back by the lamentable engineers' strike, and are still in the makers' hands. Immediately adjoining this building, pumps, which are also to be electrically driven, are being erected. From these pumps water for the service of the hotel, station, locomotives, etc., will be distributed throughout the 24 hours as may be needed. Provision is being made for raising some 45,000 gallons 150ft. per hour.

The establishment of these buildings and their requirements has led to the erection of what will probably develop into the largest—if it is not so already—electricity-generating stations for railway purposes in this country. Of all British railways none have shown a higher appreciation of the advantages of electricity than the Midland, and this has been especially so in respect of lighting. The Midland has realised—that which many seem slow to discern—that a good light means greater dispatch, and that greater dispatch means more trains disposed of in a given time, and consequently economy in space, buildings, and possibly men. This new generating station is situated at Kentish Town, and the plant installed there is intended to supersede the isolated plants now in the hotel and at the Somers Town goods depôt, where the electricity for driving the lights on the St. Pancras passenger and goods stations and those of the Somers Town goods depôt is generated.

At present this plant consists of four Lancashire boilers, each of 300 h.p. capacity, duplicate pumps, economiser, and exhaust feed heater. In the engine-room are three coupled steam dynamos, the engines being of the Willans type, while the generators are by Messrs. Thomas Parker. Each dynamo is 200 kw. capacity. Two exciters with a set of accumulator cells and the usual switchboard equipments complete the present provision. Space is provided for expansion, while the offices comprise workshop, mess-room, storeroom, and residential engineer's office. The electrical system is that of direct current owing to the fact that power and lighting have both to be dealt with. Electricity is generated at from 2,000 to 2,300 volts, and conducted by concentric cables, encased in lead and protected by steel ribbon armouring, to the several transformer rooms. These are situate at Kentish Town Station (now in hand), St. Pancras goods station, and St. Pancras passenger station. The cables are in duplicate, and are mainly laid underground with railway sleepers placed over them for their protection from the platelayers' picks. The transformers are of a rotary type, and vary from an output of 50 kw. to an output of 100 kw. At the first-named point there will be two of the smaller size, at the goods depôt four of the same size, and at the passenger station four of the larger size. Here the current, owing to its varied use, requires regulation, and for this purpose controllers or "boosters" are laid down.

In addition to the previously mentioned work for which this installation has been laid down, it is also intended to operate a large fan for the better ventilation of the Midland portion of "underground" connection of the railway, traversers and cranes for the new locomotion shed, and works which are now about to be built. Although, when designed, the generating plant made provision for a spare unit, the many applications for lighting and power already put forward will practically absorb the entire provision, and additions are already in contemplation, and seeing that the purpose of this concentration is to serve the needs of the line from the neighbourhood of the Welsh Harp, Hendon, to St. Pancras, there can be little doubt that in a very short time the capacity of the station will be doubled, if not trebled.

The various electricity stations referred to have just been opened, and by the kindness of the electrical engineer our correspondent has been able to pay a personal visit to all of them, and he speaks very highly of the admirable way in which the work has been, and is being, carried out. At the present time no less than 400 arc lamps and nearly 2,000 incandescent lights are in operation, and the number is being increased daily.

SOME GENERAL OBSERVATIONS ON ELECTRIC TRACTION.*

BY HORACE F. PARSHALL, M.I.C.E., M.I.E.E.

A general paper on electric traction must be to some extent discursive, and from the standpoint of those looking for specific facts superficial. It is a natural thing for engineers to reason from experience with electric lighting plant as to how best to design plants suitable for electric traction purposes. Such reasoning, however, is likely to be defective and lead to wrong results. A primary difference between electric lighting and electric traction, so far as the station is concerned, relates to the difference in the nature of the load—one being approximately constant from moment to moment, and the other varying between wide limits, and at such a rate that many engineers liken the strains upon traction apparatus to those upon rolling-mill engines. Another difference of great importance is that in a plant of given nominal horse-power from three to five times the quantity of electricity would be generated for traction as for lighting purposes; consequently a greater capital investment, greater refinement in the machinery, and greater margins in the individual machines, or in the number of spare machines, are commercially permissible in the case of electric traction. In general, lighting machinery is called upon to work at full load for a few hours in the day, whereas traction machinery is generally called upon to work at approximately full load for many hours in the day.

The steam generating plant for either lighting or traction of the same capacity need not differ in character to be equally efficient. Having reference, however, to the better load factor of the traction plant, and consequently a greater consumption of coal and a lesser ratio of cost of labour to that of material, better arrangements as to coal-handling machinery and coal storage are justified. More elaborate arrangements of steam-piping are also justified, since the loss, due to condensation in steam-pipes, is determined by the number of hours the pipes are under pressure, rather than by the quantity of steam carried by them. Steam-engines have been the subject of frequent discussions. It has been a much-debated point as to whether or not an engine should have a heavy flywheel. This question resolves itself into the most economical way, average loads considered, of getting the maximum effort from the steam-engine to take care of the temporary overloading incident to traction work. The dimensions of the cylinders of engines for good economy are determined with reference to average loads. For best economy, then, at good regulation heavy flywheels are necessary to assist in overloads in traction work The question of governing has also been frequently discussed. I do not understand why this question should be discussed, since nobody is of the opinion that an engine that governs closely is at a disadvantage. Such engines do not cost appreciably more, and are now generally manufactured. In reading such discussions I have frequently wondered why the electrical conditions met with in parallel running have not been taken into consideration. The necessity of close regulation of steam-engines was first demonstrated in the case of generators running in parallel where the load did not properly divide with rapidly-varying loads unless the engines governed with fair accuracy.

Another matter frequently discussed is that in respect to the speed of engines. Here, also, the electrician is entitled to some voice, since experience has clearly demonstrated that each size of dynamo has a range of speed through which its performance either as to efficiency, regulation, or sparking is best, and dynamos built outside of this range of speed are made at the expense of efficiency,

* Paper read before the Northern Society of Electrical Engineers, Jan. 24.

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regulation, or commutation. The speed of the 1,500-kw. dynamos which I designed some years ago was limited to 75 revolutions per minute. Experience since then has not demonstrated the advisability of increasing the speed beyond this, for this size of machine. My own experience justifies the statement that the mechanical and electrical conditions in the case of the larger direct-connected generators, generally coincide in the matter of speed.

The system of transmitting mains for distribution on account of the better load factor in traction installations should be designed, for most economical working, with a greater cross-section than in the case of lighting with its smaller load factor. This is obvious from Lord Kelvin's law, in which the interest that goes on perpetually is balanced against the cost of the energy wasted in the mains. Clearly, then, as the cost of energy does not vary in the simple ratio of load factor if mains are to be utilised three or four times as many hours in the year at rated capacity in one case as in another, a large cross-section cable is required if the cost of the wasted energy is to balance the interest account.

Apart from the proper designing of a given system of transmission and distribution, there remains the broad question as to what will be the nature of the transmission—that is, whether continuous currents shall be used, or whether the distribution shall be multiphase with sub-stations. The solution is to be determined in respect to the amount of power and the distance to which it is to be transmitted, and in particular cases to the conditions of distribution. Thus, where a very small voltage drop is permissible in the consumer's circuits, as in the case of earth returns, multiphase transmission with frequent sub-stations becomes a necessity, where, under less restricted conditions, continuous-current transmission would be more economical. For comparison between continuous-current high-tension transmission and multiphase transmission, see *Proceedings* Institution Civil Engineers, vol. cxxxiii., paper No. 3,090. It appears from this that the distance at which multiphase currents become efficient as compared with continuous currents, is somewhat less at 500 volts than has been frequently anticipated. The fixed losses in a multiphase system for the distribution of power for traction work are determined largely by the maximum momentary load which may come upon the sub-stations. When the ratio of the average to the maximum temporary load is comparatively large, the distance at which continuous currents become more efficient than multiphase currents is increased. In very large traction installations in which the ratio of the average to the maximum approaches unity for average working, the distance beyond which high-tension currents are more advantageous is lessened. What method of transmission will be most efficient in a particular case cannot be determined without knowledge as to the nature of the load. In the Dublin installation, which I have recently designed for 250 cars, the power station is approximately in the centre of the system. The average distance of transmission is about 2½ miles. I have used 500 volts continuous current with so-called "boosting machines," taking the current out of the rails at certain points so as to restrict the maximum drop in the earth to two or three volts. For two lines extending some eight miles from the power station, I have, at a distance of about six miles, planned to instal a rotary converter station. The multiphase load, however, being such a small fraction of the whole, I have not installed multiphase generating machines in the station, but have used a special design of rotary converter run from the main machines. Such rotaries have to be very specially designed, since, in the case of the current becoming displaced in phase, they are apt to race dangerously. This is a particular case designed after determining the average current consumption in any part of the system, when the ratio between the average and the maximum is approximately known from experience, so as to impose the minimum fixed losses, or, in other words, to insure under average conditions maximum efficiency. Were the number of cars doubled, I would locate sub-stations approximately at the feeding-in points, and would use multiphase transmission.

An advantage in the use of rotary converter stations is that at constant speeds such machines will give constant voltage regardless of the load or the drop in the lines (provided this be limited to an economical amount), or the regulation in the transformers, so that such machines can be made to supply simultaneously and satisfactorily both traction and lighting installations. To justify this statement I instance tests recently made on some 900-kw. rotary converters, from which full load could be thrown on or off from one to the other machine without any perceptible variation of the continuous-current voltage. In the designing of a multiphase system selection has to be made between quarter and three phase. The three-phase system has the important advantage that but three-quarters of the weight of copper is required as with either single or quarter phase transmission. Considered, therefore, with the energy factors common in multiphase working, the three-phase system gives better transmission efficiency with the same section of copper in the average case as continuous current. Another advantage is gained when the transformers are delta connected. Any one of the three can fail, and the other two will deliver tri-phase currents to the rotaries. There is practically no difference as to efficiency or working between tri-phase and quarter-phase rotary converters. In installations making general use of rotary converters feeding into a network at constant voltage, it is necessary to observe some care in selecting the high-tension mains, and in securing engines with approximately constant angular velocity. An engine, to be entirely satisfactory, should not produce by variable velocity a phase displacement of more than 5deg. per half cycle from that of constant velocity. The transmitting mains should be designed with comparatively small drop, so that the rotary converters work properly in parallel in different stations, and so that the rotary converters can generate constant voltage with a varying load without too great phase displacement. If proper precautions are not taken in these matters, rotary converters will not operate satisfactorily in parallel, and are likely to give a great amount of trouble from sparking and irregular variation of voltage. For working with "rotaries," I would also point out the necessity of arranging the mains so that the current in each phase is delivered approximately at the same voltage. I have recently been conducting some tests on "rotaries" working on triple-concentric mains, and the results were far from satisfactory until a phase-equalising arrangement was used. At first the current in the different phases varied by about 10 per cent., and the rotaries worked unsatisfactorily. When, however, the E.M.F.'s were equalised the rotaries worked with entire satisfaction. The conclusion to be drawn from this for three-phase working is that the cables should have the inductance, equal capacity, and equal resistance in each circuit. In installations which I have designed I have used cables drawn in conduits, and with manholes approximately 150 yards apart, so that the cables can be readily replaced or supplemented to meet the demands of the service. Armoured cables laid in a common trench are objectionable, in that the burning out of one is quite likely to destroy its neighbour.

By far the most difficult problem to solve at the present moment in large multiphase stations is in connection with the switching apparatus. Circuit breakers have been devised for continuous currents that will open at any current to be met with in practice. In the case of alternating currents the same progress has not been made. I recently examined the plans of a 70,000-h.p. station, and could not but feel that the success of the whole installation was dependent upon the switching arrangements. In this discussion I have assumed that the distribution in a traction system would be by continuous currents. I have seen nothing that would lead me to believe that any other course will come into general use.

The next point for consideration is as to what form of apparatus should be used for conducting the electricity from the distributing mains to the car: whether it should be the single-wire overhead trolley system with earth return, the two-wire system with return overhead, or with this last connected up as a three-wire system with the middle pair of trolley wires acting as a neutral, or whether a conduit system should be used. The valid objection to the single overhead trolley system, neglecting the æsthetic one, is

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in the use of the earth as a return circuit. Troubles from electrolysis have been frequent in the United States, where the E.M.F. drop in the earth return is not limited by legislation. Owing to the stringent regulations of the Board of Trade, little trouble has yet been experienced in England or on the Continent, where similar regulations are in force. I pointed out in a paper which I read before the Institution of Electrical Engineers that with even very small E.M.F.'s a certain percentage of the current in all cases leaves the rails. With amounts of copper commercially permissible, either sub-stations at frequent intervals or boosting machines, such as have already been described by Major Cardew and myself at the Institution of Electrical Engineers, are necessary to bring the E.M.F. drop down to two or three volts, which in most cases of municipal working is the safe limit. If the E.M.F. exceeds this limit, trouble from electrolysis would probably occur at some date more or less remote, according to the local conditions as to the location of the earth return in respect to the gas and water pipes and the nature of the soil. The double overhead trolley system eliminates the possibility of trouble from electrolysis. In the case, however, of most cities where numerous lines converge at certain points, the double overhead construction would be complicated and objectionable in appearance. The same applies to the double overhead three-wire system. This last system has great advantages, however, and when used in connection with rotary converters, which act both as converters and equalisers, it is possible to operate tramways over very long distances from the generating stations. It happens in such cases that the three-wire overhead system is rarely objectionable, since overhead networks are not necessary to meet the traction conditions in outlying districts. The conduit system has been used in various American and Continental cities with a considerable degree of success. The advantage of this system is that it can be a doubly insulated system, avoiding danger from electrolysis, and that there are no overhead wires. An additional rail at the side or pair of rails between the tracks, along the slot, has to be set off against the overhead wires on making comparison between the two systems as to appearance in the street.

In general, corporations are in a better position to instal conduit systems than private companies, since corporations can borrow money at low rates of interest, and have not so great amortisation to consider. Further, corporations frequently having the control of gas and water pipes can arrange matters so that the conduits can be put in at a less first cost. In some cities I believe the installation of conduits under a dual management would be impracticable, since the conduits would interfere with the gas and water pipes to such an extent that the conduits could not be installed, except by such general rearrangement, that local arrangements could not be made. Undoubtedly, in the case of heavy storms the conduit system is more troublesome than the overhead system. I had some examples of this in my recent visit to the United States. In New York it has been found necessary to employ an elaborate system of double-throw switches, so that if a part of the positive side of the system goes to earth, it can be put on the negative side and the negative on the positive side. The Dublin station has been designed to work all the cars in the city of Dublin and its suburbs. It is centrally located, and at the same time has exceptional facilities for coal and water supply. The coal is handled automatically from the ship to bunkers over the boilers, and from thence it is weighed separately into each boiler. The boilers are of the water-tube type, and the piping is on a system devised by myself, which I have termed the "by-pass" system, since each pair of boilers normally supply its corresponding engine, but can by means of the "by-pass" supply any other engine. The engines are of the vertical cross compound type, 20in. and 40in. cylinders, 42in. stroke, and 90 revolutions.

In conclusion, I would point out that the mistake most frequently made has been in under-estimating the amount of power that may ultimately be required in a traction system. Both the size and type of machinery in a generating station should be determined in respect to the maximum output of the station. Having regard to the present regulations of the Board of Trade, and to economy in transmission and distribution, the limit for a 500-volt continuous-current station is usually reached at 5,000 kw. output. Beyond this a multiphase system of transmission with rotary transformers for continuous-current distribution becomes necessary for most economical working, since experience has fully demonstrated the greater economy of work ing from a single central power station. The "universal' station is the multiphase station, since it can meet every condition with a single type of generating machinery. As pointed out in the paper, however, the distance of transmission, amount of power, and the nature of the load are the factors determining whether a continuous current or a multiphase system is best in particular cases. Having regard to lighting experience in the large American cities in which the three-wire system was originally installed, and which is now being replaced by a three-phase system with sub-stations to secure greater economy in working, it would seem wiser in many cases to sacrifice somewhat in electrical efficiency at the beginning and provide for a plant suitable for practically unlimited growth, either as to amount of power or area of district supplied from a central power station.

DISCUSSION.

[We are indebted to the *Manchester Guardian* for the following report of the discussion, which turned chiefly on the question of the trolley *versus* the conduit system.—ED. *E. E.*]

The Chairman (Mr. J. S. Raworth), while professing to take a neutral position, showed that his leanings were in the direction of the overhead trolley system, which he said appeared to be preferable to the conduit system from a commercial and practical point of view. There might be something to be said against the overhead system from an æsthetic point of view, but his experience of Continental towns told him that although the system might be regarded as ugly to begin with, people soon got accustomed to it, and would be really sorry to have it removed.

Mr. S. Z. de Ferranti said the question was whether the traction wires if they should be put up now in Manchester would not, like the lighting and telephone wires, have to be put underground in the end. It was very hard to say what was the best thing to do. If they had gone in for electric traction in this country eight or ten years ago, as they did in America, the overhead system would have been the right thing, but he did not feel quite so sure about it to-day. There had been some large installations in the States on the underground system, and although from an engineering point of view they might have been somewhat troublesome, they had been satisfactory so far as the public were concerned, and were at work to-day. If the difficulties connected with the layers of the mud in the Manchester streets could be overcome, there could be no doubt that the conduit system would be a desirable, a sightly, and a permanent system.

Dr. Edward Hopkinson said it was always said that accumulators were out of the question, but whenever he asked why he never got an answer. Many most important towns on the Continent had gone in for accumulator traction in the central part of their areas, and in a part of Birmingham it had worked well, in face of serious disadvantages. He thought, therefore, that it was worthy of serious consideration, and he suggested that Mr. Alderman Higginbottom should sift the matter as thoroughly as he had done in regard to the overhead conduit systems.

Mr. Clirehugh said he was somewhat astonished to hear Dr. Edward Hopkinson actually advocate the accumulator system. If they could get lightness and economy in storage the accumulator system would be an ideal one, but at present they had neither. The advantage of the overhead system was that in comparison with the conduit system it was very cheap, and that by going in for it they would not be burning their boats, but would be ready to go in for any improved system that might hereafter arise.

Mr. Alderman Higginbottom said the question turned to a great extent on the local conditions in the town for which the installation was proposed. He had already made the enquiries Dr. Hopkinson suggested as to accumulators, and he found that in Hanover, for example, where they had adopted the trolley outside and the accumulator inside the city, they would gladly have the trolley inside the city also if they were permitted to do so, as they found that the accumulator was not commercially successful. At present the accumulator car was out of the question, but he hoped it might by-and-by be made practicable, in which case presuming the overhead trolley system was adopted in Manchester now, it could be utilised at very small cost. The overhead system seemed to be at the present moment the most expedient for Manchester, and he thought that if they went in for it and took possession of the tramlines they could leave the future to take care of itself.

Mr. Hans Renold argued that from the mechanical engineer's point of view and from the public point of view the conduit system was preferable to the trolley system. From the point of view of economy, he said he thought we had at present no adequate means of judging which was the better system as the only figures available differed widely. He complained that Alderman Higginbottom and his committee were showing too much haste in the matter,

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The other speakers, amongst whom was Mr. C. H. Wordingham, electrical engineer to the Manchester Corporation, nearly all favoured the overhead trolley system as the best for Manchester under present circumstances.

Mr. Parshall's reply we hope to give in due course.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

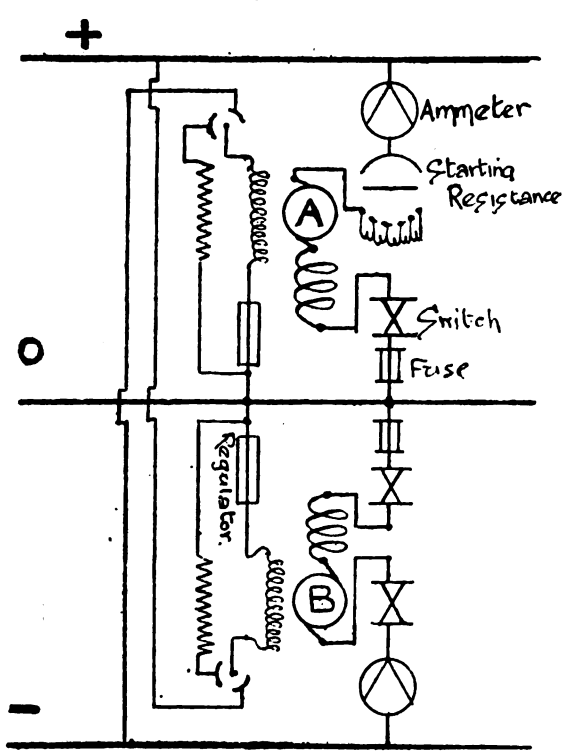
136. What position should an oil-filter occupy in relation to boilers, hot-well, and condenser: and why?—B.

137. What are the relative advantages of chimneys *v.* forced-draught apparatus for boilers?—T. J. A.

ANSWERS.

Question No. 130.—How can two compound-wound dynamos in series be used as a balancer on the three-wire system? Would such a balancer work well in parallel with accumulators?

Best Answer to No. 130 (*awarded* 10*s.*).—The diagram, which is practically self-explanatory, shows clearly how to connect up two compound-wound dynamos to act as a balancer on a three-wire system. A and B are the armatures of the two machines, and the other parts of the circuit are as named. The machines should be belted together so as to run at the same speed, or, preferably, they should be directly coupled to one another.



While it is impossible in so small a space to enter fully into the somewhat complicated details of this question, one or two of the more important points may be mentioned. Note that the shunt winding of each machine is excited from the opposite side of the system to that on which its armature and series winding are. This, as will be seen, enables the machines to respond more readily to the variations which it is their function to minimise. It is not generally possible to arrange for the shunt, on breaking, to discharge through the armature, and therefore the arrangement in the diagram may be adopted, in which a two-way switch and a non-inductive resistance, of about equal amount to the shunt-winding resistance, are used, and so arranged that the two-way switch, before disconnecting the shunt from the source of excitation, first of all puts the non-inductive resistance in parallel with it, and then, breaking the main circuit, puts the two in series, and thus allows the shunt induction to die away gradually. A shunt regulating resistance is inserted in each side, but this, when once set for the ordinary working conditions, does not, as a rule, need further adjustment.

As the system is a reversible one, the two machines should obviously be as nearly identical as possible, and have the same characteristic. Further, they should be such that their speed when working as a dynamo at full load should differ by a very small amount from the speed as a motor at full load. The system is put in operation by first of all exciting the shunts, then starting up A as an ordinary motor by means of the starting switch and resistance, and afterwards closing the switches of B. The volts between the + and − outers are supposed constant. The action of the balancer may be best grasped by considering a particular example. Assume for the moment that the efficiency is perfect. The modifications arising from imperfect efficiency may easily be made afterwards. Suppose the total volts on the outers are 230, and as an extreme case, imagine 100 amperes to be required on the negative side, while there is no load on the positive side. What would happen would be this: owing to the greater load on the negative side the volts on that side will be less than 115, while the positive side will have more than 115. Under ordinary conditions, A and B simply run as two unloaded motors in series. But now A has the pressure at its terminals increased, and, therefore, its speed will increase, an effect which will be augmented by the weakening of its shunt field, and it will run as a loaded motor and will drive B as a generator, and cause it to supply current to the negative side. What happens in this particular case is that 50 amperes come from the main generator at 230 volts difference of potential. Half of this 230 volts is lost in driving the current through A, while the other half is lost in supplying half the power required on the negative side—viz., 50 amperes at 115 volts. The power absorbed in driving A is used driving B, which, under the conditions, if perfect efficiency assumed, will give out again 50 amperes at 115 volts, and so will make up the balance of power required on the negative side. The net result is practically that A transfers 50 amperes at 115 volts from one side of the system through B to the other side, and so makes the balance perfect, and the volts equal on either side. As the efficiency is not actually perfect, more than 50 amperes would be required from the main generator, say 53, then the generator B would give out 47 to make up to 100. The fact of B's shunt being excited from the high-voltage side of course assists the action, just as A's shunt excited from the low-voltage side does, as already explained.

Note the effect of the series turns. They are wound so as to assist the shunt when the machine runs as a dynamo, and hence when running as a motor the field is weakened by the series turns and the speed further increased, while the dynamo is also helped on the other side by having its field strengthened for the same reason. And herein lies the danger of the compound balancer, for if the series turns be too many in number, the field will be too much weakened on the motor side and strengthened on the dynamo side, and the motor may lose its field and be pulled up by the dynamo, thus causing a short-circuit and blowing of fuses; hence the dynamos should be under compounded, for while a straight line characteristic gives the best theoretical result, practical difficulties come in which make such machines difficult to work without constant attention. As a matter of fact, in many cases shunt machines are used, and are less liable to go wrong, though a distinct advantage is gained by the addition of some series turns. The balancer will not keep the voltage absolutely equal on each side, owing partly to the fact there is a difference in speed between full load as motor and full load as dynamo. Hence some difference in volts on each side is necessary to start

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the action at all, and hence also the importance of having this speed difference as small as possible. But the regulation will be kept to within a very small amount over this minimum.

As regards accumulators, the question does not state whether the battery is to be right across the outers, or in two halves, one on each side of the system. In the former case the battery simply represents a main generator, and no difficulty is experienced. In the latter, the battery practically becomes another balancer, and unless the general capacity of the battery approximated pretty nearly to that of the balancer trouble might arise. For if an occasion arose in which the variation required the full output of the battery and balancer combined to regulate it, then if the internal resistance of the battery were very high it would probably give out less than its maximum, throwing the rest on the balancer, thus overloading it, and *vice versâ* But with careful selection the battery can be arranged to work in parallel with the balancer quite satisfactorily. The only difficulty is the first design.

There are many other points which might be noted, but enough has been said to indicate the general lines of working.—T. C.

Answer to No. 130 (*awarded* 5*s.*).—A pair of compound-wound dynamos mechanically coupled together will act satisfactorily as a three-wire balancer only if the combination *compounds down*—*i.e*, if the voltage of the dynamo falls as the current increases when driven by the motor off a constant-supply voltage. The result is best obtained by experimentally adjusting the number of series turns on the machines. They will then equalise the voltage on the two sides of the three-wire system within from 1 per cent. to 3 per cent., according to the size of machine. They can, in fact, by careful adjustment be made to balance more accurately than simple shunt machines. The diagram of connections would be as in Fig. 1.

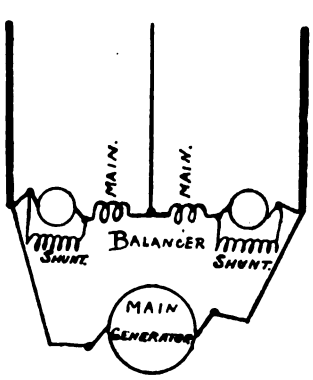

FIG. 1.

There are two ways in which a balancer can be used in parallel with a battery. One is the case in which the battery simply takes the place of the main generator in Fig 1. With this arrangement no difficulties whatever occur. The second case, which is not a usual one and cannot be recommended, is shown in Fig. 2. With this arrangement both the battery and the balancer are balancing, and the out-of-balance load is divided between them. First, consider the battery absent and the system equally loaded on both sides, then the two machines of the balancer will be simply running round light, both acting as differentially-wound motors. Now, suppose the left-hand side (Fig. 2) of the system to have more lamps switched on. The voltage of the main generator remaining the same, if the balancer were absent the voltages on the right-hand side would rise, and that on the left-hand side would fall till the two voltages were in the ratio of the number of lamps on the two sides. But if the balancer is present, as soon as the right-hand voltage increases, a little motor, B, speeds up and increases the back voltage of motor A until it becomes equal to the left-hand voltage, after which A ceases to be a motor and becomes a generator supplying the additional left-hand current, and then no further change occurs.

It will easily be seen that if the complete balancer compounded *up* instead of *down*, there would be no limit to the current given by A, for the more current it gave the higher its volts would become, and this would go on till either the main winding on motor B overpowered the shunt and the combination stopped and burnt up, or, at least, until the left-hand voltage rose and the right-hand one fell sufficiently to produce a steady state again with a great difference in voltage between the two sides. We can now consider the effect of adding the battery coupled up as in

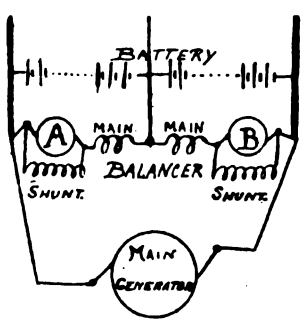

FIG. 2.

Fig. 2. The voltages on the two sides will now keep almost exactly alike (as in stations where batteries alone are used for balancing), but since the curve of battery voltage is practically level, and the characteristic of the balancer must droop a little, the proportions of the out-of-balance current carried by the battery and by the balancer will vary considerably at various loads, though less on the whole than if plain shunt machines were used.—Q.

Question No. 131.—What is the best method of measuring the resistance of the armature of a dynamo? Give working instructions.

Best Answer to No. 131 (*awarded* 10*s.*).—Before measuring the actual resistance from brush to brush it is usual to first prove individual coils to see that there is approximately the same resistance between each pair of commutator bars. This is done by the following very handy workshop method, as shown in Fig. 1. A current from one or two accumulators is passed through the armature from brush to brush, and this current is maintained constant. Two handles, into which are inserted spikes, are used to probe round the commutator, taking two adjacent segments at a time. Two wires, in series with which is a galvanometer, are used to

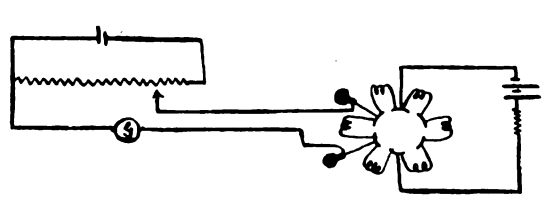

FIG. 1.

oppose the fall of potential along a graduated platinoid wire. A point can be found on the scale at which the drop of potential balances that across one coil of the armature. By thus working round the armature with the spikes any small variation in resistance of coils can be detected by the scale-wire reading. This method only compares individual coils.

To measure the actual resistance a more elaborate method is used, but undoubtedly the potentiometer system is the best. The theory of the method is to compare the drop of potential across a standard resistance with the drop across the armature when the same current is flowing through both in series. A standard resistance of $\frac{1}{10}$th ohm of manganin, capable of carrying 10 amperes without heating, is required. The method of working is to connect the standard resistance in series with the armature, and keep a steady current of 10 amperes flowing from one or two accumulators. Wires are connected from the ends of the $\frac{1}{10}$th ohm resistance and from the brushes, or, better still, to the commutator lugs. Each pair of wires is connected to two terminals on a switch, such that either pair can be inserted in the galvanometer circuit to oppose the E.M.F. on the slide wire (Fig. 2).

The first operation is to calibrate the slide by putting the Clark standard cell in circuit with the galvanometer, and setting the slider to 1,434 divisions. The adjustable

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resistance box is altered until no deflection is obtained on the galvanometer. The slider is set at 1,434 divisions because the E.M.F. of the standard cell is 1·434 volts. Therefore each division of the scale represents $\frac{1}{1000}$th of a volt. The cell is now put out of circuit, and the drop of potential across the standard $\frac{1}{10}$th ohm is measured. This

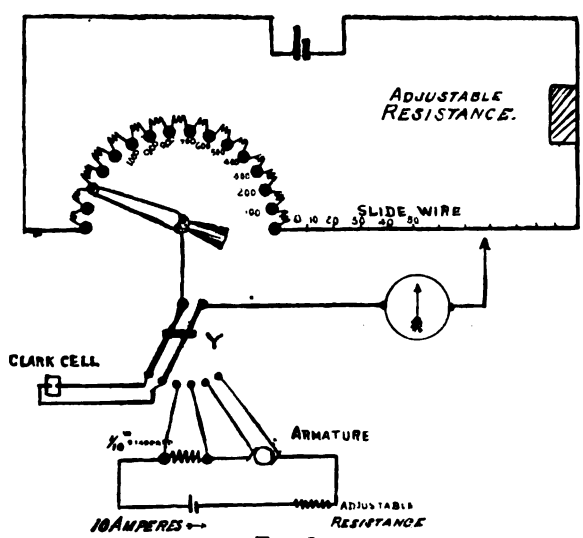


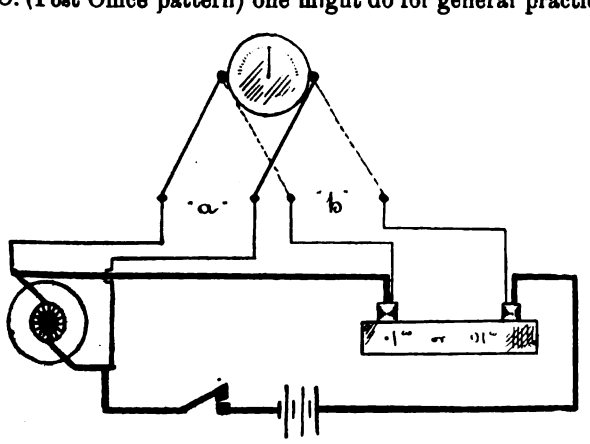
FIG. 2.

is done by moving the switch, Y, in the diagram. The switch is then moved across to measure the drop across the armature. As an example, suppose we have to set the contacts on the slide to 1,000 on the left and 0 on the right when the standard resistance is in circuit. The drop of pressure will therefore be $1{,}000 \times \frac{1}{1000}$ volts = 1 volt. With the wires from the armature in circuit the contacts on the slide have to be altered to 0 on the left and 93 on the right. The drop of pressure is therefore $93 \times \frac{1}{1000}$ volts = ·093 volt.

Therefore $\frac{\text{Resistance of armature}}{\text{Standard resistance}} = \frac{\cdot 093}{1}$.

But the standard resistance is only $\frac{1}{10}$th ohm, and hence the actual resistance of the armature is ·0093 ohm. The beauty of this method is that no corrections have to be made for either resistance or loss of pressure in leading wires.—S. J. M.

Answer to No. 131 (*awarded* 5*s.*).—To test the resistance of an armature, carefully clean brushes, commutator, or collector rings, as case may be, see that brushes are on opposite segments, now disconnect "field leads" from "brush leads," join up in series a standard low resistance [·1 or ·01ω], the armature, one or two secondary cells, and a switch. On the ends of the brushes solder a pair of potential wires, also take off a pair from the terminals of the standard resistance. The galvanometer should now be set up; a reflecting one is preferable, but a high-resistance P.O. (Post Office pattern) one might do for general practice.



The following observation must now be taken (see sketch):

1. Galvanometer leads on *a* deflection = d^2.
2. Galvanometer leads on *b* deflection = d^1.

Note.—When galvanometer is connected to *a* or *b*, a current flows through it which is numerically equal to the quotient of this difference of potential (fall of potential along the resistance) by the resistance of the galvanometer.

Let R_1 = resistance of armature;

V_1 = fall of potential along it when a steady current is flowing.

Thus current through armature = $\frac{V_1}{R_1}$ amperes.

Thus current through standard = $\frac{V_2}{R_2}$ amperes.

But the same current flows through both, as they are in series.

Therefore $\frac{V_1}{R_1} = \frac{V_2}{R_2}$ or $\frac{V_1}{V_2} = \frac{R_1}{R_2}$

Again, if r = resistance of galvanometer, and the galvanometer leads are on *b*, the current through galvanometer = $\frac{V_2}{r}$, and if the deflection is d^2, and C is the galvanometer constant, we have

$$\frac{V_2}{r} = C\, d_2.$$

For the same reason, if d_1 is the deflection when galvanometer leads are on *a*, we have

$$\frac{V_1}{r} = C\, d_1.$$

Thus, $$\frac{V_1}{V_2} = \frac{d_1}{d_2}.$$

But we found $\frac{V_1}{V_2} = \frac{R_1}{R_2}$. Therefore, $\frac{R_1}{R_2} = \frac{d^1}{d_2}$, or $R_1 = R_2 \frac{d_1}{d_2}$.

We know the values of R_2, d, and d_2; therefore, we can find value of R_1.

Precautions—Bad connections will falsify tests, so solder all connections or use mercury-cups. If great accuracy is needed, use a potentiometer instead of galvanometer, as in some galvanometers the deflections are not proportional to the currents producing them. See that E.M.F. of battery does not fall during observations.—W. S. TOPLIS.

THE SOUTHAMPTON FATAL ACCIDENT.

The following is Major P. Cardew's report on the Southampton fatality, addressed to the assistant secretary of the Board of Trade:

I have the honour to report that, as appointed by the Board of Trade, I held an enquiry on the 21st inst. into the cause of a fatal accident to Walter Day, a jointer in the employment of Messrs. W. T. Glover and Co., who are the contractors for the street work in connection with the extension of the electric light supply at Southampton. The enquiry was held in the Council Chamber at Southampton. The Town Clerk represented the Corporation of Southampton, who are the undertakers. Mr. J. D. Bassitt, solicitor, appeared for Messrs. Glover and Co., and for Mr. J. Brooking, their local superintendent. I attach my notes of the evidence given at the enquiry, and a transcript of notes taken in shorthand, kindly forwarded to me by the town clerk.

There does not appear to be any doubt as to the facts of the case, which are, briefly, as follows: The Corporation, for the purpose of extending the area of their electric supply, are laying down a system of high-pressure mains to supply transformers placed in street boxes, and also a system of low-pressure mains, to serve consumers from these transformers. The contractors for the street work are, for various reasons behind time, and in order to carry out promises made to intending consumers, who were waiting for the light, the Corporation unfortunately commenced to supply before the laying of the high-pressure mains was completed and proper joints made. The mains were still in charge of the contractors, who had working parties engaged upon them at the time, while the arrangements for supply were naturally under the control of the engineer to the Corporation, a division of responsibility which in itself is likely to lead to mistake and danger. The high-pressure mains are concentric, lead-covered cables laid in earthenware "ways," the outer conductor being connected with earth at the generating station, and the inner conductor being therefore charged to the full pressure (2,000 volts) from

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earth. The low-pressure mains are almost exactly similar in appearance to the high-pressure, and are laid in similar "ways" alongside of the high-pressure, where they follow the same route. The separate lengths of main are to be connected by means of cast-iron junction boxes, but as these had not arrived, temporary connections had been made in three street boxes by means of pieces of single cable connecting the respective inner conductors and outer conductors, the joints being covered with indiarubber tape. In the box where the accident took place branch connections were made from the high-pressure mains to two street transformers, and the work had evidently been hurried, the ends of cables and connections crossing each other, and presenting the appearance of a tangled mass. Besides the high-pressure mains there were three low-pressure mains passing through the box. Between 3 and 4 p.m. on the 12th inst. a party of the contractors' employés was engaged in passing rods through the cableways in order to draw in cables in the upper portion of the High-street, and one of them, Henry Flux by name, lifted the cover of the street box mentioned above in order to give notice when the end of the rod appeared. He saw sparking taking place between one of the cable ends and the side of the box, and pointed this out to Mr. Brooking, the superintendent, who got into the box and examined the fault, receiving a slight shock when he took hold of the insulating covering of the inner conductor. This was no doubt due to surface leakage. By hastily tracing out the faulty cable with his eye he had come to the erroneous conclusion that it was a low-pressure cable, being misled by the confusion in the box, and, strangely enough, the shock he received confirmed his mistake. He therefore asked for some rubber strip to repair the fault, and, as there was none available, went to find the jointer who had made the joints, and instructed him to retape the joint. The electrical pressure was on at the time, although it could easily have been switched off at the generating station. Brooking was warned twice by Mr. Shepherd, the clerk of works, to be careful, as the fault might be on a high-pressure main, but persisted that he had identfied it to be low-pressure. The jointer, Walter Day, went at once to the box, got into it, handled the cable carelessly, and received a fatal shock. He was at once dragged out by Brooking and Shepherd, who tried artificial respiration and fetched a doctor, but life was extinct.

This accident greatly resembles the recent fatal accident at Chelmsford; in both cases a temporary connection to the inner conductor of a concentric system of mains proved deficient in insulation, and in both cases the breakdown was the natural result of the very imperfect nature of the joint and of the use of single-cable connections to the inner conductor. On several occasions I have pointed out the danger incurred by such connections, which, moreover, are expressly forbidden by the following conditions attached by the Board of Trade to its consent to the connection with earth of the outer conductors of the system in this and all similar cases—viz.: (1) that the high-pressure mains, and any service lines in connection therewith, be concentric throughout; (2) that the outer conductor in all cases form a complete metal sheathing round the inner conductor. In the concentric system as properly carried out there are two earthed metallic shields surrounding the inner or charged conductor, and any breakdown of the insulation of the latter must inevitably cause a short-circuit, which will operate the safety fuses and cut off the pressure automatically. Even where the concentric arrangement of conductors is not carried out at the joints, as in my opinion it should be, a cast-iron joint box is always provided and thoroughly earthed on to the outer metallic protection of the main. If in any part of the circuit the insulating covering alone is relied upon for the safeguarding of the charged conductor, the system at once loses its security and becomes decidedly more dangerous than one in which separately insulated conductors are used throughout. This is now fully recognised by all engineers of experience.

There are two dangers disclosed by this enquiry against which the Board of Trade should provide in considering new proposals for supply at high pressure. These are, first, the danger that high-pressure mains may be brought into use for supply before they have been completely laid, properly jointed, examined, and tested, and while they are still in charge of other parties than the undertakers. Secondly, that high-pressure mains may be mistaken for low-pressure mains passing through the same street box if the different mains are not readily distinguishable from each other.

With regard to the first of these dangers, the Board of Trade regulations certainly provide that a high-pressure circuit shall not be brought into use unless the insulation of every part thereof has withstood the continuous application, during one hour, of pressure exceeding the maximum pressure to which it is intended to be subjected in use—that is to say, in the case of every electric line a pressure twice the said maximum pressure, and in the case of every machine, device, or apparatus a pressure 50 per cent. greater than the said maximum pressure. The undertakers shall duly record the results of each test. This test had not been carried out in this case. It would probably have at once developed the fault, but might not have done so, and I think it will be desirable to definitely forbid any attempt to supply at high pressure through unfinished mains and before the mains have been thoroughly examined and taken in charge by the undertakers. It is probable, as stated by the engineer to the Corporation, that great pressure was brought to bear on him to induce him to commence supply on these mains against his better judgment. It should also be noted that Mr. Brooking stated that he protested against supply being commenced in the unfinished mains, but had yielded to an urgent request. I fear there is a distinct tendency in the case of electrical undertakings managed by municipalities to unduly press the engineers to start the works before they are properly complete, and it would strengthen the hands of these engineers if the Board of Trade distinctly forbid any makeshift arrangements.

The second danger is one which has only lately arisen, but which certainly, in this case, has proved to be a very real one. It can, of course, easily be provided against, and the attention of the manufacturers will no doubt be directed to this point, which appears to have been overlooked.

To sum up, I am of opinion that Walter Day lost his life from electric shock received while carrying out instructions given under a misapprehension by his superior, whereby he was placed in a position of extreme danger; that the high-pressure mains from which the shock was received were not in a proper and fit condition to be brought into use for purposes of supply; and that the regulations and conditions imposed by the Board of Trade on the undertakers had not been complied with in the case of these mains.

LEGAL INTELLIGENCE.

EDINBURGH CORPORATION AND UNDERGROUND WIRES.

Sheriff Rutherfurd, in Edinburgh Sheriff Court, on Monday last, had before him an application on behalf of the Postmaster-General asking the consent of the Lord Provost, Magistrates, and Council to the placing and maintaining of a line or lines of underground telegraphs in or under Gorgie-road, Tynecastle-terrace, Dalry road, West Maitland street, George-street, St. Andrew-square, North St. Andrew-street, Princes-street, North Bridge, South Bridge and Nicholson-street. The application was objected to because the wires were intended for the use of the Telephone Company as part of their undertaking, and the Corporation objected to giving any rights in the streets to private or commercial undertakings, whether applied for directly or through the medium of the Post Office. The Solicitor-General, Q.C., and Mr. Fleming appeared for the Post Office, and the Dean of Faculty, Q.C., and Mr. F. T. Cooper for the Corporation. The following report of the proceedings is taken from the *Scotsman*:

Mr. Cooper held that the application was not made in good faith by the Postmaster-General for the purpose of the Post Office, but was simply to facilitate communication between one exchange of the Telephone Company and another, to give exchanges in connection with the trunk system of the country, which was in the hands of the Postmaster-General. If consent were given, they reserved their right even to interdict the Postmaster-General. His Lordship would take into consideration the very great interests and rights they had as owners of the ground through which these pipes were to pass. Hardly a year went pass but the streets were opened up by new requirements. As they had in George-street or St. Andrew-square the property of the solum invested in them, they did not know the moment when they might require to use that solum for preserving the public right of passage for public uses. The Postmaster-General had got ample conduits for public purposes, and he was ready to prove that if allowed. If consent were given on this matter, he did not see where it was to end. Replying to the Sheriff, counsel said the initial outlay might be the Government's, but the company would bear the cost ultimately. Mr. Cooper, continuing, said he did not expect any expense would fall upon the Corporation, except losing very valuable ground, which might be required for other purposes.

Mr. Fleming said the telephone had been declared by a decision of the Court the telegraph under the Telegraph Acts, and as the Postmaster-General had the exclusive privilege of all telegraphic messages by that decision, he had the exclusive privilege of all telephone messages in this country. By virtue of his privilege he could start a telephone system anywhere. These wires to a very large extent were to be trunk wires, which would connect centre with centre. They were trunk wires carrying telephone business, which was telegraph business, which was the exclusive monopoly of the Postmaster General.

The **Dean of Faculty** asked from where the Postmaster-General got his title to lay down conduits on the private property of anybody? Why should the Post Office and the National Telephone Company be entitled through the Post Office to do something which they could not do themselves, and upon terms which they could not obtain themselves. If the National Telephone Company could not touch the streets of Edinburgh by applying to the Corporation, why should they be able to go to the Post Office? The respondents were opposing the connection of the Post Office with the local exchange. The application of the Postmaster-General was made merely for the purpose of subserving the interests of the National Telephone Company regardless of the present occupa-

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tion and the prospective requirements of the city. The city were protected by statute against anybody interfering with the streets at all.

The Solicitor-General said there had been no previous proceeding of this sort in Scotland, although there had been a dozen in England. In this case he contended all that was required was that the consent of the Corporation should be asked, and if it was not given that notice should be served upon them. It then lay with the Corporation to state a reasonable objection. It was quite true that they did not show any connection with the Post Office, but the reason for that was easily explained. The Edinburgh Corporation was suffering from a period of moderation and good sense at one time, and they allowed the Post Office to connect the central station with the Post Office by underground wires.

Mr. Cooper said of course that was for Post Office purposes.

The Solicitor-General, continuing, said that resulted in this: that all the local exchanges, when they had to communicate with the Post Office, had first to go through the central exchange, and then the central exchange communicated with the Post Office. Now one of the clamant evils in the bringing about an unsatisfactory working of the telephones was the overhead system, which was apt to get disarranged by storms, and the Telephone Company was anxious that the connections between the local exchanges should be placed underground so as to obviate this. He could not extract any meaning from the contention of the respondents that the wires were not required for Post Office purposes, because the position of the licensee was this—he was in the shoes of the Postmaster-General with all the powers the latter had, except the one power of opening the streets without a separate consent, but he was bound to pay the Postmaster-General 10 per cent. of everything he took. Therefore, everything that the Postmaster-General did which would result or might result in increasing the income of the licensee was a Post Office purpose. If the respondents could have said that the solum was packed with tubes and pipes, then there might have been some room for the objection, but one knew that was not an averment that could possibly be made. It would be refuted on the face of itself. In conclusion, he submitted that there was no ground whatever shown for the city not giving the consent they asked, and accordingly his Lordship should grant decree in terms of the notice.

The Sheriff made avizandum of the application.

MAGNOLIA METAL DISPUTE.

The action was brought in the Queen's Bench Division, before Mr. Justice Mathew and a special jury, by the Magnolia Anti-Friction Metal Company, of New York, and others, against Mr. John Sugden, Mr. W. E. Watson, Mr. A. G. Brown, the Magnolia Metal Company, Limited, the Atlas Bronze Company, Limited, and the Atlas Metal Company, Limited, and was to recover damages for an alleged conspiracy by the defendants to deprive the plaintiffs of their business in this country. Plaintiffs also asked for an injunction restraining the defendants from continuing the acts complained of. Defendants denied the alleged conspiracy, or that they had done anything to interfere with the plaintiffs' business. The jury on the previous day found that the defendants Brown, Watson, and Sugden conspired together to enable Sugden secretly to continue the manufacture and sale of anti-friction metal after the termination of the contract between the plaintiffs and the partnership; and that they formed and used the names of the defendant companies in furtherance of the conspiracy.

Mr. Justice Mathew was satisfied that the object of the injunction was to prevent the company from assisting Sugden to commit a fraud, and, therefore, he should have no difficulty in restraining them from doing what Sugden was not entitled to do. That, however, would not prevent the company from carrying on any legitimate business.

Mr. McCall asked for a stay of the injunction so far as the Atlas Company was concerned.

Mr. Justice Mathew refused the application.

COMPANIES' MEETINGS AND REPORTS.

YORKSHIRE HOUSE-TO-HOUSE ELECTRICITY COMPANY.

The ordinary general meeting of the Yorkshire House-to-House Electricity Company was held at the Great Northern Hotel, Leeds, on Tuesday, Mr. G. Talbot in the chair. This was probably the last meeting of the Company. They have paid an interim dividend of 5 per cent., and being left with a sum £7,068, a dividend of 8¾ per cent. was proposed, making the dividend for the year 6¾ per cent. **The Chairman** mentioned that he had accepted the position of liquidator. The report and balance-sheet was adopted. An extraordinary meeting was subsequently held, when a resolution for the voluntary winding up of the Company was adopted. This Company has recently been taken over by the Corporation, details of which transactions have already appeared in our columns.

CITY AND SOUTH LONDON RAILWAY COMPANY.

Directors: Charles Grey Mott, Esq. (chairman), Harrow Weald, Middlesex; Charles Seymour Grenfell, Esq., Elibank, Taplow; Sampson Hanbury, Esq., Wyvenhoe Park, near Colchester; S. Barclay Heward, Esq., 96, Ashley-gardens, Westminster; Edwin Tate, Esq., 21, Mincing-lane, London, E.C.

Report of the directors, with abstract of accounts for the half-year ending Dec. 31, 1898, to be submitted to the half-yearly ordinary general meeting of the Company, to be held at Winchester House, Old Broad-street, E.C., on Tuesday, Jan. 31, at 12 o'clock noon:

The receipts from all sources for the past half-year have amounted to £27,588. 9s. 4d., and the cost of working has been £15,498. 5s. 7d., leaving a profit of £12,090. 3s. 9d. Inclusive of the balance brought forward from June 30 last, the net revenue account shows an aggregate total of £13,171. 0s. 8d. After making provision for the debenture stock interest, a balance remains available for dividend of £10,190. 12s. 9d. Out of this sum your directors recommend that the full dividend of 5 per cent. per annum be paid on the preference shares, and that a dividend at the rate of 2 per cent. per annum be paid upon the consolidated ordinary stock, leaving a balance of £1,419. 12s. 6d. to be carried forward to the next account. The following table shows the number of passengers, exclusive of season-ticket holders, carried since the opening of the railway in each half-year:

Half-year ended	Number of passengers (exclusive of season-ticket holders).	Receipts (including season tickets).
Dec. 31, 1890 (11 days)	165,000	£1,568 3 9
June 30, 1891	2,412 343	19.403 6 9
Dec. 31, 1891	2,749,055	19.798 16 6
June 30, 1892	2,813,162	20,931 4 2
Dec. 31, 1892	3,117,602	22,002 17 5
June 30, 1893	3,146 656	22,458 6 9
Dec. 31, 1893	3 093,351	22,067 14 10
June 30, 1894	3,383 154	23,564 10 6
Dec. 31, 1894	3,275,649	23,540 12 4
June 30, 1895	3,113,199	23,711 5 8
Dec. 31, 1895	3,172,438	23 780 3 7
June 30, 1896	3,192,672	24,021 13 0
Dec. 31, 1896	3,368,480	25,456 6 9
June 30, 1897	3 437,810	26,403 3 6
Dec. 31, 1897	3,337,861	25,472 12 10
June 30, 1898	3 478,977	26.356 16 4
Dec. 31, 1898	3,462 814	26,319 14 10
To'al since the opening of the line	50,720,223	£376,857 9 6

Taking into consideration the abnormally fine weather during the summer and autumn months, and the extreme mildness of the latter part of the half-year, your directors feel justified in congratulating the proprietors on the increase in the traffic over the corresponding period last year, both in the number of passengers carried and in the amount of receipts. The progress with the Moorgate-street extension has been uninterrupted. Both tunnels are completed from the junction with the present line at the Borough to Moorgate-street Station, and the three underground stations are almost finished. The shafts are ready for the lifts, the erection of which has already been commenced. The laying of the permanent way is also well advanced, and the subway communication between the Lombard-street Station of this Company and the Bank Station of the Central London has been constructed. The station buildings on the surface at Moorgate-street, Lombard-street, and London Bridge will be commenced forthwith. The works of the extension from Stockwell to Clapham Common are progressing very satisfactorily, and it is anticipated that the line will be completed ready for traffic early in the autumn of this year. The erection of the new boiler and engine house at the depôt at Stockwell is proceeding rapidly, and will be ready for the erection of the engines in March. The three locomotives referred to in the last report have been delivered, and as their working has given satisfaction, tenders for the full number required are now being invited. The 30 additional coaches required are now in course of delivery. The works of the extension through the heart of the City having now been completed, it is necessary, in order to utilise fully this valuable portion of the line, that the remainder of the authorised undertaking, carrying the line to the Angel at Islington, and thus bringing in the traffic from the North as well as from the South, should at once be proceeded with, and steps have already been taken to secure the site of one of the three stations along the route. It is proposed to let the contract for the works as soon as favourable arrangements can be made. It is anticipated that this portion of the railway will be constructed at a very moderate cost, and can be worked economically with power supplied from the generating station at Stockwell. Negotiations are in progress with the London, Brighton, and South Coast Railway Company for the construction of the subway authorised by the Act of 1893 connecting this Company's new station at Denman-street with the London Bridge Station of the Brighton Company. In order to further facilitate and economise the working of the City and Brixton Railway, which, when completed, is to be leased to this Company under the agreement sanctioned by the proprietors in February last, it has been arranged that, in lieu of providing a separate depôt for the Brixton Company, a short tunnel should be made connecting that company's line with this Company's depôt at Stockwell. A Bill has been introduced into Parliament with this object; and, as some modification of the agreement will be necessary, a special meeting of this Company will be held as soon as the new agreement is finally settled, that it may be submitted to the proprietors for their approval. Pending these arrangements, the construction of the City and Brixton Railway has not yet been proceeded with. The directors retiring by rotation are Mr. C. Seymour Grenfell and Mr. Edwin Tate, both of whom are eligible for re-election. Messrs. Turquand, Youngs, Bishop, and Clarke also retire, and offer themselves for re-election.

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Dr. Revenue Account.	£	s.	d.
Maintenance of way, works, and stations	810	5	10
Locomotive and generating power	5,512	3	2
Carriage repairs	553	12	11
Traffic expenses	6,017	15	8
General expenses	1,821	6	0
Law charges	6	6	0
Rates and taxes	723	18	6
Passenger duty	52	17	6
	15,498	5	7
Balance carried to net revenue account	12,090	3	9
	£27,588	9	4

Cr.	£	s.	d.
Passengers (3,462,814)	25,102	0	1
Season tickets (578)	1,217	14	9
Parcels, etc.	161	10	6
	26,481	5	4
Transfer fees	25	10	0
Rent of property	1,042	7	6
Sundry receipts	39	6	6
	£27,588	9	4

Dr. General Balance Sheet.	£	s.	d.
Balance from net revenue account	10,190	12	9
Unclaimed interest	71	8	1
Interest payable or accruing and provided for	1,011	7	7
Contractors' retention fund	24,402	0	0
Sundry outstanding accounts	15,002	19	4
Loan account	216,000	0	0
Reserve fund	1,000	0	0
	£267,678	7	9

Cr.	£	s.	d.
Cash—at bankers, current accounts	10,666	0	0
On hand	1,148	0	1
	11,814	0	1
General stores	4,437	12	6
Sundry outstanding accounts	1,181	13	3
Investments—balance June 30, 1898, £133,820. 9s. 6d.; less proportion of interest received applied in reduction of premiums, £500	133,320	9	6
Debenture stock issued against loans	36,000	0	0
Balance from capital account	80,924	12	5
	£267,678	7	9

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Stirling.—The Burgh Commissioners invite tenders for mains, full particulars of which appear in our advertisement columns. Tenders by Jan. 30.

West Hartlepool.—The Corporation invite tenders for feeders, mains, arc light leads, with road work, particulars of which appear in our advertising columns. Tenders by Feb. 13.

Nelson.—The Gas Committee of the Corporation invite tenders for the supply and erection of various plant, particulars of which appear in our advertising columns. Tenders by Feb. 14.

Belfast.—The City Electric Committee are prepared to receive tenders for the supply and erection of plant, full particulars of which appear in our advertising columns. Tenders by Feb. 2.

Leyton.—The Urban District Council invite tenders for a motor-generator, etc. Further particulars may be obtained from Mr. H. C. Bishop, Cathill-road, Leytonstone. Tenders by Feb. 6.

Buxton.—The Urban District Council invite tenders for work in connection with their electric light station in Buxton, particulars of which appear in our advertising columns. Tenders by Feb. 6.

Glasgow.—The Corporation are prepared to receive tenders for the reconstruction of tramways in Crown-street and Cathcart-road, particulars of which appear in our advertising columns. Tenders by Feb. 6.

Lowestoft.—The Mayor and Corporation of the borough of Lowestoft are prepared to receive tenders for the supply and erection of various plant, all details of which appear in our advertisement columns. Tenders by Feb. 6.

Ealing.—The Urban District Council invite tenders for the supply and erection of two 500-h.p. steam alternators and one 150-h.p. steam dynamo-alternator, full particulars of which appear in our advertisement columns. Tenders by Jan. 30.

Bradford.—Tenders are invited by the Bradford Corporation for an installation for electric lighting at the Hammerton-street destructor. Specification may be obtained at the Electricity Department, Town Hall, Bradford. Tenders by Feb. 1.

Kingston-on-Thames.—The Guardians of the Union invite tenders for the provision of telephonic communication between the various buildings upon the workhouse premises, Kingston-on-Thames. For particulars see our advertising columns. Tenders by Feb. 14.

Hull.—The Corporation are prepared to receive tenders for the electric light wiring and fittings for the tramways power station, Osborne-street. The contract will include four arc lamps and about 40 incandescent lamps. For particulars see our advertising columns. Tenders by Feb. 8.

Southampton.—Tenders are invited for complete electrical installation, including boilers and accumulators to 150 h.p. Specification can be obtained on application, by letter, to Mr. H. Cleaver, engineer, 52, Bridge-road, Southampton, enclosing a deposit of £1. 1s., which will be returned on receipt of a bona fide tender.

London, N.—The Tottenham Urban District Council invite designs for a refuse destructor to be erected within their district. Three premiums of £25, £15, and £10 will be awarded for the three best designs, in order of merit. Designs to be sent by 12 noon on Feb. 7. Particulars may be obtained upon application to Mr. P. E. Murphy, engineer to the Council, Coombes Croft House, 712, High-road, Tottenham.

Edinburgh.—Tenders are required by the Corporation for the steelwork of roofs required in the construction of the McDonald-road electric lighting station. Specifications, etc., may be obtained on deposit of a crossed cheque for £2 (which will be returned on receipt of a bona fide tender) to Mr. John Cooper, burgh engineer, 1, Parliament-square, Edinburgh. Tenders by Feb. 3. The same applies to tenders for the iron and steel works (exclusive of steel roofing) required in the construction of the McDonald-road electric lighting station, comprising boiler-house, coal store, chimney stalk, engine-room, battery room, pump and tank rooms, offices, stores, etc., and other relative works.

London, E.—The Electrical Committee of the Whitechapel Board of Works invite tenders for the supply and erection of the following plant: (Section A) armoured and unarmoured cables; (B) arc lamps and posts; (C) steam dynamo and balancing booster; (D) storage batteries; (E) boilers and fittings, feed pumps, pipes, and heater. Persons tendering are at liberty to tender for any section or sections, or for the whole of the sections, but not for part of one section. Specifications can be obtained from Mr. Arthur Wright, 26 and 27, Bush-lane, Cannon-street, London, E.C., on payment of £5. 5s. each, which sum will be returned on receipt of a bona fide tender. Tenders must be delivered by 12 noon on Feb. 7.

London.—The London County Council invite tenders for the manufacture, delivery, and erection complete of four gas-engines, with starting appliances, at the proposed Victoria-embankment electric lighting station, in the parish of St. Martin-in-the-Fields. Persons desiring to submit tenders may obtain the drawings, specification, form of tender, and other particulars at the Engineer's Department, County Hall, Spring-gardens, S.W., upon payment of £2. This amount will after the Council or its committee has come to a decision upon the tenders received, but not before, be returned to the tenderer, provided he shall have sent in a bona fide tender and not have withdrawn the same. Tenders will be received up to 10 a.m. on Jan. 31.

London.—The London County Council invite tenders for the manufacture, delivery, and erection complete of four continuous-current dynamos, one motor-generator, two switchboards with switches, measuring instruments, and other work required for the proposed Victoria-embankment electric lighting station, in the parish of St. Martin-in-the-Fields. Any person desiring to submit a tender may inspect the drawings and obtain the specifications, forms of tender, etc., on application at the Engineer's Department, County Hall, Spring-gardens, S.W., and upon payment of £2. This amount will, after the Council or its committee shall have come to a decision upon the tenders received, but not before, be returned to the tenderer, provided he shall have sent in a bona fide tender and not have withdrawn the same. Tenders by 10 a.m. on Jan 31.

Shanghai.—The Shanghai Municipal Council invite tenders for a concession for constructing and working about 23 miles of electric tramways on the trolley system in the streets of Shanghai. The special attention of tenderers is drawn to the fact that the tender (if any) recommended by the Council will require ratification by the ratepayers. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 being deposited with Messrs. Pook and Co., which sum will be retained by the Council, and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China (telegraphic address Dynamo, Shanghai; "ABC," fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Tramway Concession," must be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, and received by 12 noon on March 15.

Shanghai.—The following resolution in reference to the telephone system in Shanghai was passed at the last annual meeting of the ratepayers of the Foreign Settlements at Shanghai, north of the Yang-king-pang: "Resolution VIII.—That the Council be and is hereby authorised to enter into negotiations with the China and Japan Telephone Company or any other company, and in its discretion grant a franchise with a view to the community being supplied with an adequate and efficient telephone service at a fixed maximum charge." In accordance with the above resolution the Shanghai Municipal Council invite tenders for a concession for a period of 30 years for the exclusive right of establishing and working a telephone system in Shanghai. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 sterling being deposited with them, which

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sum will be retained and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China. Telegraphic address, Dynamo, Shanghai (ABC, fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Telephone Concession," to be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, by 12 noon on March 31.

RESULTS OF TENDERS.

Edinburgh.—The Corporation have accepted the tender of Messrs. Mather and Platt, Manchester, at £9,138, for switchboards for the M'Donald-road electric station.

Southwark.—The Vestry have received the following tenders for lighting the church clock by electricity: Rashleigh Phipps and Co., £31. 10s., without automatic switch (accepted); J. W. Cannon, £45, with switch; Benson and Co., £40, with switch.

BUSINESS NOTES.

Romford.—The Urban District Council are opposing the National Telephone Company's Bill.

Monmouth.—The electric lighting work is nearing completion, and the light will probably be switched on by March.

Fleetwood.—We learn that a trial survey has been made for a new electric overhead trolley line from Knott End to Morecambe.

Bradford.—The local Chamber of Commerce has declared itself in favour of a Government telephone system throughout the country.

Grays.—The electric lighting scheme proposed by Mr. Preece has been approved by the District Council, and is likely to be put in hand shortly.

Edinburgh.—The Town Council have resolved not to take any action as to the proposition to work the Portobello section of the tramways with electric power.

Wallasey.—The District Council are opposing the Bills promoted by the Lancashire Electric Power Company and the National Telephone Company.

Perth.—The Police Commission have appointed Mr. W. C. C. Hawtayne consulting engineer to the Commissioners in connection with the introduction of electric lighting.

Waterloo and City Railway Company.—The directors have declared a dividend on the ordinary stock of the Company at the rate of 3 per cent. per annum for the full half-year ending Dec. 31 last.

Kensington.—Notices and plans from the Kensington and Knightsbridge Electric Lighting Company and the Notting Hill Electric Lighting Company have been approved, subject to the usual conditions.

Chelmsford.—The Town Council have received an offer from the electric lighting company to purchase the interests of the company at cost price. The capital of the lighting company is about £41,000 to £42,000.

The Exchange.—A large investment business was going in electric lighting shares during the last week. Several stocks rose above one point, while most of the others were very strong at fractional advances.

Barking.—The District Council have decided to apply to the Board of Trade for a provisional order to construct electrical tramways throughout the town. The estimated cost is £73,284, exclusive of buildings.

Waterloo.—The Urban District Council have passed a resolution consenting to the Liverpool Overhead Railway Company's proposal to place a short length of line in the road alongside their station, which runs parallel to Fort-road.

Littleborough.—The District Council have resolved to call in the services of an electrical engineer, who will visit the district and report upon the cost and practicability of providing a scheme of electrical supply for the same.

Cowes.—The Town Council have decided to authorise the Gas Committee to ascertain from the Edmundson Electric Lighting Company the price they are prepared to pay the Council for their interest in the electric lighting order.

Direct United States Cable Company, Limited.—The report for the six months ended Dec. 31 states the half year's revenue at £54,366, as compared with £50,098 for the corresponding period of 1897, showing an increase of £4,268.

Norwich.—We understand that the electricity company intends to make the electric light the light of the people through the popular penny-in-the-slot meter principle. At present the slots are for threepenny bits, sixpences, and shillings.

Aberdeen.—The Tramways Committee of the Town Council have inspected the trolley system of electric tramway traction which has been established on the Springburn route in Glasgow. Afterwards a luncheon took place at the North British Station Hotel.

St. James's and Pall Mall Electric Light Company.—The directors recommend a dividend for the half-year ending Dec. 31 of 7s. 6d., together with a bonus of 2s. per share on the ordinary shares, making a dividend of 12½ per cent. and a bonus of 2 per cent. for the year 1898.

Light Railway.—Arrangements are being made for the construction of a light railway from Liverpool to Bolton and through Edgworth to Darwen, where it will be in connection with the tram service to Blackburn, Burnley, Haslingden, and other important centres of East Lancashire.

Edinburgh Telephones.—The Town Council of Edinburgh have unanimously decided that the Magistrates and Council of that town shall approach the Postmaster-General, and ask him to establish and maintain a Post Office telephone system and exchange within the present telephone area.

Collision.—Two costermongers have been awarded £45 and £110 respectively, with costs, at the Wandsworth County Court, against the London Electrical Cab Company, one of whose vehicles collided with the plaintiff's pony barrow in Battersea Park-road, overturning it and injuring the occupants.

Winchester.—At a meeting held at the Dolphin Hotel, Petersfield, last week the proposal of a light railway to connect Petersfield with Winchester, and a loop to join Bishop's Waltham with Droxford on the new Fareham and Meon Valley Railway, was brought forward. Mr. W. G. Nicholson, M.P., presided.

Chichester.—Complaints as to the quality of the gas having been made, it was reported at a recent meeting of the Council that remonstrances had been forwarded to the gas company The Lighting Committee had under consideration the question of supplying the electric light, but had not yet agreed on a report.

Barnsley.—The Local Government Board have granted the Council's application to borrow £25,000 for the purposes of electric lighting. The erection of the buildings is to be proceeded with at once, and it is expected that the foundation stones will be laid in four or five weeks by the chairman of the Park and Lighting Committee.

Ravensthorpe.—At the last meeting of the District Council a letter was submitted from the British Electric Power Distribution Company asking for an interview to discuss with the Council the basis for the pioneering of a scheme of electric lighting. The feeling of the Council appears to be against allowing the company to come into the township.

Fire.—We had no opportunity of chronicling before to-day the fire which broke out at the premises of the General Electric Company, Limited, on Friday last, that being the day on which our last number was issued. We learned the same day that the fire brigade succeeded in mastering the outbreak in less than an hour, and that the business of the firm was being carried on as usual.

Catford.—From correspondence recently published in the *Kentish Mercury*, it appears that the directors of the tramway company have taken important steps lately to change over the system of traction on the line from horses to electric traction, and that without using the overhead trolley system. Some extensions in several directions from the present tramlines are also intended.

Liverpool Overhead Railway Company.—The accounts for the past half-year show an available balance of £16,586, and a dividend is recommended at the rate of 5 per cent. per annum on the preference shares and 4 per cent. per annum on the ordinary charges, against 3½ per cent. per annum on the ordinary shares for the corresponding period last year. The balance carried forward is £4 586, against £2,878 last year.

Q and V Type Storage Cells.—We are informed by the Electrical Power Storage Company, Limited, that to meet the increased demand for E.P.S. small storage batteries, additional premises have been opened at 13, Brownlow-street, Holborn, W.C. These premises are now equipped as a warehouse and factory, in which an adequate stock will be kept, so that orders for batteries, repairs, and recharging will be dealt with promptly.

Wholesale Destruction of Insulators.—At the Leeds West Riding Police Court on Tuesday, Thomas Hodgkins, carter, of Castleford, was fined 15s. and costs for wilful damage to telegraph insulators on the Leeds and Selby road, near Garforth Cliff, by breaking it by throwing stones. In the course of the hearing of the case it was stated that last year 174 insulators had been maliciously broken, and that the replacing of each cost 2s. 6d.

Sheffield.—It is expected that the electric cars will be running in about three or four months. Already the committee are considering an extension of the power station at Kelham Island, and it is very probable that in the very near future the power station will have to be doubled in size. The car-sheds at Tinsley are being expeditiously proceeded with. When finished they will hold from 70 to 80 new cars, and will prove a very valuable depôt. They are to cost about £8,000.

The Stewart Lilliputian Arc Lamp.—We have received from the Stewart Electrical Syndicate, Limited, an illustration of a small enclosed arc lamp they are making a speciality of. It only measures some 13½in. over all, and burns from 12 to 25 hours with one pair of carbons. The lamp contains no clutch and no sliding contacts, consisting merely of a magnet coil and its plunger, to which the upper carbon is directly attached. The lamp has neither clutch, gears, rack, rod, or pinions.

Windsor.—The Windsor Electric Installation Company has been directed to lay a cable from its works in Peascod-street to the Castle, in order to supply the current for the Palace, which has hitherto been generated at the station under the North Terrace, opposite the Royal Library. The cable will be carried up Castle-hill to the Grand Quadrangle, and will be capable of lighting about 2,000 lamps. The work, it is understood, will be completed before the Queen's return from Osborne.

Ediswan Night-Light Switch.—This switch consists of a circular base with a glazed face. On the base about one-half of the space is taken up by the switch, and on the other side a small 2½-c.p. incandescent lamp is mounted. The object of the arrangement is that when the principal lamp in the room is turned out

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by the switch, the smaller lamp enclosed in the night light can be, or is, switched on, thus serving not only as a night light, but indicating the position of the switch in the room.

Kingston (Surrey).—The Town Council have agreed to make enquiries of the local authorities of other towns as to the systems of tramways there adopted, and as to the financial results, and, further, that enquiries be made of the Corporation of Richmond and of the local authorities of Surbiton, Ham, and Esher and the Dittons whether they will be prepared to consider and to confer with the Corporation as to the desirability of entering into arrangements in regard to tramways uniting such districts.

North Riding.—At the meeting of the County Council on the 25th inst. the Chairman stated, with reference to the Telegraph Act, 1892, Amendment Bill and the National Telephone Company's No. 1 and No. 2 Bills, to be introduced in the next session of Parliament, that some correspondence had passed, with the result that the National Telephone Company had agreed to include the North Riding in their schedule of the Bill; therefore, the notice of motion to appoint a committee on the subject was withdrawn.

Hastings.—After a lengthy debate the Town Council have decided to refund to the electric lighting company one-half of Mr. Robert Hammond's account for attending to qualify and give evidence before the Local Government Board inspector upon the question of goodwill which was raised some time ago with reference to the application of the Council for sanction to the borrowing of the amount provisionally agreed to be paid for the purchase of the undertaking of the Hastings and St. Leonards-on-Sea Electric Light Company, Limited.

Salford.—The Town Council at their last meeting considered a resolution of the Electric Light Committee, recommending the Council to appoint Messrs. Lacey, Clirehugh, and Sillar as consulting engineers for a term of three years at a sum of £500 per annum. After a very long discussion the matter was adjourned until the next meeting of the Council. The Council have adopted the Bill to be promoted in Parliament for various purposes, including the making and working of the tramways, making certain street improvements, and purchasing land.

Batley.—The sub-committee appointed by the Batley Town Council to give special consideration to electricity for lighting and traction have visited Halifax, where they inspected the installation by means of which electricity is generated both for lighting and traction. The deputation afterwards travelled on three of the routes of the tramway. After the inspection the visitors were entertained at luncheon by the chairman of the Halifax Electric Lighting Committee, and subsequently they paid a visit to Bradford, where the overhead system is also in vogue.

Waterloo and Baker-street Railway.—The promoters of the electric railway undertaking from Waterloo to Baker-street have submitted plans to the Vestry of St. Martin-in-the-Fields, which propose the construction of a subway for passengers from the north-east corner of Spring-gardens and Charing Cross to a point opposite the Grand Hotel, and thence to the south-east corner of Trafalgar-square, to communicate with a railway station to be constructed at Charing Cross. If this scheme is carried out, then the electric railway companies may justly pose as benefactors to those who have to use the London streets, and particularly the dangerous crossing at the point referred to.

Annual Supper.—The thirteenth annual supper to the workmen connected with the South Staffordshire Tramways Company took place on Wednesday at the Town Hall, Wednesbury, and there was a large attendance. Mr. S. L. Schuster (chairman of the company) presided, and was supported by Messrs. T. R. Blundstone, A Dawson (directors), C. W. D. Joynson (Mayor of Wednesbury), I. Oldbury (ex-Mayor of Wednesbury), J. J. Robbins (general manager and engineer), H. Hatchett (secretary), W. E. Kenway (Birmingham). J. C. Johnson. J. Hemming. E. M. Scott, A. Norton. W. H. Edgerton, W. H. Richards, C. W. Shackleton, W. H. Pickworth, S Tranter, W. Tranter.

Manchester Telephones.—A meeting of the General Committee "for obtaining an independent telephone service for Manchester and Salford and district" was held on Wednesday in the Accountants' Hall, King-street, "to consider the refusal of the Postmaster-General to grant a license to the Mutual Telephone Company, and to decide upon the action to be taken by the committee in order to secure the fulfilment of the object for which it was formed." After a long report had been read it was pointed out by a gentleman present that the license had not been refused, but that it was referred to Parliament. Resolutions in favour of the competing telephone company above mentioned were passed, and were ordered to be circulated freely.

Newcastle.—At a meeting of the New Tramways Committee of the Newcastle Corporation on Wednesday, it was decided to prepare a report of their visit to various towns in relation to the working of the cable and electric system of trams, and present the same at the next meeting of the City Council. The committee will recommend the Council to adopt the overhead trolley electric system for trams for the city, and to engage a consulting expert in order to carry out the system as quickly as possible. They are also to negotiate with the present tramway company to see if they will allow such work as affects their lines to be carried on before the lease expires, in order to advance the work with all possible speed. A further recommendation is that, as far as it can be practically carried out, the inside of the lines be laid with wood.

Personal.—Mr. W. J. Davy informs us that he has finally severed his connection with the Davy Electrical Construction Company, Limited, and has succeeded in abrogating his agreement with that concern.—We are informed that Mr. E. C. Rimington has recently taken over the consulting business formerly carried on by Messrs. Harrison and O'Brien, at 19 and 21, Queen Victoria-street, E.C. Mr. Rimington is making a speciality of investigating and reporting on new inventions and apparatus. For these purposes the laboratory at the above address is well furnished with complete sets of special instruments. Mr. Hadyn J. Harrison will continue to render his assistance in the business.—The Lancaster Town Council have accepted the resignation of the electrical engineer, Mr. C. M. Johnstone, he having been appointed electrical engineer at Shrewsbury.

Fulham.—Both the Battersea and Fulham Vestries are opposing the application made by the County of London and Brush Provincial Electric Light Company, Limited, for a provisional order for the supply of electricity. The same company have presented a Bill in Parliament for powers to carry cables over Wandsworth Bridge and Putney Bridge. The Horsfall Furnace Syndicate have been instructed to at once proceed with the work of the erection of chimney shaft, furnaces, boilers, etc. We learn that the specifications, etc., for the machinery, engines, and mains for the electric lighting station are ready, and the engineer is of opinion that it would be better to write to seven or eight of the best firms in England than to advertise for tenders. He has been instructed to report on the matter at the next meeting of the Vestry, and to submit the specifications for inspection.

New Issue.—The Giffre Electro-Chemical and Power Company has been formed to acquire all the shares of a French company, called the Société Electro-chimique du Giffre, carrying on business in Haute Savoie, France, and having a total authorised capital of £40,000, divided into 1,000 shares of £40 each, the whole of which have been issued, and are paid up to the extent of £20 on each share. The new company's authorised capital is £140,000, in £1 shares, the present issue being 130,000 shares, of which 20,000 will be issued to the vendors as fully paid, leaving 110,000 shares, which are now offered for subscription, with 10 000 reserved for future issue. If the merits of the concern justify an increase in capital from £40,000 (£20,000 paid up) to £140,000, we ought to be extremely grateful to our neighbours across the Channel for letting us have this "good thing" instead of keeping it themselves.

Rotherhithe.—The Vestry have decided to oppose the Brush Electric Lighting Company's application for powers for electric lighting in Rotherhithe. It was said that already one company had powers in the district, and electric light was supplied to several consumers in consequence, and the breaking-up of the roads by another company was objected to, especially as the Vestry might at some future time see the wisdom of itself supplying light and power in the district. Although it was said that the financial position of Rotherhithe would hardly justify any experiments in electric lighting for some time to come, notice was given for the next meeting to move that the Vestry should itself seek to obtain powers for supplying electric light and energy in the district. The Vestry also appointed Messrs. Brown and Mortimer delegates to attend a conference on electric light convened by the Battersea Vestry.

Halifax.—Sir Francis Marindin, representing the Board of Trade, inspected the new section of the Halifax electric tramways from Commercial-street to Salterhebble and to Skircoat Green on Friday last. The first part is completed, but that from the junction on the Skircoat-road to the green is not quite finished. A telephone wire crosses the road between the Stafford Arms Hotel and the terminus, and Sir Francis gave directions that a guard wire should be fixed at this point. Subject to this being done, he gave sanction for the cars to be run. A formal opening of the line to Salterhebble then took place, the Mayor (Councillor J. T. Simpson) starting the first car. A 15 minutes' service was inaugurated, but until the guard-wire referred to has been fixed the cars will not go further than the point referred to. The work of extending the tramways to Booth Town and to Illingworth is being proceeded with, and other routes have been mapped out.

Greenwich.—The Greenwich Committee reported at the last meeting of the District Board that they had considered a letter from the assistant secretary (Fisheries and Harbour Department) of the Board of Trade forwarding for any observations the District Board might wish to offer a draft amended form of consent to an extra high-pressure supply being given by the London Electric Supply Corporation, Limited, together with an amended description of the system to be adopted by the company's orders of 1889 and 1890 in the form in which the Board proposed to approve it, and recommended that, in reply, the Board of Trade be informed that the District Board was of opinion that the responsibility of preparing and issuing the consent and order should rest with the upper Board alone, and that, therefore, the District Board had no observations to offer. This was agreed to, as was also a similar recommendation from the St. Paul (Deptford) Committee.

Annual Dinner.—On Saturday the staffs of the London and Belvedere offices of Messrs. Callender's Cable and Construction Company, Limited, held their first annual dinner and social evening at the Bridge House Hotel, London Bridge. Dinner commenced at seven o'clock, with Mr. Manning (secretary of the company) in the chair and Mr. Johnston (manager of the Belvedere office) in the vice-chair. The toast of "The Company" was proposed by Mr. Manning, who, in the course of a brief speech, wished the company every success. Mr. Johnston seconded, and the toast was enthusiastically responded to. Mr. Manning then proposed "The Works Staff," and, in the course of an apt speech, referred to the exceptional opportunities for becoming better acquainted a dinner of that character afforded. Mr. Carr, in seconding, said that he had been connected indirectly and directly with the company for some years, and dwelt upon the marked growth of the company. Other toasts and music followed.

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Burnopfield.—The Tanfield Urban District Council are being congratulated in the local Press upon the steps which they have taken in lighting the village of Burnopfield by electricity. The final trial was made last week, and everything passed off most satisfactorily. The work was placed in the hands of the Co operative Wholesale Society, Limited, and has been carried out through their Newcastle branch under the superintendence of their engineer, Mr. Wm. Fletcher, of Swalwell. There are at present 46 16 c.p. lamps. The mains are carried overhead on poles, the total length of wire being over three miles. The current is supplied from the installation belonging to the Burnopfield Co-operative Society, and consists of a steam plant, comprising a Robey 25 b.h.p. undertype engine and a Tyne dynamo, with an output of 130 amperes at 105 volts. The switchboard for the public lighting is located in the engine-room, and consists of one main switch and two circuit switches (east and west), voltmeter, and amperemeter, mounted on an enamelled slate with oak frame.

Manchester.—At a meeting of the Tramways Committee of the Corporation on Tuesday a resolution was carried to the effect that having again fully considered the question of overhead *v.* conduit system of haulage of tramcars, the committee expresses its conviction that the trolley or overhead system is the one which is best suited to the immediate requirements of the city and district. This action has been taken in order to settle definitely the question of the rival systems of tram haulage when it comes up at the next meeting of the Council. The executive committee appointed at the recent conference of municipal corporations in Lancashire and Cheshire on the subject of the proposed Electric Power Bills have resolved that all the municipal corporations within the area be urged to adopt resolutions for opposing the second reading of the following Bills: General Power Distributing Company, Lancashire Electric Power Company, South Lancashire and Cheshire Electricity Company, Leicestershire and Warwickshire Electric Supply Company, and the Midland Electric Power Distribution and Lighting Provisional Order.

Liverpool.—The present distance travelled by the electric tramways in the city is probably 4½ miles, and that by horse tramways 70 miles. One result of the recent adoption of penny stages has been to add no fewer than a quarter of million to the number of passengers travelling per week by tramcar, as compared with the corresponding period of last year, and it is anticipated that the increased weight caused by the addition to the number of passengers, to say nothing of delays caused by additional stoppages, will reduce the mileage travelled. The Tramway Committee have appointed Mr. Francis M'Kenna to the position of deputy general manager. A resolution has been passed by the City Council to the effect that Mr. John O'Neill be allowed to retire as from Feb. 1 next from the position of general manager of the tramways on a pension of £566. 13s. 4d., being two-thirds of his salary, to be paid out of the tramway revenue, and that the Council record their high appreciation of the energy displayed by Mr. O'Neill as manager since the Corporation took over the tramways, and regret that the present state of his health makes his resignation necessary.

Appointments Vacant.—The Electricity Committee of the borough of Lancaster are prepared to receive applications from qualified men for the appointment of an electrical engineer; two thoroughly competent electrical engineers are required to erect and run electric plant and rock-drilling machinery in East Indies; the Committee of the Birmingham Municipal Technical School require an experienced man to clean and trim arc lamps; an electrical fitter, used to vice and bench, is required in the north of London. Full particulars of the above vacancies appear in our advertising columns.—The Corporation of South Shields require an electrical tester, able to test meters, transformers, and cables. Salary 35s. per week. Applications, endorsed "Electrical Tester," giving full particulars of experience, with testimonials, to be received by Mr. Jos. A. Jeckell, borough electrical engineer, not later than 28th inst. They also require an improver as assistant to mains superintendent. Applicants to give full particulars of their training. Salary given will be in accordance with capability. Applications to be endorsed "Improver," and to reach the Borough Electrical Engineer by 28th inst.

Dorking.—At the last meeting of the Urban District Council the Finance Committee presented a report on electric lighting, in which they stated that having considered the result of the interviews with Messrs. Hawtayne, Raworth, and Trentham, and some discussion having taken place thereon, they had ultimately resolved that it was evident that all of the gentlemen who had appeared before the committee were very able men, possessing a thorough knowledge of the subject. Each of them, however, took a slightly different view of the question as applied to this town, and after carefully weighing the matter the committee recommended that Mr. Trentham be asked to submit a detailed report, unless the Council were prepared to incur the expense of obtaining one from each of the three selected engineers. The committee also reported the receipt of a letter from Mr. Warden Stevens in which that gentleman stated that it had come to his knowledge that the committee proposed to appoint another consulting engineer. Such action would be damaging to his reputation, there being no just reason for the same. He would be glad to know if that was the case or whether the opinion only of another expert obtained on his recommendations. The committee recommended the Council to reply that Mr. Warden Stevens had been employed by the Council for a report, etc., and that his fees in connection with the work had been paid. The report was considered in committee at the end of the public business.

Southwark.—The surveyor having reported that the cost of lighting the church clock by electricity will practically be the same as is at present paid for the supply of gas, the Vestry decided at their meeting on the 24th inst. to light the clock by electricity. It is not suggested at the present time to provide and fix an automatic switch, but to instruct one of the Vestry's employés to turn the current on and off at certain fixed hours. At the same time, should it be found necessary to fix the switch, Messrs. Rashleigh Phipps and Co., whose tender has been accepted, have undertaken to provide and fix it at any time for the sum of £6. With regard to intercommunication in London by underground electric railways, the committee, having considered a letter from the Vestry of Westminster requesting the Vestry to join that authority in making representation to the London County Council to oppose certain underground electric railway schemes with a view to the appointment of a parliamentary committee to consider and report upon the routes along which further underground railways of this character for London should pass, so that such schemes should be based upon a considered and formulated plan of intercommunication throughout the county generally, to be defined by Parliament itself, have recommended that the London County Council be informed of the Vestry's concurrence with the view expressed by the Vestry of Westminster. The Kensington Vestry have taken similar action.

St. Giles.—At the last meeting of the Board of Works the Clerk (Mr H. C. Jones) said that at the last meeting of the Board, through the Charing Cross and Strand Electric Supply Corporation keeping open for a long time large sections of the roadways when laying their mains, he was directed to inform the corporation that in future the Board will open the trenches necessary for the laying of the mains, and restore and make good the paving afterwards, and if they thought it desirable they would submit the question to the decision of the Board of Trade. Their objection was that the corporation would not put themselves under the obligation of not opening more than 50ft. of the roadway at one time. He had a letter from the corporation stating that they would only open 15ft. of the roadway at one time, and would fill in the trenches at night. This offer he had accepted. The action of the clerk was approved. A letter was read from the assistant secretary of the Fishery and Harbour Department, Board of Trade, dated the 20th inst., transmitting a description of the system which the Board of Trade propose to approve for the supply of electrical energy by the Charing Cross and Strand Electricity Supply Corporation, under the Holborn and St. Giles Electric Lighting Order, 1898, and stating that the Board of Trade propose to give their consent to the use of high-pressure trunk mains for the transmission of electric power not exceeding 400,000 watts in each cable. The Board approved of the proposal of the Board of Trade.

Croydon.—The sanction of the Local Government Board has been received to loans for the following amounts, repayable in 20 years—viz.: purchase of site and premises for sub-station, Upper Norwood, £850; purchase of Crystal Palace District Electric Supply Company's undertaking within the borough, £2 250. The estimates for the further extension of the works are as follows: 500-kw. steam alternator, £5,200; pipework, switchboard, and rheostats, £540; two boilers and piping, including brickwork, £1,970; one water softener and connections, £260; new cooling pond, pipework, and sprays, £600; new battery and connections, £740; new pump, £210; extension to stores, £160; new hot-well, £110—total, £9,790. The estimate for public lighting and low-tension main extension is—Bramley-hill, £200; Selhurst-road and Whitehorse road, including transformer chamber, £484; Beulah-hill, Harold-road, and Highfield-hill, etc. including transformer chamber, £1,210; Portland-road, South Norwood, and Station-road, £740; sub-station G and cable, London-road and Broad-green, in addition to item of £1,000 on April 4 last, £600; to this add sundry small extensions, house services, extra transformers, etc., for Croydon, £1 400; extra mains in North End, £600; extra mains at Norwood, £620; sub-station J (Addiscombe), £340; mains from St. James's-road to sub-station J, £430; low-tension mains in Addiscombe, £340; ring main, sub-station J to I, £280; sub-station S (Gloucester), with switch gear, £240; sub station I, at East Croydon, £280; house services, etc., £1,500; 100 lamps and posts complete, with switch gear, labour, cable, etc., £3 483; contingencies on the whole of these works, say, £463—total, £22,000. Application is to be made by the County Council to the Local Government Board for sanction to borrow the sum of £22,000 for carrying out the above works.

Lancashire Electrical Power Bill.—This Bill came before Mr. Thoms, examiner of private Bills, at Westminster on Tuesday. It contains powers for providing electric generating stations, erecting buildings, and works in various parts of Lancashire and Cheshire, and storing and distributing electricity for various purposes. The capital of the company is £3,000,000, in £10 shares, and among other districts to be served are Bootle, Preston, Clayton-le-Dale, Whalley, Padiham, Burnley, Rochdale, Stalybridge, Macclesfield, Knutsford, Ellesmere, Neston, and Parkquay. Mr. Bell appeared as parliamentary agent for the promoters, and Mr. Lees for the memorialists against the Bill, who included the Corporation of Warrington, and the urban districts of Ormskirk, Lytham, Burscough, Stretford, and Dukinfield. The principal allegation against the Bill on proofs of standing orders was that the Bill proposed to supply electricity to certain places which were not specified in the parliamentary notices published in the *London Gazette*, but only indicated on a map. Mr. Lees said the Bill defined absolutely the area of supply, and yet the promoters had not given the necessary particulars in the parliamentary notice. In previous Bills the examiners had decided against promoters on similar grounds, and there was nothing in the present Bill to make it different from other Electrical Power Bills. Mr. Bell said the only Bill before

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the examiners last year in which opposition was made was a General Powers Distributing Bill, so that this was a new departure. The Examiner's ruling in a former case was that it was not sufficient to simply refer to a map, but that the area of supply ought to have been stated in the published notice, but in that case they had not deposited a map at all; the map was only referred to. In the present Bill they had devoted a page to defining the area. Mr. Lees said the Bill provided for the selling and supplying of electricity to Bootle and other places in Lancashire and Cheshire, but the parliamentary notices did not specify the power to supply these places. The Examiner said there was a full definition of the districts in the Bill, and he could not understand why the promoters did not see their way to putting them into the notices. Mr. Bell said that to have put all the places in Lancashire and Cheshire which they proposed to supply into a notice would have required a full copy of the *London Gazette*. The Examiner decided against the promoters on this and other points, and said he would report the various matters to the Standing Orders Committee after the meeting of Parliament.

Speed of Trams.—Major Marindin's report on the speed of the electric trams at Clontarf states that he was unable to recommend that the application for an increase of the maximum speed from 10 to 12 miles an hour between Annesley Bridge and Dollymount be acceded to. The speed of the trams in the city portion of the section should be limited in accordance with the Corporation resolution—viz., seven miles an hour in ordinary open streets, five miles an hour in congested districts, and four miles an hour at facing points. The following are the regulated speeds at different points: between Nelson's Column and Amiens-street railway bridge five miles an hour, Amiens-street Bridge and Annesley Bridge seven miles an hour, and Annesley Bridge and Dollymount 10 miles an hour, except on the curve between Vernon-avenue and Fort View-avenue, where the speed should not exceed eight miles an hour. Between Amiens-street Bridge and Annesley Bridge the road was so wide and open that he did not think a speed of eight miles an hour would involve any risk. As regards the Donnybrook line, the report states that both the city engineer and the surveyor to the Pembroke Commissioners were thoroughly satisfied with the manner in which the work had been carried out. On the portion inside the city boundary the speed must, according to the recent resolution of the Corporation, be limited to seven miles an hour, although the roads are so wide and open that he (Sir Francis Marindin) did not think there would be any risk if the cars were run at eight miles an hour, with a limit of six miles an hour round the curve at the south-east corner of Merrion-square. Outside the city the local authority wished for a higher rate of speed, and, in the inspector's opinion, 10 miles an hour might be safely allowed as a maximum, with a limit of eight miles an hour from Baggott's Bridge to the junction with the line at the end of the Pembroke-road, six miles an hour round the curve at this junction, and round the curve at the junction with the tramway in Waterloo-road, and four miles an hour through the village of Donnybrook from Eglinton-terrace to Church-lane. Speed indicators must be attached to the cars for the guidance of the drivers. The Board of Trade propose to act in accordance with the recommendations contained in Sir Francis Marindin's report. With reference to the speed of the electric trams on the Dalkey and Kingstown line, Sir Francis Marindin reported in favour of an increase to 10 miles an hour on wide roads, including the interval between Haddington-road and Williamstown. The present speed of the tram is eight miles an hour.

Glasgow.—The electric tramway in High-street, from the Tron Church to the junction with Parliamentary-road, was inspected on Saturday by Major Marindin on behalf of the Board of Trade. Accompanied by Mr. Young, the general manager, and Mr. Clark, the engineer, Major Marindin made a journey over the route in a special car, and afterwards inspected the overhead wires and their connections, with the result that he expressed himself satisfied. A special feature of the service on the route will be the early morning cars for workmen. The electric power will be derived from the station of the Springburn system, with which the new route will run in connection. Halfpenny sections obtain, the fares ranging from ½d. for part to 1½d. for the whole of the line opened. The *Glasgow Herald* says that Mr. John Young has prepared a draft scheme for the extension of the electric overhead system of traction to the various routes in the city. Taking into consideration the site of the proposed 1901 exhibition, the number of horses to be set free, and the existence of space for the necessary depôt accommodation, he recommends that the next section to be converted should be the main east and west route, from Whiteinch to London-road, and Dalmarnock, *viâ* Bridgeton Cross. About 800 horses could be dispensed with. The necessary sheds would cost £6,250. Mr. Young suggests that the work on this route should be begun immediately, and that the others should be taken up in the following order: Overnewton to Crosshill and Langside, freeing 450 horses; and Pollokshaws and Shawlands and Pollokshields routes from Eglinton Toll outwards, freeing 300 horses. These routes might be joined, for a time at least, with the Springburn system, thus avoiding the turning of cars in Mitchell-street. Mr. Young estimates an expenditure of £25,000 in providing additional car sheds at Coplawhill, and the cost of equipping the three routes at £54,000, in addition to £61,000, which would be the cost of renewing the lines in ordinary course. Mr. Young suggests that the Parkhead and Paisley-road route might next be undertaken, and the Maryhill and Mount Florida, Dennistoun and Kelvinside, Woodlands-road, and Possilpark and Govan lines dealt with in the order most practicable. The scheme is to be considered by the Sub-Committee on Electric Tramway Traction. At the last meeting of the Town Council the minutes of the Electricity Committee, which were approved, stated that a letter had been received from the Kelvinside Electricity Company offering to sell their undertaking to the Corporation for the sum of £45,000. The special sub-committee on the subject instructed the engineer to prepare and submit a report as to the value of the company's undertaking to the Corporation. A sub-committee was appointed for the purpose of considering and reporting as to the expediency of the Corporation selling or hiring electric motors and other apparatus in connection with which electricity may be used for motive or heating purposes.

London County Council.—The Council do not approve of the plans submitted by the Blackheath and Greenwich District Electric Light Company, Limited, for the construction of a generating station and works on the north-west side of Blackwall-lane, East Greenwich, it being considered undesirable to sanction the construction of a wood and iron temporary enclosure to any part of the building, and, moreover, the proposed construction of the building is considered in several respects unsatisfactory. The Council have sanctioned a further expenditure of £65 in respect of electric light installation at the chief station of the fire brigade, the work to be executed by the National Electric Free Wiring Company as an extra under a supplemental contract. The Council have also sanctioned the provision of telephonic communication between each of the 20 divisional stations of the metropolitan police and nearest superintendent's station of the fire brigade, the annual cost being estimated at £377. 2s. 6d. On the establishment of telephonic communication between the superintendents' stations of metropolitan police and fire brigade, like communication between the fire brigade stations at Battersea, Camberwell, Tooting, and Clapham, and the police stations in the same localities, is to be discontinued. Agreements have been entered into in respect of the provision and maintenance of four fire alarms at Putney and Roehampton, and in respect of telephonic communication between the Whitefriars stations and the street stations in Farringdon-street and the Strand, and the watch-boxes in St. Martin's-le-Grand and Snow-hill, and between the Woolwich station and Woolwich free ferry. Extensions of mains were granted to the following companies under the usual conditions except where stated otherwise: Metropolitan Electric Supply Company (three)—there is an extra condition—viz., that the work in the Strand, Wellington-street, Catherine-street, and Southampton-street when once commenced be carried on continuously both by day and by night until completed; London Electric Supply Corporation; Kensington and Knightsbridge Electric Lighting Company (two); Blackheath and Greenwich District Electric Light Company; County of London and Brush Provincial Electric Lighting Company; Notting Hill Electric Lighting Company; Charing Cross and Strand Electricity Supply Corporation, under the St. Martin's Order, 1889; Vestry of St. Pancras (two)—the Vestry of St. Pancras has asked that, as regards house-service lines, the Council will waive the requirement of Section 11 of the St. Pancras (Middlesex) Electric Lighting Order, 1883, that a notice accompanied by a plan shall be given of all intended work, and that the Council will accept instead four days' notice without plans in respect of such works. The Council will accept, as compliance with the requirements in Section 11 of the St. Pancras (Middlesex) Electric Lighting Order, 1883, four days' notices without plans of the intention of the Vestry to lay down house-service lines from mains already laid; Vestry of Islington, under the Islington Order, 1893 (two); South London Electric Supply Corporation, under the Lambeth Order, 1892. The Council, on Oct. 25, 1898, sanctioned the works referred to in a notice of the Blackheath and Greenwich District Electric Light Company, with the exception of the laying of mains along Deptford Bridge, which part of the works the Council formally disapproved. The company appealed to the Board of Trade against this disapproval; and at the hearing of the appeal on Jan. 12 the Council's solicitor drew the attention of the Board's inspector to Section 81 of the company's order, which provides "that nothing in the order shall authorise the undertakers . . . to interfere with or make use of any county bridge . . . vested in the Council, except with the consent in writing of the Council;" and the inspector was further informed that the Council's consent to the laying of the mains along Deptford Bridge had never been obtained or even applied for under that section, which, moreover, did not confer upon the company any right of appeal. The inspector decided that the objection raised was fatal, and that, therefore, the appeal could not be proceeded with.

Bradford.—A report has been issued by the city electrical engineer (Mr. A. H. Gibbings) dealing with the extensions and new plant required for the electricity department of the Bradford Corporation. We are indebted to the *Bradford Observer* for the following particulars: "The recommendations are based upon an estimated increase in the demand for the supply of current at a rate equal to the increase in the past three years. In this period the percentage increase, instead of decreasing, has increased year by year. Towards meeting the demand the Gas and Electricity Committee have already placed orders for two 300-h.p. sets, which will be delivered by September. This will leave the new works with very nearly a full load on all the machinery, and space only left for two further sets of 600 h.p. each. In the event, however, of any outlying districts in the area proposed to be incorporated requiring a supply of electricity, it will be advisable to couple high-tension dynamos to those engines rather than to be handicapped by waiting until the works are extended. It will also be necessary to order a condenser, at an estimated cost of £1,500, which will complete the condensing arrangements for the present new works, an induced-draught boiler for the new works, a grinding machine for the commutators of

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the 600-h.p. sets, motors and gearing on the travelling crane in place of the hand gearing, two feed-water heaters, and an electrical boiler feed pump. Mr. Gibbings further states: 'The extensions for the outdoor department, with the ordinary increase of business, and not allowing for special lines of new cables or new feeders which the committee may subsequently decide to lay, will amount to £10,000. I have included the approximate cost of all the items mentioned in this report—namely, those which have already been passed by the committee and those which are herein recommended, in the subjoined table, the borrowing powers for which it will be necessary to apply for before putting any of the work in hand. I would point out to the committee that the last borrowing powers, which were completed in similar statement form in December, 1897, have not yet been granted by the Local Government Board. The estimated cost in the accompanying list is, of course, somewhat in excess of the anticipated expenditure, owing to the antipathy of the Local Government Board subsequently to grant additional sums which may have to be incurred, through unforeseen circumstances, on any particular item. It is, therefore, best to be well on the right side of our requirements. The details are appended: two 300 h.p. engines and dynamos, £450; two switchboards, £250; two condensing plants, £3,500; one motor-generator for balancing, £800; one induced-draught boiler, £1,800; one grinding machine for commutator, £50; motors and gearing for travelling crane, £150; two feed-water heaters, £250; one feed pump, electrical (new works), £150; one lathe, £200; one drilling machine, £90; one shaping machine, £60; one screwing machine for pipes, £20; one feed pump, electrical (old works), £120. Extensions of existing condensing reservoirs for increased load at new works, estimated cost, £3,000; cables for ordinary extensions to various districts, £10,000; one additional battery of 1,500 ampere-hours capacity, to give 250 volts when discharged 50 per cent., £2,000; switchboard and connections for above, £250. Buildings: additions to Bolton-road works, one new floor in present battery-room, £150; one new floor in old boiler-shed, £200—total, £27,540.'"

Watford.—At the last meeting of the Urban District Council it was reported by the Clerk that the tenders for electricity meters and cut-outs were advertised for one year, in accordance with the directions of the committee. In accordance with the recommendation of Mr. Hawtayne, the Reason Manufacturing Company's tender for cut-outs, and Messrs. Venner and Co.'s tender for meters, was accepted. Mr. Edwin Radford, clerk of the works, presented the following report to the Council: "Gentlemen,—In accordance with instructions received from your clerk, on the 10th inst., I hereby beg to report on the above works as follows, continuing from my last report, dated Oct. 18 1898: At that date the iron windows were not delivered and the brickwork delayed in consequence, as, although the contractor was allowed to go on by means of toothing up the reveals of the windows, he could not go any higher than the springing of the arches. Five of the windows were, however, delivered on Nov. 1, and the brickwork then proceeded, but slowly, by reason of the scarcity of bricklayers. By Nov. 16 all the front wall was finished; on the 19th the windows were delivered for the openings in the back wall, the whole of the engine-house part being now ready for roof principals, which were commenced to be fixed on the 22nd. This part of the work would have been commenced on the 21st, but was stopped by wet weather. The 23rd also was wet, and no work done in consequence. On the 24th I made the discovery that a manufacturer's error in the making of roof principals had occurred, upon which I submitted a detail drawing to the architects showing a way out of the difficulty—viz., by fishing the boiler-house and engine-house principals together. To this I got a reply on Dec. 1 that, in order to avoid delay, the architects would sanction the alteration I had suggested. I may here mention that the weather was again very inclement on Nov. 25 and 26 and little or no work could be done in consequence. The brickwork was then ready for Green's economiser. On Nov. 30 a foreman arrived from the boiler makers (Messrs. Babcock and Wilcox) to commence erecting the boilers; he, however, could not commence, as the stone bases on which the boiler stanchions stand had not been delivered. Acting on my advice, he returned to his firm for instructions. On Dec. 3 I observed that very common flagstones (from 2½in. to 3in. thick and of little better quality than self-faced) were being used, two together, instead of 6in. block York. This I objected to, and told the erector that I must insist on stones of the proper size and quality being used. On the 7th, however, I received a letter from Mr. Hawtayne, by hand, from one of the Brush Company's employés, instructing me to allow the flagstones to be used, which I did. The weather was again very wet on the 6th and 7th. The Green's economiser was commenced to be fixed on the latter date, the erecting of boilers being proceeded with. On the 10th I began to be very dubious about being able to get at some of the tubes to the boilers to clean or remove in case of fracture. At first I thought that the cleaning rods might be jointed, as in sweeps' apparatus, and, with regard to the cutting out and removal and making good of any faulty tubes, a loose collar might be used. I was, however, informed by Messrs. Babcock's manager that this could not be done. On Dec. 12 I was shown, by Mr. Waterland, a Brush Company's drawing of the boilers for the first time, on which I observed an arbitrary dimension relating to the back wall which had not been adhered to in the drawings of the buildings, and which consequently could not be carried out, but which would have been had I been in possession of that drawing from the first, and an unfortunate structural error would thus have been avoided. I am now getting over the difficulty by removing two 3ft. piers which occupy the space denoted, '1ft. 6in.,' and filling the opening with folding doors, one half of which doors are provided for in the contract. On the 14th I was shown another drawing, by Mr. Waterland, of the travelling crane for the first time. This had a dimension on it which I at once saw was contrary to the figured dimension on the building drawing of the width of the engine-house, and that the transverse girders of the crane must be too short if the makers had worked to their drawing. This difficulty I have overcome by having distance pieces between the stanchions and walls and using longer bolts. It will be now seen that the delay in the delivery of iron windows, the wet weather, etc., have had a prejudicial effect on the finishing of these buildings. The roofs and all glazing, however, is now virtually finished, also all brickwork, with the exception of a small portion of flues. The large door frame mentioned above is fixed and brickwork in same connection is being proceeded with, and will, for one set, I should think, be finished in about a week's time, if I may be allowed to use axed arches instead of T. B L. rubbed and gauged ditto, on which point I have consulted Mr. Hawtayne, but have not yet received a reply. One large set of the electricity-producing plant is being fixed. The floor of the engine-house cannot be proceeded with until the whole of this plant is fixed, as no provision has been made for access to the holding-down bolts of engine beds. The floor of the boiler-house will be got on with as soon as the boiler setting and the alteration to back wall are complete. The boiler setting is going on, and here I must mention what I consider is a grave matter, and that is, that there is no firebrick lining on the side walls of setting, a distance of about 8ft. 6in. from main flue, neither is there any on the end walls closely abutting and where they connect with the main flue, which last-mentioned flue is lined and paved throughout with firebricks, a total length of about 85ft. There is also a firebrick lining in the chimney shaft carried to a height of 25ft. and about 40ft. away from any furnace, while the above-mentioned 8ft. 6in. of the side walls and also the end walls of the new boiler settings will have the fire close to them. This is, I consider, a seriously weak point. Not having received the specification or drawing showing this portion of the work until Jan. 6 last I was unable to remark on the matter. I have mentioned the point to Mr. Hawtayne and also to the Brush Company's foreman, but the work is still progressing. I may further state that I had an interview with Mr. Hawtayne on the 9th inst., and he has promised to see that for the future I am supplied with complete drawings, specifications, and quantities, of which I demonstrated to his satisfaction I have not yet been put in possession."

PROVISIONAL PATENTS, 1899.

JANUARY 16.

947. Improvements in or relating to electrical furnaces for the production of calcium carbide and other substances. Joseph Barlick, 50, Wellington-street, Leeds.

962. Improvements in electric arc lamps. Walter Crudgington, 24, Temple-row, Birmingham.

974. Improved prepayment electricity meter for continuous or direct currents whose action depends on deposition of copper in a balance against silver coins. Edward Frederick Terrey and Charles Herbert Ingless Phillips, 37, Gladstone-road, Boscombe, Bournemouth.

1001. Improvements in and relating to electric heaters. Edwin Forsythe Porter, 77, Chancery-lane, London. (Complete specification.)

1024. Improvements in dynamometrical apparatus. Henri Bouron, 36, Chancery-lane, London. (Complete specification.)

1044. Improvements in switches for electromotors and the like. Robert Alexander Sloan and John Edward Lloyd Barnes, 34, Castle-street, Liverpool.

JANUARY 17.

1047. Improved construction of straight and curved underground conduits for enclosing electric conductors, haulage cables, and other means of communication allowing connection of vehicles, sledges, and moving bodies to same, and allowing access below. George William Sutcliffe, Whingarth, Marple, *vid* Stockport.

1063. Improvements in the method of and means employed for controlling the trolleys of electric cars. William Whitehead Richardson, Penny Bank-chambers, Halifax.

1067. Improvements in electric heaters. Friedrich Wilhelm Schindler, 15, Took's-court, Cursitor-street, London.

1109. Improvements in electric light brackets. Walter Gordon Wilson and Percy Sinclair Pilcher, 34, Great Peter-street, Westminster, London.

1103. Improvements in telautographs. Philip Arthur Newton, 6 Bream's-buildings, Chancery-lane, London. (The Gray National Telautograph Company, United States.) (Complete specification.)

1105. Improvements in coin-freed electrical shocking machines. Archibald Campbell, 73, St. Stephen's-road, Upton Park, London.

1106. Improvements in and relating to facia for electrical instruments. Max Byng and Richard Pentney Eidsforth, 73, St. Stephen's-road, Upton Park, London.

1147. Improvements in or connected with electric arc lamps. William James Davy, 40, Chancery-lane, London.

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1141. A method of and means for deriving two or more alternating currents of different phase from a source of single-phase electrical supply. Herbert Appleton Wagner, Norfolk House Norfolk-street, Strand, London.

JANUARY 18.

1154. Improvements in or relating to the regulation of pressure of electric circuits and apparatus therefor. Leopold William Heath and James Hermann Field, 14, Victoria-street, Westminster, London.

1156. Improvements in current-collecting apparatus for electric tramways. Charles William Godson Little and Arthur James Ireland, Heckington, Lincolnshire.

1179. Improvements in the construction of dynamo-electric machines and motors. Matthew William Walbank Mackie, 77, Turnmill-street, London.

1188. Improvements in guards for overhead electric conductors such as trolley wires and the like. Peter Lloyd Jones, 34, Castle-street, Liverpool.

1201. Electric generator of heat. Arthur Westrop, South Lodge, Enfield.

1208. Improved system of underground electric conductors. Alessandro Sterzo, 77, Colmore-row, Birmingham. (Complete specification.)

1218. Improvements in telautograph apparatus. Frederick William Cushing, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

1230. Improvements in lighting trains by electricity. Chaimsonovitz Prosper Elieson and William Slater Naylor, 4, South-street, Finsbury, London.

1232. A process of and means for transforming electric currents. Hans Peter Jörgen Julius Thomsen, 1, Queen-Victoria-street, London. (Complete specification.)

1233. Improvements in arc lamps. Frederick John Borland, 322, High Holborn, London.

JANUARY 19.

1266. Improvements in and connected with the manufacture of electrical cables or conductor conduits. Arthur Musker, 15, Water-street, Liverpool.

1293. Improvements on portable electric lamps. Henry Nehmer and Ferdinand Nehmer, 27, Sektorde-street, Clerkenwell, London.

1324. Improvements in and in the manufacture of electrode plates for electric accumulators. William Phillips Thompson, 6, Lord-street, Liverpool. (The Accumulatoren und Elektricitätswerke-A.G. vorm. W. A. Boese und Co., Germany.) (Complete specification.)

1334. Improvements relating to electrically-illuminated signs or advertisements. William Latta Campbell, 19, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JANUARY 20.

1381. Improved process in moulding, electrifying, and hardening castings to withstand intense heat, furnace bars for marine, locomotive, land boilers, other furnaces, and the like. John Stanley Holme, Southolme Villa, Egremont, *vid* Liverpool.

1394. Improved electric clock and general registering or equal power maintaining or discharging machine. James John Stockall, sen., 50, Ferme Park-road, Finsbury Park, London.

1427. Improvement in and relating to primary batteries. Walter Rowbotham, 18, Southampton-buildings, Chancery-lane, London.

1431. Improvements in supports for the active material of accumulator electrodes. Floris Wüste, Friedrich von Rupprecht, and Carl von Rupprecht, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JANUARY 21.

1434 Improvements in telegraphic relays and to appliances for use in connection therewith. Sidney George Brown, Van Buren, Poole-road, Bournemouth.

1435. An electric mechanism for driving turret and other clocks. Sharman D. Neill, 12, Donegall-place, Belfast.

1439. An electric lamp-hour meter. Archibald John Howard and William Frank Howard, Euston Villa, Cheddon-road, Taunton.

1483. Improvements in and relating to automatic electric railway signalling. George Croydon Marks, 18, Southampton-buildings, Chancery-lane, London. (Irénée Mazel, France.)

SPECIFICATIONS PUBLISHED.

1897.

27749. Arc lamps. Davy and Thomas-Davies.

30321. Switching apparatus for preventing self-induction sparks from being formed during the operations of disconnecting and reversing electromotors. Egger.

1898.

2429. Means for controlling the working of lifts, motors, and other appliances operated by electric energy. Ker.

22419. Telephone transmitters. Byng.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1899.	Corresponding week 1898.	Increase or decrease	Total receipts for half-year. 1899.	1898.
		£	£	£	£	£
Birmingham Tramway	Jan. 21	3 744	3,517	+ 227	11,350	10 523
Blackpool and Fleetwood Tramroad	,, 21	129	—	—	410	—
Bristol Tramways and Carriage Co.	,, 20	2 578	2,380	+ 198	—	—
City and South London Railway	,, 22	1,133	1,075	+ 58	3,419	4,334
Dover Tramways	,, 21	148	108	+ 40	454	333
Dublin U.T., elec. cars	,, 20	582	547†	+ 35	1,599	1,565†
Dublin S.D. Electric Tramways	,, 20	634	455	+ 178	1,749	1,215
Halifax Corporation Tramways	,, 11	238	—	—	7,356*	—
Liverpool Overhead Railway	,, 22	1,326	1 354	- 28	5,293	5,510
South Staffordshire Tramways	,, 20	679	634	+ 45	1,766	1,785

* Since June 29, 1898. † Including horse cars.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	23-24
Bournemouth and Poole Electric Supply, Limited, Ord.	10	12½-13½
—— 4½ per cent. Cum. Pref	10	10½-11½
British Electric Traction, Limited. Ordinary, Nos. 1-30,000	10	17½-18½
—— 6 p. c. Cm. Pf., 30,001-40,000 (all paid)	10	13½-14
—— 5 per cent. Perpetual Debenture Stock	10	119-121
Brush Electrical Engineering Limited, Ordinary	2	1¾-2
—— Non. Cum., 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	114-116
—— 4½ per cent. 2nd Debenture Stock	100	101-104
Callender's Cable Company, Debentures	100	110-113
—— Ordinary	5	9½-10½
Central London Railway, Ordinary	10	9⅞-10⅛
——	8	7¾-8½
—— Pref. Half-Shares	8	3½-4
—— ,, ,,	5	4-4½
Charing Cross and Strand	5	11-12
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	8½-9½
—— 4½ per cent. Debentures	100	113-115
City of London, Ordinary	10	23½-24½
—— ,, 90,001-100,000	10	23-24
—— 6 per cent. Cumulative Pref.	10	16½-16¾
—— 5 per cent. Debenture Stock	100	125-130
City and South London Railway, Consolidated Ordinary	100	69-71
—— Ordinary	8	3½-4
—— 4 per cent. Debenture Stock	100	133-135
—— 5 per cent. Pref. Shares	10	14½-15½
—— ,, ,, '96	10	14-15
County of London and Brush Prov. Elec. Light Co. (Ord	10	12½-13½
—— ,, ,, No. 30,001-40,000	10	12-13
—— 6 per cent. Cum. Pref.	10	14½-15½
Crompton and Co.	8	2½-3
—— 5 per cent. Debentures	—	94-99
Crystal Palace District, Ordinary 5 per cent. Stock	100	125-130
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	8	2½-3
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	97-99
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5-5½
Electric Construction, Limited	2	2½-2¾
—— 7 per cent. Cumulative Pref.	2	3-3½
—— 4 per cent. Perp. 1st Mort. Deb.	100	103-105
W. T. Henley's Telegraph Works, Ordinary	10	24-25
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9-10
—— 7 per cent. Preference	5	9½-10½
Imperial Tramways, Limited	6	16½-17½
India Rubber, Gutta Percha, and Telegraph Works	10	22-23
—— 4 per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	13-14
London Electric Supply, Ordinary	8	3½-4
—— 6 per cent. Pref.	5	6½-7
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	102-104
Metropolitan Electric Supply, Limited, Ord., No. 1-62,500	4	19-20
—— ,, ,, No. 62,501-85,000	4	12-13
—— 4½ per cent. First Mortgage Debenture Stock	100	118-121
National Telephone, Ordinary	5	5½-6
—— 6 per cent. Cum. First Pref.	10	14-16
—— 6 per cent. Cum. Second Pref.	10	13-15
—— 5 per cent. Non. Cum. Third Pref.	5	5½-6½
—— 3½ per cent. Deb. Stock, Red.	100	99-102
Notting Hill Electric Lighting Company, Limited	10	17-18
Oriental, Limited, 1879	1	1½-1¾
—— £5 Shares	5	7¼-7½
—— £4½ Shares, New	4½	6¼-6½
Oriental Telephone and Electric Company	1	⅝-¾
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6¾-7
Royal Electrical Company of Montreal	¼	160-165
—— 4½ per cent. First Shares Mortgage Debentures	100	105-107
South London Electric Supply, Ordinary	3	3-3½
St. James's and Pall Mall, Limited, Ordinary	8	17-18
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	37-41
—— 5 per cent. Bonds	100	103-105
Waterloo and City Railway, Ordinary	100	108-111
Westminster Electric Supply, Ordinary	5	15½-16½

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NOTES.

The National Telephone Company's Bills.—The memorials presented against these Bills by the Corporations of Edinburgh and Glasgow on account of alleged insufficiency of notice in the advertisements, were thrown out by the Examiner of Standing Order Proofs last week.

The Keely Motor.—It is stated that a post-mortem examination of the laboratories of the late J. W. Keely has revealed that compressed air was responsible for the success of the Keely motor. The tubes used to convey this compressed air to the motors were found concealed in the floors.

International Congress on Physics for 1900.—The French Physical Society has decided to call an International Congress on Physics in 1900, which will be held in the exhibition buildings. The day proposed for opening the congress is July 16, and it is suggested that the meetings shall be continued for about a week.

Acetylene Lighting.—The need for great care in the arrangement and management of acetylene plant has been sadly illustrated by the explosion this week at Netherseal Colliery, near Ashby-de-la-Zouch. The roof of the building containing the gas plant was blown off and the place wrecked. A man near the site of the explosion was killed.

New Cables.—The concession for the laying of the proposed German-American cable has been granted to Messrs. Felten and Guilleaume, of Mulheim-am-Rhine. We understand from the *Financial Times* that a company with a capital of one million pounds is to be formed to work the concession, and that the cable will be manufactured at some new works in Cologne.—It is also stated that a concession for a submarine cable from Stamboul to Constanza has been granted to Dr. Zender, who is connected with the Deutsche Bank.

Faraday House.—We are informed that, as a result of the recent scholarship examinations in connection with the Electrical Standardising, Testing, and Training Institution, the Board of Control of this institution have made the following awards: to Mr. Gerald Adamson Hopkins, a Maxwell scholarship of 50 guineas, tenable for two years; to Mr. Thomas Gregory Smith, of Blackheath School, an exhibition of 30 guineas, tenable for two years; to Mr. Leonard Roseveare, of Dunheved College, Launceston, a prize of 20 guineas.

The Niagara Power Company.—In a recent issue we referred to the fact that the Niagara Falls Power Commissioners were endeavouring to invalidate the charter which had been granted to the Niagara Falls Power and Electric Company, because that company had not by Sept. 1 completed a water-power plant of 25,000 h.p., and had not ready for transmission at least 10,000 e.h.p. The case has been tried in the Court of Common Pleas and judgment entered for the Power Company on every point at issue, so that these important works will not be hindered in their development.

Electrical Engineers (R.E.) Volunteers.—The first grand smoking concert of this newly-formed volunteer corps took place at the Holborn Restaurant on Friday last, Jan. 27, Major R. E. Crompton presiding. A capital programme was gone through, contributed by members of the corps and others. At the conclusion the Chairman briefly addressed the company, hoping that that would be the first of many similar gatherings. With the singing of "God Save the Queen" the proceedings then terminated at a very reasonable hour (about 11 p.m.), a thing which is not characteristic of smoking concerts as a rule.

Telephone Athletic Association.—The sixth annual Bohemian concert of this association was held last Friday evening in Westminster Town Hall, Mr. W. E. L. Gaine in the chair. There was a fairly large gathering, representative of most of the telephone companies. Amongst the stewards were Messrs. W. Aitken, V. Baldwin, J. W. Campion, L. Carr, A. Dalzell, H. Davis, C. Elliot, Haley, Kenny, Leslie, Shill, and C. W. Stevens. The concert committee was composed of Messrs. E. Hare, T. C. Walker, and A. T. Waller, and to these gentlemen the audience were indebted for a very pleasant evening. There was a good programme, the items from which were very well rendered.

Street Boxes in Westminster.—At a meeting of the St. James's Vestry yesterday a letter from the Board of Trade was considered with respect to the London Electric Supply Corporation's proposed use of an extra high-pressure supply in the district. An amended form of consent was enclosed from the Board of Trade, and it was pointed out to the Vestry that they would probably not desire to offer any observations on that point. With regard, however, to the proposed system of supply by which transformers are to be permitted in street boxes, there might be grounds for objection, and the Vestry were recommended by the Works Committee to strongly object to these transformer boxes being placed in the public thoroughfares unless the consent of the Vestry was just obtained.

Meters for Steam.—The Swiss Society of Chemical Industries has decided to open a competition for communications on two subjects. The first prize will be given to the author of a treatise on the best way of developing the electro-chemical industry in Switzerland. The second question on which prize essays are invited is on the construction of a reliable and good meter for ascertaining the quantity of steam passing through a given pipe. The prize offered in the first case at present amounts to £100, and in the second case to £75. The candidates are asked to send in their names by May 1, but after that a full year will be given for the communications to be sent in. The competitions are open to all nationalities, and the communications should be addressed to the president of the society at Mitlodi, in the Canton of Glaris.

Samoa and the Pacific Cable.—The Colonial correspondent of the *Morning Post* points out that the greatest importance of Samoa to England is its connection with the proposed Pacific cable. The islands stand in the direct route of the cable, and it would be no doubt convenient to have one of the all-British stations at Samoa. For this purpose, of course, the absolute possession of one of the islands would be most useful, but even then the cutting of the cable by the enemy in time of war would not be difficult. The opinion is expressed that Mr. Chamberlain will make some announcement with respect to the Pacific cable early in the approaching session, and that it is even possible that the subject may find a place in the Queen's Speech. As various Colonial Governments have come to a definite decision on the matter, it seems to us that it only remains for the English Government to agree to the proposed division of cost, and to proceed at once with the design and execution of the work.

Snow-Ploughs.—The street railway companies of Detroit have adopted a somewhat novel system of keeping their tracks clear of snow. This is based on the homœopathic treatment, by which small and frequent doses replace the more drastic method. Instead of using the regular snow-ploughs at long intervals, which gives the drifting snow every chance to block the line, a diagonal board is placed under the rear platform of an ordinary car, which sweeps the snow to one side of the track. Every car can be

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speedily equipped with this snow-sweeper should necessity arise through a very severe storm. But in an ordinary fall of snow a sweeper on every fourth or fifth car is quite sufficient to keep the tracks clear. The company also employs a snow leveller, as it is called, to push back into the gutters the heap of snow left by the scraper-boards. We gather from the *Street Railway Journal* that this leveller is only needed once or twice a day in most snowfalls.

The British Association Meeting at Bristol.—The great success of the Bristol meeting of this association was due in a very large measure to the efforts of the local officers of the meeting. In recognition of the services rendered by these officers, a complimentary dinner was held last week in Bristol, followed by the presentation of a piece of plate to each of the three following gentlemen: Mr. J. W. Arrowsmith, the hon. treasurer, and Mr. Arthur Lee and Dr. Bertram Rogers, the hon. secretaries. The large and influential company was presided over by the chairman of the local executive committee, Mr. W. H. Davies, who was supported by the Mayor of Bristol, the Lord Bishop of Bristol, Canon Glazebrook, and many other leading gentlemen of the district. After dinner a number of speeches were made, in which the great success of the Bristol meeting of the British Association was referred to. The salvers were then presented to the guests of the evening, who suitably responded.

Electricity as a Gold Mine.—Mr. Robert Hammond delivered a humorous lecture on the Gloucester electric lighting scheme, under the auspices of the Gloucester Engineering Society last week. From the report we have had sent us, in one of the local papers, we see that the audience were delighted with the number of side jokes with which Mr. Hammond managed to illustrate his lecture. How far the reporter was responsible for some of these jokes we cannot say, but in the following case we almost think he must take the credit by developing a further point of similarity between an electric lighting undertaking and a gold mine. Mr. Hammond was referring to the fact that people would go to bed instead of sitting up to increase the output of electricity works, and he is credited with saying that the officials could watch the "lode" factor, and tell by the diminished quantities that people were going to bed. We trust that the "lode" at Gloucester will turn out a very profitable one.

Street-Lighting in Liverpool.—At a recent meeting of the Town Council of Liverpool a question was raised as to whether it was not possible to light up the streets of Liverpool with electricity. We regret to find that a gentleman holding a post on the committees of the town and Corporation replied this would be entirely impossible, owing to the enormous increase in the rates that would be necessary. We are sure that if this gentleman were to look into the question on a fair basis and compare the light now obtained from gas with that which they would obtain if arc lamps were used in all the principal streets, he would find that the enormous increase existed only in the abstract. As the Corporation owns the electricity works and are generating electricity in such enormous quantities, the street-lighting load would not entail any heavy additional outlay. The lamps could be supplied from the present low-tension network, and we are sure that if only one or two of the principal streets are provided with arc lamps as an experiment, the other will follow in due course.

Launch Charging.—The business of charging electric launches on the Thames is growing year by year, and although some of the large suppliers of electric launches have their own stations at different parts of the river, some of the towns on the Thames have arranged that their municipal electric supply shall be available for charging electric launches. This is especially so at Windsor, where during the summer a fairly large amount of current is sold for this purpose. At Kingston, where the alternate system of distribution is in use, the charging arrangements are not so easily provided for. Mr. J. E. Edgcome, the engineer in charge of these works, has laid a special armoured cable from the works to a small launch-charging house on the riverside. This circuit is supplied from the spare exciter in the station. The arrangements on the exciter panel of the switchboard are such that although any exciter can be put on to this charging circuit, it cannot be switched on to a dynamo while used to excite the alternators. In this way an interruption to the general supply through a fault in the launch-charging station is entirely avoided.

Dundee Tramways.—Two interesting reports on the proposed extension of tramways in Dundee are being considered by the Corporation. The first was prepared by Mr. Fisher, the tramway manager, and the second by Mr. William Mackinson, the borough engineer. The general conclusions of the two gentlemen are somewhat as follows: Mr. Mackinson recommends a cable system, and Mr. Fisher opposes it strongly in favour of an electric system. With respect to the first case, Mr. Fisher points out that the cable system in Dundee, if initiated on the proposed line, cannot be extended to the outlying districts on account of the cost. He also doubts the financial success of the concern if it was worked by cable. Again, as regards if electric cars were used in the suburbs, Mr. Fisher considers that the slow-moving cable cars in the centre would interfere with an otherwise good schedule. We think that with the experience of Glasgow before them the Dundee Corporation cannot do better than profit by the results obtained in that town and equip their lines with the overhead trolley system, which, both in first cost and in maintenance, will enable them to give great facilities of communication to all the outlying districts.

X-Ray Printing.—Dr. F. S. Kowle contributes to the current number of the *Electrical Engineer* of New York an interesting article on a new process for printing by the use of X-rays, which he claims is a faster method than any other system now used. The principle underlying the proposed method is the fact that the emanations from the X-ray tube proceed in straight lines. The author takes a sheet of paper, or other substance, and writes off or prints on it the characters which have to be produced in multiple. The ink used and the film are so selected that either one or the other shall be opaque to the rays. A large number of sensitised films are then laid underneath the sheet containing the writing, and the whole block exposed to the radiations from the vacuum tube. The author details various solutions and films which can be used, and by which he can produce either a white text on a black ground or a black text on a white ground. The fault in the arrangement appears to be in that although the rays do proceed in straight lines, they do not emanate from a mathematical point. Hence the cone of chemical rays which proceeds from the block is not a sharply defined one. In this way the number of films which can be placed under the negative is limited, if clear printing is to result.

Coal Bonuses.—The practice of allowing stokers of boilers at engineering works a bonus if the quantity of coal used in a certain time is less than a certain average figure, is an old-established one. In central stations, however, this system can be carried out with a greater degree of accuracy on the ratio between coal consumed and steam actually generated. Thus, at the electric lighting station

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at Tunbridge Wells, Mr. Boot has introduced a system by which the stokers are first paid the standard wage, and then receive a further amount, which is calculated by comparing the coal actually burned with the number of units generated during the same period of time, as read on the station meters. This bonus is given once a month, and is a great inducement to the stokers to use the coal economically, and to work the boilers in the cheapest possible way. We learn that at the St. Austell station a similar system is in use. In this case the maximum cost of coal per unit generated is fixed at 8d. per Board of Trade unit generated. If the stokers can keep the cost per unit below this, they are allowed 25 per cent. of the saving effected; whereas should they at any one time exceed this amount, 25 per cent. of the excess is deducted from the bonus. The system with advantage could be used at a great number of electric lighting stations.

Police Telephones.—We have just noticed in our American namesake an illustration of some police telephones, fixed in the streets of a prominent town in the United States of America. The illustration is a good example of how badly wooden telephone poles, even with a large telephone box, can look in a public street. There are three poles visible in the photograph, and none of them are vertical. The illustration shows a police box equipped with a double-pole receiver and long-distance transmitter. The receiver has all parts firmly clamped in the brass adjustable head, which is securely locked, making it practically impossible to get out of adjustment or be affected by variation of temperature. The cord running directly into the shell, leaves no binding posts to break and cords to become loose and disconnected. The transmitter is sealed and the heavy metal diaphragms protected with an auxiliary diaphragm of weatherproof material cannot get out of order from dampness. These telephones are supplied with battery from the police headquarters, thus leaving no batteries to deteriorate, freeze, or otherwise become out of order at the various stations. The police telephone system can be connected at police headquarters with the public exchange, which enables a patrolman to call up any subscriber from any one of the patrol boxes. This feature is most useful in the case of burglary or fire.

The Overhead Trolley and Fires.—The superintendent of the Glasgow fire brigade, in the course of his report for 1898, expresses himself as follows with respect to the overhead wires used for the electric tramway: "During the past year the introduction of the overhead trolley system on the Corporation tramways has necessitated the use of indiarubber gloves at all fires within the area. No accident from this cause has occurred to any of the staff or the plant of the department. At the same time, the reported extension of the system the firemaster views with some anxiety. It not only increases the danger of our occupation, but imperils our electric system, on which we now place so much reliance." We quite agree with this gentleman that the shock from 500 volts is not a pleasant thing to receive unexpectedly, but we think that he over-estimates considerably the trouble which the complete equipment of the tramways in Glasgow would entail on his department. The simplest way out of the difficulty appears to us to be to suspend the running of the tramcars over the section of the street in which the fire occurs. With the system of dividing up the trolley wire into sections now so usually adopted, it would be only necessary for the engineer in charge of the fire brigade to earth the trolley wire opposite the fire in order to make it disconnect itself from the supply station. This would certainly stop the running of the trams over the section, but in all large fires the traffic has to be suspended to give the fire-engines the full control of the street opposite the burning building. Hence, no additional disorganisation of traffic would ensue beyond that which has to be borne even when electric trams are not in use.

Synchronising Alternators.—We recently had our attention called to a fairly well-known method of synchronising alternators, but as it is one which cannot be too widely known amongst our central-station engineers, we again give particulars such as we obtain from the engineer in charge of the Wakefield electricity works. In this station large flywheel alternators are used, and the bolts which clamp the magnets on to the flywheel correspond in principle with the number of the bolts. These bolts are painted white. The station is lighted by arc lamps, which are connected with the 'bus bars of the switchboard. As is well known, the light given by an arc lamp is extinguished at every reversal of the current. The effect of the light from these lamps on the bolt heads, then, gives a ready means of determining whether the incoming alternator is running at the right speed. If this machine is running too fast, the bolt heads will be seen to slowly revolve in a forward direction, and the man at the stop-valve thus gets an indication that he must slow the engine down. On the other hand, if the engine is running too slow, the bolts appear to be revolving backwards against the direction of revolution of the machine. This gives an indication to the engine driver which is very valuable, and of course the actual switching-in is done in the usual way by a man at the switchboard, who watches the synchronising voltmeter or lamps.

Cable Cutting.—We understand from an American technical journal that the claims for damages are now being presented against the United States for the cable cutting done by their ships in the recent war with Spain. We are told, for instance, by the *Western Electrician* that the English company which owns the submarine cables in the Philippines and the West Indies have already presented their claims to the United States, and that our Government have promised to urge the matter forward on behalf of the claimants. Our contemporary considers that before the question of damages can be really gone into the status of the telegraph company and the property destroyed must be carefully determined. Thus it is stated that the cable at Manila was in the possession of the Spanish Government, and that it was actually being used to transmit intelligence against the interests of the United States. The same is said to have been the case in the West Indies, as the lines there were used to communicate between Cuba and Spain. It is contended that this fact alone precludes the possibility of the telegraph company establishing valid claims for damages. How far the American authorities will be right in treating the cables as contraband of war it is difficult to say, but the fact that a given company has been subsidised by the Spanish Government certainly does not lay that company's goods open to seizure. A further feature in the controversy is the authoritative announcement that, in spite of the cutting of cables in the south of Cuba, communication with Madrid was maintained continuously until the American army entered Santiago, for it seems that messages were transmitted *vid* Jamaica. It would therefore appear that if the American Government has to pay damages, as is only fair, they would not be paying for advantages corresponding to the amount of compensation.

Picture Telegraphy.—The *Elektrotechnische Zeitschrift* publishes an article by Dr. Johann Walter on a method for transmitting designs and drawings by means of either the Hughes or Morse apparatus. The principal idea of Dr

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Walter's scheme is a system of signals, each of which indicates one of a number of small squares into which the original drawing is subdivided. By means of other signals indicating straight lines, curves, etc., it would then be possible to wire directions—such as, for instance: "curve from Af to Bf, straight line from Bf to Sc," and so forth. From directions such as these the drawing is to be constructed at the other end and transmitted to the addressee. As will be seen from even these short indications, the practical value of such an arrangement is not very great. The cost is enormous, and the liability to errors is infinitely greater even than that incurred when sending ordinary cipher word messages. One or two mis-spelt ciphers in a word message may be guessed at when the sense of the others is ascertained. In a drawing this would not be possible. Mr. Kapp, in a leader on the subject, says that for long distances the system might possibly be worked with advantage. In comparison to a letter, 17 to 27 hours might be saved between London and Paris, and 19 to 29 between London and Berlin, and 41 to 51 between Berlin and Naples. In single cases, he says, this might be of great value, but he doubts whether the system would recommend itself for general use. It would be quite possible to give it a trial immediately—at least, persons who are privileged to transmit cipher messages might avail themselves of it by placing their correspondents in the way of reconstructing the design themselves. In this manner the method might perhaps gradually obtain a footing, but there did not appear (he thinks) an immediate necessity for the establishment of special offices for the reproduction of drawings from cipher messages and *vice versâ*.

Independent Telephony.—The New York *Electrical Engineer* describes in a recent number the system of telephony installed lately by the Calhom County Telephone Company, of Battle Creek, Michigan. This has facilities for connection with more than 300 towns and cities in the State, and a subscriber can communicate with any one of these stations. The equipment used throughout the entire plant was manufactured by the Stromberg-Carlson Telephone Manufacturing Company. The exchange switchboard is made up in sections of 100 lines each, and has trunking capacity for a 1,000 subscriber exchange. The trunking jacks are placed immediately underneath the subscribers' jacks. The board is well protected from lightning and other heavy electrical currents by fuses and carbon lightning arresters. The toll board is fitted with 10 toll line equipments, and has three trunking jacks to each section of the exchange board. It is also furnished with monitor spring jacks, enabling the State line operator to talk direct with any operator on the exchange board or to listen in on the operator's circuit without ringing. The testing board is for testing the long-distance service through State trunk lines. Each line equipment in this board consists of a high-wound ringer and bells, and three specially designed spring jacks. One jack is for making connection between the through trunk line and the local toll line switchboard. At the other two jacks, either wire of the line can be connected to the ground or the lines opened or short-circuited. This enables an operator to test the line either way for any trouble on the lines, or to learn readily if the trouble is in the office instrument. The battery plant at the exchange consists of two batteries, each of 15 storage cells, of which one set is being charged while the other is in use. By means of a switch at the side of the battery shelves, either set is thrown into operation, and at the same time the other set is thrown upon the charging circuit. A second switch is used for throwing off the charging circuit entirely. The plant is also provided with an emergency equipment of 20 cells of Gordon battery.

The Institution of Junior Engineers.—At the meeting of this institution held on Friday last, Prof. Ewing gave his lecture on the measurements of electricity. In the first part of his paper he described in detail the various methods which have been used from time to time in measuring Young's modulus of elasticity and the modulus of rigidity, giving examples of the accuracy which could be expected from the various methods. The lecturer next described the very imperfectly elastic condition into which iron or steel is thrown by overstraining it—that is, say, by straining beyond the ordinary limit of elasticity. Immediately after being overstrained and when the load is removed, the piece on being reloaded does not follow Hooke's law at all, and cannot be said to have any elastic limit. But as time passes the elasticity comes back, and after an interval of a few days in the case of wrought iron, or of many weeks in the case of steel, it is found that the material has practically perfect elasticity up to a limit which may be much higher than the primitive elastic limit. This recovery of elasticity had formed the subject of investigation by Bauschinger. Curves were exhibited to show the progressive recovery of elasticity in overstrained material through the lapse of time. The experiments described had been made by Mr. Muir in the lecturer's laboratory at Cambridge, using the Ewing extensometer. The curves showed that there was much hysteresis in the relation of strain to load, in overstrained metal, when cyclic processes of loading were gone through before the recovery of elasticity had taken place. Mr. Muir had, on the lecturer's suggestion, tested the effect of heated overstrained metal to moderate temperatures, and had made the remarkable discovery that a bar of overstrained iron or steel is completely restored to a perfectly elastic state by being exposed for a few minutes to the temperature of boiling water or steam. By alternately heating the bar in this way, and loading it just beyond to its new limit of elasticity so as to slightly overstrain it, a piece of mild steel may be made to break with scarcely any total elongation and to show an extraordinarily high range of elasticity and ultimate strength.

The Institution of Civil Engineers at Manchester.—The annual dinner in connection with the Manchester Association of Students of the Institution of Civil Engineers was held last week, when Mr. W. B. Worthington presided. In the course of a speech by Mr. J. F. Aspinall, proposing "The City and Trade of Manchester," the speaker expressed surprise that in this important centre electricity was used so little as a motive power. He also regretted that so much electrical machinery was imported into England from America and Germany. In responding to the toast of "The Institution of Civil Engineers," Mr. W. H. Preece urged on those present the advantages which a studentship of the institution conferred. Having referred to Mr. Aspinall's disparaging remarks with reference to the lack of enterprise shown in the Manchester electrical industry, he gave an instance to prove that the merchants were equally behind in their methods of dealing with our trade in Persia. He (Mr. Preece) was a member of the Royal Commission dealing with the French Exhibition of 1900. The commission had obtained a contract for the supply of a certain portion of electrical power required at the exhibition, and this contract had been offered to all our manufacturers who were in a position to comply with it. He regretted to say that not one single English firm would come forward and undertake the work. Mr. Preece added that, however much we were behind in some things, in telegraphy we

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were easily first. No sooner was Lord Kitchener established at Khartoum than he called the electrical engineers to his aid, and he anticipated that very soon there would be direct communication between Cairo and the Cape. Some skilled officers, members of his staff at the Post Office, had gone out to Khartoum, and had commenced to extend the telegraph down the Blue Nile, and before very long they would meet another body of men who were working up from the south, and he had every reason to believe that before this year was out Cairo and the Cape would be in telegraphic communication with each other. With regard to telephones, Mr. Preece urged that the Government should take them over and develop them to the fullest extent.

The Electrolytic Production of Bleaching Solutions.—Electrolysis plays an important part in Germany in the preparation of bleaching solutions, especially those for dealing with the finer wares, when it is a question of giving the best possible finish to the fibres. Formerly, when chloride of lime found exclusive employment, even the most careful mixing with water gave but imperfect results since small particles of the chloride were very liable to remain undissolved, which, being retained by the material to be bleached, gave rise to blemishes and holes in the same. Electrically-prepared bleaching lye is, on the other hand, quite free of this defect. By subjecting an ordinary brine solution to the action of the electric current, a perfectly clean bleaching fluid of any desired strength, and containing no corrosive stuffs in suspension, may be obtained. Uniformity and freedom from blemishes are thus secured, even should the material during the bleaching process not be carefully handled. Still a further advantage attaches to this electrical process of bleaching, since while chloride of lime admits the preparation of a bleaching lye highly destructive in its intensity, it is impossible, on the other hand, with the electrical process to obtain a solution of such a harmful intensity. Hitherto platinum electrodes have been employed in apparatus for the electrical production of bleaching lye, naturally rendering the initial cost of the same very high. However, a German firm has introduced a much cheaper form of electrode, the use of which is said not to lessen the efficiency of the apparatus. Except for the negative electrodes, no metal is employed at all. Specially-prepared plates serve as electrodes, which are slid into grooves provided in a trough-shaped containing box. These plates do not reach the bottom of the box, but rest on glass or other insulators, so that spaces undisturbed by the charging current exist into which any flakes from the plates, etc., may deposit themselves, thus removing all danger of a short-circuit between two neighbouring electrodes. The electrodes act bipolar-wise, so that only the two end plates are connected with the generating source, and only the latter with their terminal screws extend above the solution, the remaining plates being completely immersed. The number and magnitude of the interstices between the plates depend upon the intensity of current employed and the quantity of bleaching lye required. Simple as is the construction of the apparatus, its use is even more so. From a suitable tank or barrel a continuous stream of brine is fed to the electrode trough, being discharged from the same as finished bleaching lye. As only the two end electrodes are in direct connection with the generating source a certain E.M F. is, of course, necessary to overcome the resistance offered by the solution. Ordinary continuous-current dynamos which are employed for illuminating purposes at night may, therefore, be used during the day for the production of bleaching lye. With an E.M F. of 65 or 110 volts it is possible within the space of 10 hours to prepare three cubic metres of bleaching lye from 300 to 400lb. of salt.

The Electricity Works at Paderno d'Adda.—Mr. Ernesto Vannotti describes in the *Elektrotechnische Zeitschrift* the turbine-driven plant installed at Paderno d'Adda, for the transmission of power to Monza and Mailand, 33 km. distant. Current is generated by this plant at an initial pressure of 13,500 volts, which fact lends to it particular interest. The power station, which is designed for an eventual capacity of 13,000 e.h.p., consumes 45 cubic metres of water per second, with a fall of 28·81m. at low water, and 52 cubic metres with a 24·86m. fall at high water. The turbines are of the Jonval type with horizontal axes, and each developes 2,160 h.p. running at 180 revolutions per minute. To these are attached, by means of Zodel elastic couplings, the generating machines, which latter are of the three-phase alternating type, with stationary armatures and rotating fields, excited by direct-coupled dynamos, giving a maximum output of 38 kw. each. Four units are at present installed. Messrs. Brown, Boveri, and Co., of Baden, it may be mentioned, supplied the alternators, which are constructed on the Brown principle—that is to say, the armature is supported on either side by eight arms branching radially from two hubs, the latter being carried in turn by cylindrical bearings fixed to the journal pedestals. In this manner inspection of the coils is facilitated, since the armature may be easily turned about its supports, besides which more exact centering is secured. The armature coils are wound through special seamless insulating tubes, which before use were subjected to a six hours' insulation test with 30,000 volts. To obtain a better cooling surface, the exposed ends of the coils are divided into groups and spread out. The rotating magnet system consists of 28 circular-shaped exciting coils wound upon iron cores with laminated pole-shoes, and carried by a steel flywheel cast in one piece. The inner diameter of the armature measures 4·100m. and the outer 5·140m. As the leads to Mailand are divided into two halves, the generators are so designed that in case of one half breaking down, thus necessitating the transmission of the whole energy over the other half, they may be worked up to 15,000 volts with a load of 73·5 amperes per phase by $\cos \phi = 0{\cdot}8$ and the great fall of E.M.F. in the mains so compensated. Tests proved the efficiency of these generators on a load of 64·5 amperes per phase at 13,500 volts terminal pressure, $\cos \phi = 1$, to reach 95·1 per cent., while on a load of 79 amperes at 13,500 volts, $\cos \phi = 0{\cdot}8$, the efficiency amounted to 93·4 per cent., including the loss in the exciters. The high-tension transmission cables are carried 10m. above ground upon iron poles spaced 60m. apart. At present there are three of these cables in position, consisting each of three copper wires of 9mm. diameter, arranged in the form of an isosceles triangle with 60cm. sides. The energy loss in each line when fully loaded amounts to about 10 per cent. But while the self-impedance and capacity of a single wire may be neglected, the self-induction of the lines as well as their mutual induction, on the other hand, represent a value which is not to be depreciated. The phase distortion on short-circuit amounts to 45deg., while the fall of potential over each line is 8·1 per cent. at full load (80 amperes) $\cos \phi = 1$, and 11·7 per cent. when $\cos \phi = 0{\cdot}8$. As Mr. Ernesto Vannotti, in concluding, justly observes, the success of this station marks a great advance in the evolution of the high-tension machine—an advance especially meritorious having regard to the circumstance that machines for the direct generation of so high a pressure had not previously been constructed.

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NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

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CXLII.

The more slowly, up to a certain point, an accumulator is discharged, the greater is its apparent capacity. This fact may be instructively illustrated by time-capacity curves of discharge. A characteristic curve of this kind is the same for any weight of plates, or of cell complete, in the case of a given storage battery. In considering these curves it must be borne in mind that when we want to increase the time of discharge—down to a given P.D.—we must necessarily decrease the rate of discharge. (This may seem a very trite observation, but I have found it very necessary indeed when the curves are first put before the learner.) The following diagram, applicable to the quick-charge Tudor accumulator, exhibits the increase of

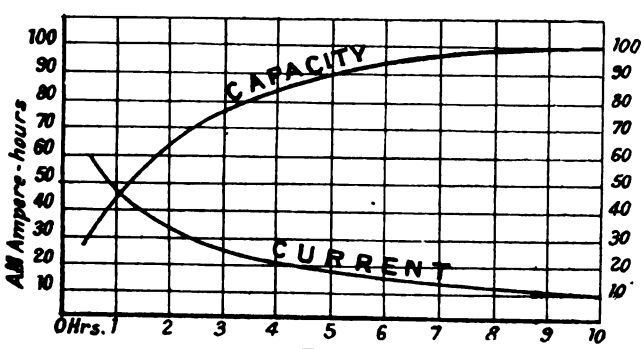

FIG. 1.

capacity with time of discharge, and the decrease of current corresponding to such increase. The curve of fall of current is ordinarily omitted, as in the case of Figs. 2 and 3, since it approximates to an inverse replica of the capacity curve, and the current for any given period of discharge is simply the ordinate of the curve corresponding to that period, divided by the abscissa; since

$$\text{amperes} = \frac{\text{ampere-hours}}{\text{hours}} = \frac{\text{ordinate}}{\text{abscissa}}.$$

According to these curves, experimentally obtained by M. Blanchon, the maximum capacity practically is obtained when the time of discharge is 10 hours. If the time of discharge be halved, the fall of capacity is only 10 per cent., but when the time of discharge is further diminished the capacity falls quickly. Thus, at two hours the capacity is only 65 per cent. of the maximum, at one hour about 45 per cent., and for the very low period of discharge of half an hour the capacity, as shown by the curve, is only 30 per cent. of the maximum. It has, however, been stated by Mr. Pescatore* that the capacity obtained in the half-hour discharge is 35 per cent. of the maximum. Each indicated value on the capacity curve corresponds to an average current on the ampere curve cut by the same ordinate, and *vice versâ*. "These," says M. Blanchon, "are practical curves of the Tudor cells. Similar curves for cells with heterogeneous formation ('pasted' plates) would have to take into account that the electrodes must not be used at discharge rates of one hour but of 10 hours. The curve of capacities would be much more inclined to the axis of x; the capacity for a two or one hour charge would not attain 40 or 30 per cent. of the 10 hours' capacity; and the capacity for a half-hour discharge would be nearly insignificant." Much progress, however, has been made in the manufacture of plates of the pasted or Faure type since the above was written, although it is questionable whether the condition of comparative permanence has been attained in this direction. The most serious danger in plates of the Faure type is the disintegration of the peroxide active material, which it is sought to remedy by the use of supports external to the active peroxide, and in contact therefore with the electrolyte. My own view is that this danger will have to be obviated by the use of a conductive compound, mainly composed of peroxide of lead, which will not disintegrate in use; and compounds of this character have long been under test in the laboratory with satisfactory results.

* The *Electrical Engineer*, Sept. 17, 1897, p. 369.

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With the additional datum that the maximum capacity per pound of plates is from 3 to 3·7 ampere-hours, which would make the capacity per pound of battery about 2·3 to 2·85 ampere-hours, the above curves become of real practical value, in traction work especially, so far as relates to the Tudor accumulator. And similar curves—or rather a similar capacity curve, since, as above explained, the ampere curve may be omitted—can be constructed for any accumulator which has been discharged at various rates. From such curves the weight of plates, or of cell complete, required for a discharge of so many ampere-hours in a given time, and also the mean current corresponding to this discharge, may be obtained, if not by mere inspection, at least with very little calculation. As the curves for any given cell are constant for any weight, either of plates or of cell, it is very convenient to express the capacity as ampere-hours per unit weight—pounds, hundredweights, or kilogrammes—of plates or of battery. For the present, at least, we may adopt the pound avoirdupois as our unit.

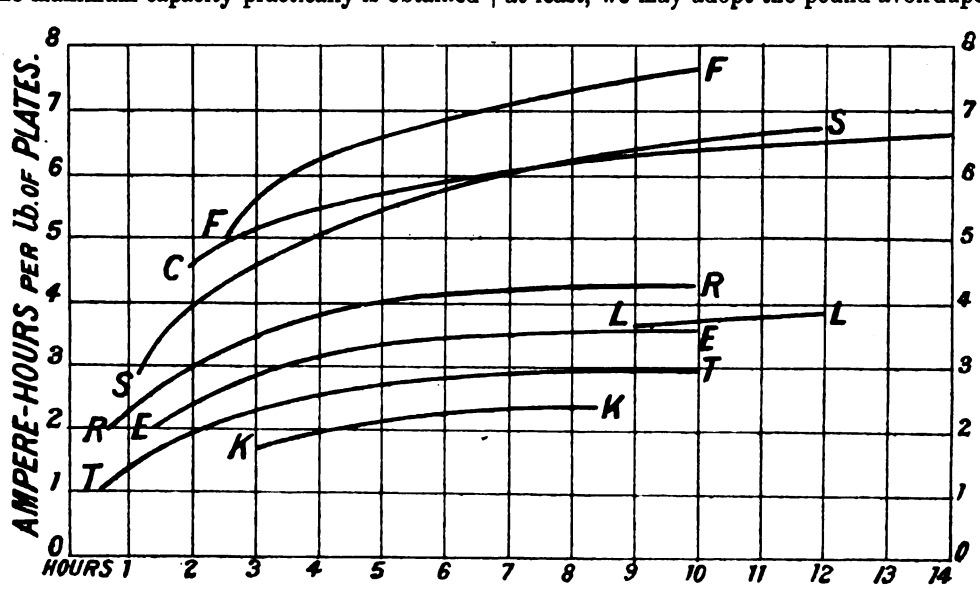

FIG. 2.

But the question arises, shall we express capacity in ampere-hours per pound of plates, or in ampere-hours per pound of cell? The manufacturer might with reason point out that the true criterion for a storage battery is the capacity, at a given rate of discharge, of the plates—that the weight of the containing boxes may vary according to circumstances, according to the price of materials, and at the option of the purchaser. And, with equal reason, the man who requires an accumulator may say that the weight of plates that will do a certain amount of work is for him an

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insufficient and unsatisfactory datum—that the construction of a light and strong receptacle, the diminution or the increase of the weight of electrolyte so as to utilise the full capacity of the plates without having excess of fluid, are matters to be considered by the manufacturer and settled between him and the electro-chemist.

I think it is desirable, therefore, to give two sets of curves expressing capacities at practically possible rates of discharge—viz., Fig. 2, from which may be calculated the weight of plates, and Fig. 3 to allow of the calculation of the weight of battery complete, corresponding to any required quantity of electrical work to be effected in any given time. It must be understood that there is no finality in the data on which these curves are based; they are subject to correction, and I shall be glad of further data whence similar curves may be derived.

CXLIV.

The curves K and L relate to E.P.S. cells of the types indicated by the letters. They are inserted mainly for the purpose of comparison. The curve K (Fig. 2) shows by inspection (1) that the minimum safe period of discharge is about three hours and ten minutes; (2) that for this period of discharge the capacity per pound of plates is about 1·77 ampere-hours; (3) that if the period of discharge be increased to, say, five hours the capacity becomes augmented by 21·4 per cent.; (4) that no appreciable gain in capacity will be obtained by prolonging the time of discharge beyond eight hours; and (5) that when the discharge takes place in eight hours thirty-six minutes the capacity is a maximum of 2·37 ampere-hours per pound of plates. Now, turning to the curve K in Fig. 3, we perceive that, for the first-mentioned period of discharge, the available capacity per pound of *cell* is about 1·15 ampere-hours, whereas the maximum capacity per pound of cell, obtained in a discharge extending over eight hours, is 1·54 ampere-hours.

In regard to the curve L (Fig. 2), this indicates (1) that the cell cannot be safely and completely discharged (to the point at which the E.M.F. falls to 1·9) in a period of time less than nine hours and forty minutes; (2) that for a discharge extending over this period the available capacity per pound of *plates* is 3·75 ampere-hours; and (3) that if the time of discharge be extended to 12 hours the rise in capacity is from 3·75 to 3·9, or 4 per cent. In Fig. 3 we find that the capacity per pound of *cell* for a nine hours forty minutes discharge is 2·4 ampere-hours, and if the discharge be extended to 12 hours, the increase in capacity will be 4 per cent., as in Fig. 2.

I should have been glad to insert a curve for the E.P.S. T-type cell, but I had no data available for the purpose. I may mention, however, that the minimum safe period of discharge is slightly under three hours, and that the capacity per pound of cell for this period is 2·2 ampere-hours.

The so-called Faure-King cell, which, like the Fulmen cell, is a modification of one invented by Donato Tommasi, is not amongst the curves shown in Figs. 2 and 3, but the following data will enable the reader to insert it in both tables. For a five hours' discharge the capacity per pound of *plates* is 5·6 ampere-hours, nearly; whilst, if the discharge be prolonged to 8½ hours, it becomes 6·1 ampere-hours. The corresponding storage capacities per pound of *cell* are, for the two periods of discharge respectively, 4·42 and 4·9 ampere-hours. In Fig. 2, the curve for this cell intersects the curve S, at a point corresponding to a period of discharge of about 5½ hours.

CXLV.

The curves T (Figs. 2 and 3) show the increase of available capacity with time of discharge in the case of the Tudor cell; but in addition to this—which is exhibited also in Fig. 1—the curve in Fig. 2 shows the available capacity per pound of plate, and the curve in Fig. 3 shows the capacity per pound of cell, for any period of discharge from half an hour to 10 hours. These curves intimate, moreover, that this cell may, safely and practically, be discharged in 30 minutes, and that it is the only one, at least amongst those represented in the diagrams, which can be discharged in so short a period. But, of course, they do not show—what ought to be specially mentioned in the case of this cell—that it will withstand careless treatment and rough usage and belongs to a long-lived type. The distinctive character of this battery, however, resides in its peroxide element; the spongy-lead element being of an ordinary description.

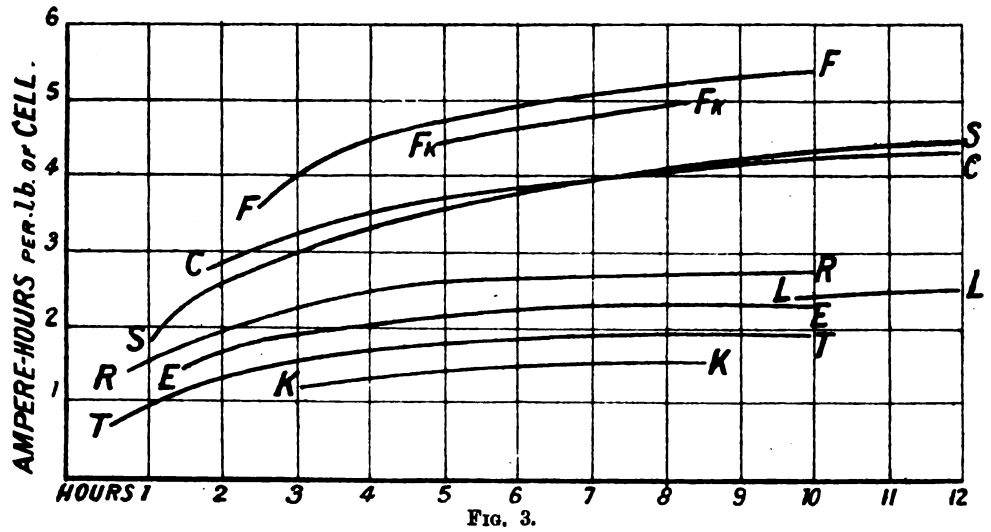

FIG. 3.

The storage batteries to which the remaining curves apply are: E, the Epstein; R, the "R" type or Manchester plate "Chloride" cell; C, the "Chloride" traction cell (Société anonyme pour le travail électrique des Métaux); S, the "S" type "Chloride" cell; and F, the Fulmen accumulator.

HIGH-VOLTAGE POWER TRANSMISSION.*

BY CHAS. F. SCOTT.

(Concluded from page 83.)

Troubles have arisen on some lines by the burning off of pins by the passage of sparks from the outer edge of the insulator to the pin. These sparks make small holes in the pin no larger than a needle point, but after continuous sparking for some time the pin becomes entirely charred. An iron pin suggested itself as a remedy, but additional strains and liability to breakdown are liable when a conductor is placed within the insulator. The burning off of pins has occurred where small porcelain insulators are porous and the outside glaze is imperfect, while the glaze on the inside is good. When the porcelain is filled with water the current readily passes through it to the lower rim of the insulator and then sparks across to the pin. In one place which has been running for about three years some 250 pins burned off. The early insulators have been replaced by larger and better ones, and this defect has disappeared.

A 10,000-volt line which runs for a dozen miles or more

* Paper read before the American Institute of Electrical Engineers

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within a few hundred yards of the Pacific coast has burned cross-arms on nearly every pole. The cross-arms near the ends of the line, which are away from the coast, are not burned. Usually the burning appears as a mere blackening of the cross-arm for a short space between the insulators on one side of the arm. In some cases the charring is deeper, and appears on both sides. The side on which almost all of the burning occurs is the one toward which the winds come from the ocean, bearing the mist of salt water. The wire shows discoloration, and the iron braces for holding the cross-arms are in a few cases eaten through. Moreover, the cross-arms were green and full of sap when erected. The early porcelain insulators were porous, and have now been replaced, and the pins are of iron. The charring has ceased almost entirely since the new porcelains were put up.

It may be observed that in the plants which are herein referred to and in the experimental tests, no mention has been made of insulators with cups containing oil for reducing the surface leakage. Insulators of this kind were used in the Frankfort-Lauffen experimental transmission line at 30,000 volts. Practically, however, the surface insulation is adequate without oil-cups, and the principal duty of the insulator is to prevent the current passing over the surface and jumping to the pin or cross-arm, a matter with which the oil would have nothing to do.

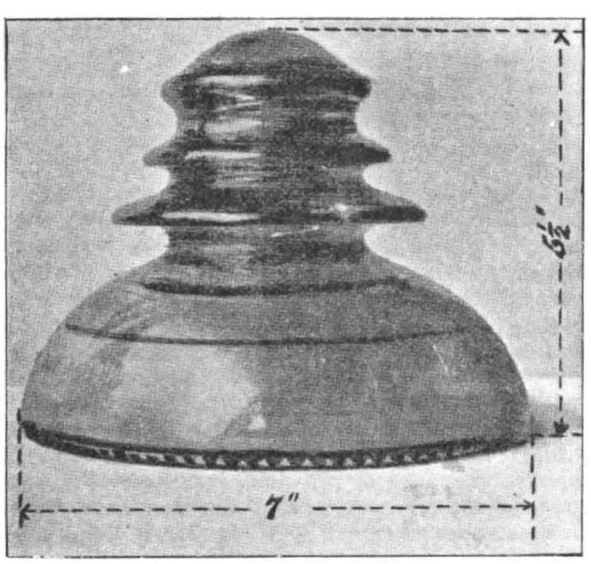

FIG. 16.

Telephone lines are in use in a number of plants placed on the poles which carry the transmission wires. The telephone lines are usually placed some distance below the transmission wires, and are crossed at frequent intervals. The telephones in general work very satisfactorily.

There appears to be practically nothing in power transmission in Europe using high potentials outside of Switzerland. The installation in Paderno in Switzerland is operating at 15,000 volts, the highest voltage which has been used in that country. The damp weather is one of the limiting factors. The insulators used are porcelain with a triple petticoat.

The highest voltage which is used for transmission is in the Provo plant of the Telluride Power Transmission Company at Utah, which transmits power 35 miles to the Mercur mills at 40,000 volts. Raising transformers are three in number, and are connected in the star form. Each transformer has a capacity of 250 kw. The middle points of both the high-tension and low-tension circuits are grounded. In general design these transformers resemble the transformers used in the high-tension tests at Telluride; the design and construction having been under the direction of the same man in both cases. The line extends from Provo at an elevation of 4,500ft. to Mercur, at 2,000ft. above Provo, and the line reaches an extreme height of about 10,000ft. above the sea level. Three miles of the line are strictly mountain construction. The lightning protection is afforded by choke-coils and Wurts non-arcing metal arresters. The insulators are of glass. The design was based on the tests at Telluride, and they were made especially for this plant. The form is shown is Fig. 16. The insulators are held on special pins of oak, which are thoroughly paraffined. The lower part of the insulator is 5in. above the cross-arm.

In dry weather there has been no difficulty whatever in operating. The insulators do their work as effectively as could be expected if the voltage were only a few thousand volts. When everything is dry the line will operate without difficulty, even if some of the insulators are off and the wire rests upon the cross-arm. When it rains there is sometimes trouble. It is indicated in the station by the ammeters giving quick swings, showing momentarily strong currents. Sometimes this is apparently a short-circuit, and blows a fuse. In every case when there has been trouble on the line it has been in rainy weather, and broken insulators have been found which located the trouble. It is certain that in most cases these have been previously broken by bullets, and in other cases it is probable that the insulators were likewise broken. It is believed therefore that had there been no intentional breakage of insulators there would have been no trouble upon the line since the plant began operating in February last. A few of the insulators near the station are not far from the overflow, and are in a moisture equivalent to a rain all the time without doing any damage. Snow has often backed from the cross-arm up against the bottom of the insulator and around the first petticoat. It is usually found that the part of the insulator around and near the wire does not receive deposits of moisture or frost but remains dry, the

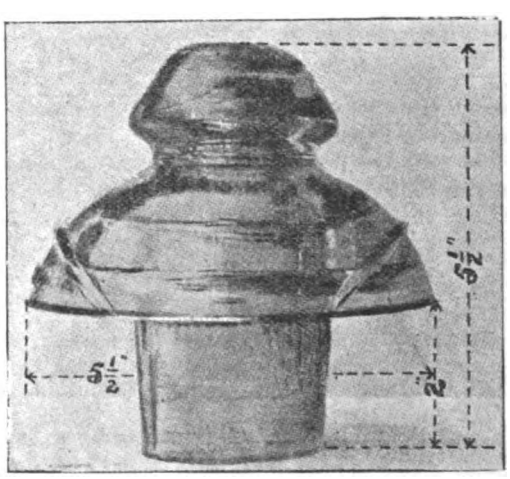

FIG. 17.

particles being repelled. At this plant, current for about 700 h.p. is carried through three fuses of copper wire 0·01in. in diameter. Iron wire is used on a branch line for transmitting about 100 h.p. for about three miles.

This plant has been in operation in winter and in summer, "in thunder, lightning, or in rain," the sole supply of power for the enormous De Lamar mines and mills at Mercur, and is a happy and fitting consummation of the high-tension tests described in the beginning of this paper.

LIMITATIONS OF HIGH-VOLTAGE TRANSMISSION.

The important commercial question is: to what distance can power be transmitted? The relation between distance and voltage is well known. The same weight of copper can transmit with equal efficiency the same power to any distance provided the voltage is increased directly as the distance is increased. The limiting commercial ratio between voltage and distance is easily found. If the distance be three miles per 1,000 volts, and the loss 16 per cent., the cost of copper is about 20·00dol. per horse-power. The interest on the latter investment is about 1·00dol. per year. A distance in miles equal to three times the number of thousand volts may therefore be covered without an excessive annual charge per horse-power for copper. The limits to the voltage which are practicable depend principally upon the insulator and upon the loss between wires.

The Insulator.—The two fundamental requirements are dielectric strength sufficient to prevent puncture, and a size and form which will prevent the passage of the current around the insulator. A given insulator will be adequate

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for a higher voltage where the atmosphere is comparatively pure and dry than it will be under other conditions. The rapid progress which has been made in the design and construction of insulators during the last few years will doubtless provide an insulator which will accommodate the highest voltages that can be used due to other limitations. The insulator therefore while remaining the critical point in a transmission system will probably not determine the limit of practicable voltages.

Loss Between Wires.—The loss between bare wires at high voltages seems to determine a positive limit, beyond which the voltage cannot be increased. This loss is subject to variation due to diameter of wire, distance between wires, and wave form of the E.M.F., but the variations which may occur under favourable commercial conditions locate the point of increase of loss about 50,000 or 60,000 volts. Under favourable conditions this may be raised somewhat, but it is not probable that any material increase can be made.

Amount of Power.—The amount of power to be transmitted involves some interesting commercial limits. There are certain elements in a transmission which do not vary greatly with the amount of power transmitted. Thus, the charging current to the line will be practically the same whether the wire will transmit 1,000 h.p. or 100 h.p. If the charging current happens to represent 300 h.p. it would be insignificant in one case, but for the smaller output it would require generating apparatus several times that necessary for the actual power. It is not mechanically practicable to use wires as small as would be sufficient, in so far as conductivity is concerned, for transmitting a small power. For example, a No. 7 copper wire, which is as small as is ordinarily used, if employed in a three-phase circuit 50 miles in length, will transmit over 1,000 kw. at 40,000 volts with 10 per cent. loss. If only a few hundred kilowatts were to be transmitted, the cost per kilowatt would be excessively high, and, on the other hand, a lower voltage could be used without undue loss. In some cases, indeed, where a high voltage is used for small power—as, for example, on a branch circuit—an iron telegraph wire would have ample conductivity. In other cases an aluminium wire could be used to advantage, as an aluminium wire of the same conductivity as a copper wire has only about half the weight, and possesses greater mechanical strength in comparison to its weight. It may also be noted that high-voltage transformers cannot be economically built for small output, as the insulation spaces required are so large. The cross-section of the copper is often not more than 10 or 20 per cent. of the area of the opening in the iron. The cost per kilowatt increases very rapidly when the size of transformer falls under a few hundred kilowatts.

Cables and Conduits.—The overhead transmission line has been considered, and its limitations are the insulating strength of the insulator and the losses through the intervening medium. In a cable or a conduit the insulation must be provided continuously instead of at points 100ft. apart. Rubber-covered cables are made for 10,000 and 20,000, but it is quite possible that it will not be commercially practicable to make cables for much higher voltages. The effect of continued electric stresses on the insulation of the cable, which is an unknown factor, may prove to be a very important one. A conduit composed of a pipe containing oil, in which the wires are separated by glass tubes, has been proposed. Many mechanical difficulties arise in constructions of this kind; the cost is high, and the action of continued high voltages on solids and liquids opens a field which is little known. A suitable insulation on the wires on high-voltage lines may enable higher voltages to be used than can be used with a bare wire. Liquid air, with its high insulating properties and the low temperature and consequent high conductivity which it would give to a conducting wire, may enable us to use air insulation in a new way.

Difficulties and Precautions.—High voltages have been referred to in this paper with perhaps undue familiarity. Familiarity with high voltages is not one which breeds contempt. A voltage which can produce sparks several inches in length, which can be felt through several feet of air, which causes hissing sounds, which produces luminosity, and which in a confined room generates strong odours of ozone, is one which creates profound respect. Dangers and difficulties accompany it, and the highest intelligence, vigilance, and excellence must be employed to avoid accident and ensure success. While ordinary types of construction do not seem to reach their limitations until some 50,000 volts is reached—and pressures of this order have been and are in regular use—nevertheless they are not to be used indiscriminately or where they can be avoided. There are difficulties enough in handling 15,000 and 20,000 volts. As the pressure is raised the liabilities to trouble increase at an alarming rate. It is, however, a fact that these voltages have been and can be used, and also that no new or modified methods of transmission will be required before 50,000 or 60,000 volts can be employed for distances up to 150 or 200 miles.

INSTITUTION OF ELECTRICAL ENGINEERS.

The Institution Wiring Rules.

BY R. E. CROMPTON (PAST-PRESIDENT).

Nearly four years have elapsed since the Council decided that the Institution wiring rules should be revised. A committee was then appointed to deal with the matter, and subsequently sat throughout the greater portion of two sessions, with the result that the revised rules were issued in July, 1897. I have discussed these rules with several gentlemen who are competent to express an opinion on the matter, and I find the general feeling to be that the labours of our committee were not misspent, and that the rules in their present form are, of all those now in existence, the best fitted to become the standard set accepted by all parties.

My object, therefore, in writing this note is to try and promote the adoption of the Institution rules as the standard rules to be prescribed by consumers, insurance companies, and municipal authorities, and to be worked too by wiring contractors. Of these four classes, the fire insurance companies are of course the most interested, as they act as guarantors of the safety of installations passed by them, and it is to the gentlemen who act as inspectors and technical advisers to the insurance companies that I primarily address myself. The objects which the committee had in view when framing the present rules were identical with those of the fire insurance companies, every principle laid down, and every detail described having for its object the avoidance of fire risk. I say this advisedly, for although some few details were intended to prevent either danger to person from shock or discontinuity of supply, yet even in guarding against these dangers we are indirectly guarding against fire risk also. At present there are issued by fire insurance companies several distinct sets of rules, differing among themselves, indirectly in principle, but mainly in the size and carrying capacity allowed for the conductors and in small matters of dimension. In these respects I believe the Institution rules occupy a midway position—that is to say, they are more stringent than some and less so than others, but all are dealing with the same questions of electrical supply and with the same fire risks. Why, then, should this diversity in rules continue? Is not this the time for us to invite insurance inspectors to appoint a committee to decide in what points the Institution rules can be improved, made more (or less) stringent, or added to, so that they may be satisfactory to all, and may thus establish that uniformity which will undoubtedly result in simplifying the work of contractors, and which therefore, assuredly, in the end, will give the consumer better value for his money? The committee throughout tried to place themselves in the position of fire insurance inspectors, and, if I recollect aright, the rules in their draft condition were sent out to a number of inspectors for their criticisms and remarks, and all criticisms received were accepted and dealt with as far as was possible. If it is a fact that these rules differ in points which fire insurance inspectors consider vital, now is the time for these gentlemen to come forward and give us the opportunity of amending or supplementing them; but I sincerely hope that this discussion will open the eyes of everyone to the desirability of uniformity, and to the great

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waste of time, and the annoyance to consumers and everyone concerned, that arise from the multiplicity of rules which at present exists. It has been said that the Institution rules cannot be enforced. It is true that the Institution as a body cannot enforce its rules, but in drawing them up it did the next best thing—it appointed, from amongst those of its members who were best qualified to deal with this matter, a committee to draw up a set of rules which would be a guide to any consumer, and which could be adopted and enforced by anyone having the requisite authority. In fact, all that is now required is that wherever the words "should be" occur in the rules, the words "must be" should be substituted.

Rules for the Regulation of the Wiring of Premises for Connection to Public Supply Mains.

BY J. PIGG, ASSOCIATE.

The importance of ensuring the performance of good work in the wiring of premises for connection to public supply mains for lighting or power purposes can scarcely be over-estimated from whatever standpoint it may be considered. That the importance of this subject is recognised is shown by the attention recently given to it. Hitherto, however, attention has been mainly concentrated upon the merits of different systems of wiring, or, more correctly, upon systems of protecting wiring, to the exclusion of other matters of hardly less importance.

The writer has recently had occasion to examine the rules issued by various authorities for the regulation of the wiring of premises for connection to public supply mains, with results such as would seem to justify calling attention to them. Such rules partake of the nature of a specification for the proper performance of certain work; but, whilst it is recognised that such rules have, necessarily, to be drawn somewhat broadly to cover a variety of cases, the divergences in practice and requirements observable on examination are so great for what is practically the same class of work, and the attainment of the same objects, as to excite surprise.

A cursory examination of the subject shows that there are three classes directly interested in the execution of reliable work. These are (1) the consumer; (2) the guarantor; (3) the undertaker. Besides these there are others hardly less directly interested, such as the Board of Trade, and the representative bodies of the profession.

Of the three classes enumerated, the first is seldom in a position to specify how the work to be executed on his behalf shall be done, or to recognise good work from bad. Where the conditions under which the work is to be done are issued by the consumer they are, as a rule, due to the employment of a consultant, by whose advice he is guided. There are, of course, cases where individuals or companies, engaged primarily in other than electrical business, find it necessary to employ an electrical staff; and where such firms find it desirable to employ outside labour, the specifications are drawn by their own engineers, and the work is carried out under their supervision. In many cases, however, and perhaps in the majority, the magnitude of the work is not sufficient to justify the employment of a consultant, and the consumer is compelled to place himself under the protection of one or both the other classes enumerated.

The second class referred to as directly interested in the execution of good work are the corporations which, individually or collectively, guarantee the consumer against such risks as are incidental to the occupancy of the premises, for the purposes for which they are utilised. Such corporations are the various fire insurance companies who, from the nature of the risks they undertake, have, necessarily, to estimate the possibilities of each case submitted to them in all its aspects. Such corporations in their capacity of guarantors issue rules which are, more or less, applicable to the generality of cases, and which are subject to modification to suit special circumstances. The guarantor, where the risk is undertaken, occupies the position of greatest responsibility, in respect of the premises, and represents the consumer, in so far as any damage sustained by the latter can be satisfied by a pecuniary recompense. It is only necessary to say that, whilst the consumer obtains advantages of a solid character under such a guarantee, the conferring of these advantages is contingent upon the striking of a bargain between the consumer and the guarantor, and where no such agreement exists the corporations referred to have little or no interest.

The third class interested are the private companies or municipal authorities which undertake to supply the consumer with electrical energy. The interests of the undertakers differ materially in character from those of the consumer or the guarantor, but their maintenance acts equally in demanding reliable work. Whilst the consumer, or the guarantor on his behalf, is principally interested in the execution of work which shall not endanger his premises or their contents, the undertakers are more concerned with the safety of their generating and distributing plant, and the maintenance of a continuous supply to their customers.

Hence we find that undertakers invariably disclaim any responsibility for whatever may happen to the consumer, or his premises, or their contents, through defects in the work carried out in adapting the premises to the utilisation of electrical energy, which they are to supply; even when such work is done under their rules, and when such rules specially ask for facilities for its inspection on behalf of the undertakers during its progress. The repudiation of responsibility is, of course, natural, but it should not be forgotten that the consumer obtains an indirect guarantee by the issue of such rules and from the inspection and testing—and gets it for nothing.

The Board of Trade is interested in the execution of good work in its capacity of guardian of the safety of the public. The representative bodies of the electrical profession are interested in the reputation of the profession, and are looked to by individual members for guidance and advice. Of these representative bodies only one has as yet issued such rules. As these bodies, however great their moral authority may be, have no direct control over those entrusted with the execution of such work as is under consideration, it is difficult to see how any rules issued by them can, however admirable they may be, ever become more than the recommendations they are stated to be.

The methods to be employed in adapting premises for the utilisation of electrical energy are, in the main, the same everywhere, and the objects aimed at in the issue of rules do not differ materially. It would therefore appear natural to expect some degree of uniformity in the methods of specifying the objects to be attained, at any rate, amongst authorities in the same class. An examination of the rules issued by various authorities for the control of such work shows very considerable differences in practice, and the magnitude of the results to be attained in the completed work; and the differences exist, not only between the different classes interested, but also between members of the same class.

The Board of Trade regulations for securing the safety of the public refer in very meagre terms to internal wiring, and practically only fix a maximum leakage as a limit of connection to the supply mains.

The general rules recommended by the Institution of Electrical Engineers are not capable of being enforced by that body, and it would therefore seem as if the specifications under which wiring *must* be done are narrowed down to those issued by the consumer, or, on his behalf, by the guarantor, and those issued by the undertakers. Whilst this is the case, it will not be without interest if the rules issued by all the classes referred to are contrasted.

One of the most important points of any installation of wiring which is intended to be connected to public supply mains is the insulation resistance required by those responsible for, or interested in, the proper performance of the work. The subject of insulation resistance is equally important from the standpoint of any of the classes interested, and it is one upon which there does not seem much room for divergence of opinion. Very considerable differences of opinion, however, do exist in the requirements of different authorities in this respect, not only in the magnitude of the results required, but even in the manner of specifying the results to be obtained, and in the bases upon which the specifications are drawn.

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In many cases "insulation," or "insulation resistance," is specified without any indication being afforded of the points between which the difference of potential is to be established for the purpose of the test. In some such cases, however, the method of making the tests may be inferred from the directions respecting the apparatus to be included in the test; but in other cases the question of whether the insulation resistance will be measured "to earth," or "between mains," or both, cannot be determined from the specification. In other cases, again, the insulation resistance specified is "to earth," and in still further instances the insulation resistances required "to earth" and "between mains" are both specified.

The manner in which the insulation resistance required for any installation is specified varies greatly with different authorities. The Board of Trade regulation, No. 41, indicates the minimum insulation resistance by specifying the maximum leakage allowable as a proportion of the maximum current used for the purposes of the installation. The regulation does not directly specify the method of making the tests to determine the value of the leakage current, or the testing pressure to be used, but the only reasonable interpretation would lead to tests "to earth" and "between mains," with a pressure equal to that ordinarily used in the installation. Under such conditions of test, the testing current would have the same value as the leakage current from the wiring during ordinary use.

Such a method of specifying the results to be obtained may be put in the general form:

$$\text{Leakage current} = \frac{A}{p};$$

whence

$$R = \frac{p\,E}{A};$$

where p is a constant, depending for its value upon the opinion of the framer of the rule; A is the maximum strength of the working current in amperes; E is the testing pressure in volts; and R is the insulation resistance required in ohms.

The specification of the Liverpool and London and Globe Insurance Company is similar to the Board of Trade regulation already referred to, but differs, however, in that the maximum strength of the leakage current is only half that allowed by the Board of Trade regulation, with double the working pressure for testing.

The rule of the Institution of Electrical Engineers relating to the insulation resistances to be exacted gives the values as the ratios of a constant resistance to the maximum strengths of the working currents of the respective installations, or, in a general form—

$$R = \frac{R_1}{A},$$

where R is expressed in megohms, and A is the maximum current in amperes used on the installation. Under this rule, also, the testing pressure is to be twice that used in ordinary working; and, with the exception of a set of rules issued quite recently, the rule has the distinction of being the only one that has come under the author's notice in which the duration of electrification is specified.

The rule of the Institution of Electrical Engineers is followed, more or less closely, by a number of other authorities; the principal difference being in the values assigned to R_1.

Another form of specification, very closely allied to that of the Institution of Electrical Engineers, is that in which the insulation resistance is *indicated* by the number obtained by dividing another number by the number expressing the maximum strength of the working current in amperes. In this form of specification the differences exist in the values assigned to the number which is to be divided.

The method adopted by the Phœnix Fire Office differs from those already referred to in that the actual resistances required for installations of different numbers of lamps are directly specified in ohms, and are not to be derived from a general equation. The range throughout which the insulation resistances are specified is between 12 and 1,000 lights, irrespective, as far as the specification shows, of the currents required by individual lamps, and, within the limits to which the rules are applicable, of the pressure used on the installations. The Phœnix Fire Office rules have the distinction of being the only set of rules with which the author is acquainted in which the insulation resistances required for installations using alternating currents are double those required for, otherwise, exactly similar installations where continuous currents are used.

A number of authorities specify the insulation resistances required in the same way, but the actual values required vary considerably. In one case, however, which has come under notice, the figures are specified as for 33-watt lamps or their equivalent.

An examination of the figures given by different authorities shows that the requirements differ not only between the authorities concerned, but that differences exist in the requirements for installations of different numbers of lamps to be supplied by the same authority. Thus the Phœnix Fire Office specifies as under:

12 lights	1,000,000 ohms.
25 „	500,000 „

These figures are equivalent to 12 megohms and 12·5 megohms per light respectively, and the latter figure is maintained throughout the whole subsequent range of the specification. If the figures specified by other authorities who use this method are examined in the same way, it will be found that they are by no means so consistent in this respect. In one case, for example, the requirements commence with 60 megohms per lamp, rise to a maximum of 112 megohms, and fall again to 60 megohms, all in a range of 300 lamps. Thus, consumers having installations of 10, 150, and 300 lamps would have to obtain insulation resistances at the rates of 60, 112, and 60 megohms respectively for connection to the same supply mains.

Another method of specifying the insulation resistance required is that, where the values are expressed as the ratio of a constant resistance to the total number of lamps fixed on the respective installations. Such requirements may be expressed generally by

$$R = \frac{R_1}{N},$$

where R is the insulation resistance required; R_1 is a constant resistance for any one set of rules; and N is the number of lamps fixed.

Since R_1 is the insulation resistance per lamp, and for any one set of rules is constant, we see that the differences between such specifications and that of the Phœnix Fire Office is in the wording of the rules, and the values assigned to R_1 only.

Another variation of this manner of specifying the requirements is that in which the insulation resistance is specified as to be not less than 100 lamp-megohms for installations of above a certain size.

Yet another method of specifying the requirements in this respect is that in which the insulation resistance is to be not less than

$$R = \frac{R_1}{n},$$

where R_1 is a constant resistance, and n is "the number of points."

(To be continued.)

At the meeting of the Institution held on Thursday, 26th ult., with Prof. Silvanus P. Thompson in the chair, the discussion on the electric wiring rules was commenced. Before calling on the speakers to discuss the papers, **Prof. Thompson** announced that under the old articles of association the hon. members were restricted to eminent men who were not actively engaged in the electrical profession. Since the new articles came into force on Jan. 1 last this regulation had been amended. The Council had been desirous for some time of electing Lord Kelvin an hon. member, and, on receiving an intimation from him that he would agree to the proposal, they had that night added his name to the list of hon. members.

Mr. R. E. Crompton, in opening the discussion, said his views were contained in the short paper which had been sent to those present, and that he wished to call attention to the advisability of making the Institution rules the standard rules throughout the country. He advocated that any alterations or modifications required to bring them in line to local requirements should be

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added. The committee, in preparing these rules, had gone most carefully into the matter, and the committee were, he might add, gentlemen of exceptional experience. They had not hesitated, however, to call in engineers who had had special experience in connection with the wiring of buildings. In this way the conclusions of the committee had been submitted to a large number of outside engineers in order that they should be as acceptable as possible to all. In discussing the papers, he asked those present to keep in mind the desirability of uniformity of such regulations, and to point out any deficiencies in the Institution rules, or in amendments, which would make them more acceptable in certain cases.

Mr. C. H. Wordingham agreed with Mr. Crompton that it was a matter of pressing importance to get a set of rules acceptable to all. The want of uniformity pressed most hardly on the contractors, and he thought that a conference of the leading contractors in London and the provinces would help to arrive at finality in the matter. It must be borne in mind that there was a considerable difference between wiring rules pure and simple and the rules that had been issued by the electric light station engineer. This difference would be referred to in his paper.

Mr. J. Pigg said that his opinions would be found expressed in his paper, and he had nothing to add to them on this occasion.

Mr. Bernard Drake remarked that having been associated with Mr. Crompton, as a member of the sub-committee, in drawing up the wiring rules of the Institution, he was naturally interested in the present discussion. It had been a matter of regret to him to note as a contractor the small extent to which the rules were taken as the standard, and they must endeavour to discover the cause. In his opinion it was chiefly due to the tacit opposition of the insurance companies, each of which appeared to desire their own rules to be adopted. They said with some truth, that they had to pay the piper and should therefore be allowed to call the tune. The only way of meeting this would seem to be concerted action on the part of the contractors who had to do the work. If all would combine and say they would only work under the Institution rules the problem would be solved. At present the position was absurd, for a contractor had to agree to carry out the rules of the insurance companies interested, and these were often diametrically opposite. For instance, two companies were interested in one building, the rules of one stated that there must be a fuse in every ceiling rose, whereas the other said no fuses in ceiling roses would be allowed. They were indebted to Mr. Pigg for the trouble he had taken in compiling his paper, especially as regards the insulation requirements. When learning engineering at Whitworth's works, he (Mr. Drake) was informed that the Whitworth standard screws were arrived at by collecting the screws of all the leading makers and striking a mean. Could they not adopt the same plan? If the rules were not right let them revise them again, but they must avoid the present necessity for stocking apparatus of six or more patterns to meet the same requirements. Mr. Wordingham's suggestion as to the starting of an Institution laboratory was excellent, but it should restrict itself to certifying the results obtained under test, and the manufacturers should be allowed to witness the test.

Major-General Webber referred to the first set of rules which were prepared by the Institution of Electrical Engineers in 1883, and pointed out the small extent these rules had had to be altered. When the last set were prepared, in only one case had the decision expressed in the earlier rules to be reversed. They had tried their best to get the fire insurance companies to act with them in preparing these last rules, but had not been successful. He would call attention to the fact that where the Institution rules had only been revised once, certain of the fire offices had made some nine or ten revisions in the same time. He advocated the establishment of a testing laboratory under the guidance of the Institution, and perhaps other engineering assistance, at which electrical instruments could be tested and consulted. He thought that in this respect the Kew Observatory practice might be followed.

Mr. F. Bathurst said that he might be accused of riding his hobby horse rather hard when he said that rather than uniform rules being wanted, they should require no rules at all if a perfect system of house wiring were adopted. At the present time eight or ten different systems of electric wiring were competing one against the other, and rules had to be made broad enough to cover all these systems. It had been said, and rightly said, that there had been practically no fires caused by electricity, and hence he thought the policy should be to adopt such systems as would induce the fire insurance companies to reduce their premiums. If the non-tariff offices were approached and gave the desired reduction, the others would follow in time. He did not agree with Mr. Wordingham that the station engineers should test and certify electrical instruments. That would, in his opinion, lead to confusion being worse confounded. He personally believed that in earthing one wire the solution of the whole matter would be found. With one wire earthed, the cost of an electrical installation would compare fairly with the cost of laying gas-pipes, and only half the insulation would be required. In his opinion the electrolytic trouble which had been feared if one wire was earthed, would not be found to exist. Being here reminded that the 10 minutes allowed to a speaker had elapsed, Mr. Bathurst said he would send in writing the rest of what he had intended to say.

Prof. W. E. Ayrton wished to ascertain on what grounds the various insurance companies and electrical engineers in charge of central stations had determined the insulation resistance they would allow. In some cases as much as 120 megohms per lamp were asked for, whereas in other cases an insulation resistance of 12 megohms per lamp was accepted. On what principle had these widely varying figures been selected? He did not agree with one of the previous speakers that an arithmetical mean of the various standards should be taken.

Mr. Galthorpe said that the company to which he was electric lighting surveyor had accepted the Institution rules with very small differences and alterations. He believed that the insulation resistance demanded in these rules was reasonably and sufficiently high, but he thought some modifications should be made to meet the case of wires laid in new buildings on wet plaster. In such cases, insulation resistance was always low at first, even with very good work, but in the course of a few months it would be found to be all right. He pointed out that the electric supply undertaking rules were 10 times more numerous than the fire insurance offices' rules, and varied just as much amongst themselves. In certain cases where the installations were inaccessible, he had adopted the plan of accepting a certificate of a member of the Institution of Electrical Engineers to the effect that the work had been carried out in accordance with the Institution rules.

Mr. H. Human, of the Guardian Fire Insurance Company, agreed in the desirability of having uniform rules, and said he thought the personal views of the engineers responsible for these rules caused the great differences that were found. He saw no reason, however, why they should not all come into line on the essential points. The fire offices had naturally to make their clauses respecting the working of dynamos and motors stringent in all such cases where these machines were at work in factories where inflammable materials were used. The extent of the pressure at which installation tests were to be made was important. He thought that the formula $\frac{10 \text{ megohms}}{\text{lamps}}$ gave quite sufficient protection against fire risks. The expression $\frac{\text{volts}}{\text{lamps}} =$ megohms had been suggested, and was, he thought, satisfactory, except, perhaps, when higher voltages than 100 were used. It had been suggested to bring the current used into the question, but he thought they were more concerned with the number of lamps used than with their candle-power. He believed that he was the first to draw up rules for the sectional area of conductors which would give a uniform rise of temperature to the same. The standard he adopted was 10deg. C.

Mr. Shepherd said that if the wiring contractors and the electric lighting engineers would agree on the matter, he thought the fire offices would be bound to join in.

Mr. Wallis Jones pointed out that the atmospheric conditions at the time the insulation resistance tests were made were not referred to at all in any rule as far as he knew. This made a very great difference in the results, and would often determine whether the wiring was sufficiently good or not. As far as safety from fires went, if the arrangement of fuses was really good, there was no danger whatever. Thus five-ampere fuses at 100 volts, or three-ampere fuses at 200 volts, gave perfect immunity from fire. It was open to question, he thought, if it was a good practice to earth one wire of a 250-volt system, as then a nasty shock could be got from the other pole.

Mr. E. T. Ruthven Murray agreed that more uniformity in rules was required. It was hard on a contractor in a town to find that his wiring rules were changed when the engineer in charge of a central station was replaced by another. Recently he had had to get out a new set of rules for the district he had taken over.

Prof. Ayrton here caused some amusement by asking Mr. Murray, if he was so desirous of uniformity, why he had changed the rules?

Mr. F. C. Raphael said there was no doubt the insulation resistance was a great matter, but he thought it would be better to take a high value, and level up to that, than to take a mean of the insulation resistances required in a large number of cases. He had given a good deal of time to investigating the matter before he knew that Mr. Pigg was going to prepare his excellent paper. In so doing he had come across one instance in which the central-station engineer in charge of one of our largest municipal undertakings was responsible for two rules in force which were mutually contradictory. The first said that all fuses were to be made of tinned wire with a copper connection piece at the end, and that in no case was a copper fuse to be used; the other rule said that copper fuses were to be used.

Mr. H. Hirst remarked that no one had acted on the suggestion Mr. Crompton had drawn out at the beginning of the meeting. He thought it would be good if the Institution would exert some strong authority in the matter and made their rules binding on their members.

Mr. F. Brown (of Walsall) said that a good deal of complaint had been levelled against the fire insurance offices. The fault he had to find in this respect was that they did not inspect their installations in the country. Instead, they sent down a large sheet of questions which they asked the engineer to fill in, and they did not enclose a fee for the time it would take him in so doing. What happened to the sheets after they had been filled up was not known, but he did not believe that they were systematically examined. As a result, a large number of small installations were equipped in a way which was disgraceful. A good deal had been said about the section of conductors, but nothing at all as to the permissible drop allowed between the supply terminals and the lamps. By using small wires, which, although conforming to the fire office rules, gave the consumer an exceedingly poor light, certain contractors were able to take work very cheaply. He thought that some standard in this respect should be adopted.

As a number of other gentlemen expressed a wish to speak, the discussion was adjourned until the next meeting, which will be held on Feb. 9.

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SOME PRACTICAL HINTS ON THE PRODUCTION AND USE OF ELECTRICITY FOR LIGHTING COUNTRY HOUSES.*

BY BERNARD M. DRAKE, M.I.E.E.

The electric light is no longer the light of the future; it is essentially the light of the present, and has come to stay. Only a few years back its use in a country house was regarded as a curiosity; now, the redolent oil lamp and guttering candle have been laid aside with the high-wheeled bicycle and other relics of bygone days. Thus to the multifarious knowledge of the architect must now be added a grasp of the "practics" of electric lighting and its attendant paraphernalia. Fortunately the development of the industry has brought with it simplification, and whereas it was usual to cover a wall with switchboards, the functions of which were regarded as a trade secret to be imparted only to the initiated, now it is found possible to meet all practical requirements with three or four switches, which any gardener can learn in an hour to manipulate. Any amateur can elaborate, but the work of a genius will be stamped by its simplicity. It is manifestly impossible in a short paper to do more than skim this intricate subject, and the writer has tried to confine himself to the practical points which crop up daily in an architect's office, and are searched for in vain amongst the miscellaneous text-books on electric lighting at his disposal. It has been remarked with some truth that those who know are too busy to write books, and those who fail to make a success of their own business are ever ready to turn to the instruction of others as a means of livelihood; certainly with regard to electric lighting, this applies in more ways than one. In the following remarks it is assumed that the superiority of electric lighting is now so well proved that no attempt is necessary to make the most of its advantages, or to conceal the pitfalls into which the unwary may stumble. In discussing the matter with architects, the writer feels that to make his paper of practical use he must state frankly the *pros* and *cons.* of the different courses open, even at the risk of conveying the impression that the system is not altogether without its drawbacks.

The first question that naturally occurs in lighting a country house is the provision to be made for the generating plant, and where it shall be put. This brings us to a consideration of the different developed methods at our disposal, which are briefly as follows: (1) steam-engine; (2) petroleum-engine; (3) gas-engine; (4) waterwheel or turbine; (5) wind-engine; (6) primary battery. The advantages and disadvantages of each may be summed up as follows:

1. Steam-Engine.

Advantages.—Is more developed than any other, and being made in larger quantities is better value; more understood by local engineers, and therefore more easily repaired; yields a steady light free from pulsations; has a storage in the boiler, and is therefore less liable to sudden stoppage. The two principal classes of steam plants are (1) the Cornish or Lancashire separate boiler, requiring a chimney (preferably of brick), which supplies steam to an independent engine; (2) the so-called semi-portable self-contained engine and boiler. The former is by far the most durable, and should be used where hard work is expected or the water produces incrustation. The engine and dynamo may be coupled direct, but for country-house work the belt is a safeguard, for it is thrown off in case of faulty manipulation and the dynamo saved from damage. The semi-portable occupies less space, and saves considerably in builder's work; it may be advantageously put down where the house will only be occupied for part of the year, provided a supply of soft water is available.

Disadvantages.—A steam-engine requires careful stoking, or it will make smoke; it takes half an hour to get up steam, and uses a considerable amount of coal before the run commences; the attendant cannot safely leave it while at work, and it uses three gallons of water per horse-power per hour, which must be specially treated if it is likely to produce scaling in the boiler. There is possible risk of explosion if the water is allowed to run low, and it requires considerable outlay in building and foundations.

2. Petroleum-Engine.

Advantages.—Requires the attendant only at starting and stopping, with occasional visits to inspect bearings. Cartage from the nearest station is only one-sixth the weight of the coal that would be required for the same output. Requires little outlay for foundations and builder's work. Risk of explosion practically nil if carefully arranged. Only a small quantity of water is required for cooling the cylinder.

Disadvantages.—Smell of the exhaust, which will travel 200 yards if allowed to escape from a hot iron pipe as sent out by most of the makers, though it can be rendered imperceptible at 50 yards if properly treated. The same applies to noise of exhaust. Engine requires an expert if it becomes deranged; petroleum is liable to market fluctuations; the light is subject to pulsation unless sufficient flywheels are provided. Being dependent on a separate explosion for each movement of the piston, it is more liable to sudden stoppage than a steam-engine. The fire insurance companies require special arrangements to be made for the storing of petroleum.

3. Gas-Engine.

Advantages.—Requires less attention than steam or petroleum, and less cleaning after work. Is more perfected than the petroleum-engine, and cheaper in first cost. More easily repaired, and less likely to get out of order. No cartage of fuel required or trouble of ordering coal or petroleum. Small outlay for builder's work. Can be started in a few minutes.

Disadvantages.—Noise of exhaust if not properly treated. Gives a pulsating light unless sufficient flywheels are fitted. Requires gas supply to be regular and of even pressure. Risk of gas supply being intercepted by frost. Is dependent on each explosion for continuity of action.

4. Water Turbine or Wheel.

Advantages.—Where a good head of water is available, it is undoubtedly the best source of power, requiring the minimum of attention, capable of being started immediately, yielding a light free from pulsation, and wearing better than any of the preceding engines. Even where there is no large fall at any one place it is frequently possible to dam up the course of the stream and carry a pipe to a lower position, where the turbine may be placed. As the charging only occupies a few hours a day, it is often possible to bring into use discarded mills which were abandoned as being incapable of providing continuous power. It is also practicable to utilise a stream which in itself would give only a fraction of the necessary power by allowing it to accumulate during the 24 hours.

Disadvantages.—Extra first cost due to earth work, especially with low falls. Risk of stoppage from severe frost. In comparing water power with engines, the interest on additional first cost must be balanced against the coal bill saved.

5. Wind-Engine.

Can only be recommended as an auxiliary in regular practice, the cost of accumulators necessary to tide over a long period of stillness being far greater than that of an auxiliary engine, apart from the fact that an accumulator cannot be kept in order with a small charging current.

6. Primary Battery.

The direct production of electricity without engine and dynamos may be accomplished some day on a practical basis, but so far the attempts have proved far more costly than engines and dynamos, and have required too much attendance. Most of these have used either zinc or iron, and carbon with nitric and sulphuric acid, and have been discarded owing to the nitrous fumes produced, the difficulty of keeping the cells in order, and the rapid depreciation. Later modifications are stated to be an improvement in details, though the outlines appear to be the same. Owing to the high resistance and polarisation or production of bubbles on the surface of the plates, there will always be difficulty in maintaining the voltage constant, unless the primary battery is merely used to charge an accumulator.

It will be seen from the above that each case requires an individual study of the local conditions and working requirements before deciding what will be best, and it is not a matter which can be safely left to the decorator or hot-water engineer to diagnose. The writer has frequently found that a combination of gas and petroleum, or turbine and steam-engine, gives the best results.

Dynamo.

From whatever source the power is obtained, the dynamo for ordinary requirements is the same, except that it will be required to be fitted with a flywheel for use with petroleum and slow-speed gas engines, provided the engine has to be run while the lights are used. Where only required for charging the accumulators, this may be omitted, as it wastes a certain amount of power. The most important features in the dynamo for country-house lighting are:

1. *Absence of Sparking.*—Sparking will wear out both brushes and commutator.

2. *Perfect Balance of the Armature or Revolving Portion of Machine.*—Vibration (which can be detected by placing the hand on the frame) is one of the causes of what are known as flats on the commutator. It is useless to try and bolt down a badly-balanced machine, for the trouble will only recur at intervals when the bolts have shaken loose.

3. *Strong Shaft and Wide Bearings.*—Unless the shaft is very strong and the bearings wide there will be trouble from hot bearings, for the strain produced by the magnets when the metal begins to wear is very great.

4. *Good Automatic Lubrication.*—The best form of lubricator is a loose ring revolving in an oil bath. This avoids any risk of the bearing being damaged owing to the attendant having forgotten to fill the lubricators, for by this system the oil only requires renewal after long intervals.

* Paper read before the Royal Institute of British Architects, Dec. 19, 1898.

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5. *Absence of Heating.*—Undue heating of the armature and magnets, say 70deg. above that of the engine-room, means unnecessary loss of efficiency.

ACCUMULATOR.

This may be taken as a necessity in every country-house installation, and the position of the room for its accommodation will require careful consideration. For reasonable distances up to 150 yards the engine and accumulator rooms should be placed alongside each other, as the attendant can see that each cell charges up equally, which is essential to success. He can also switch down the discharge regulating switch, and thus keep the voltage on the lamps regular while the engine is running. On the other hand, there is more loss of brilliancy in the lights as the full number are switched on than would take place if the cells were put in, or close to, the main building. Where the current is brought from a distance, or the light will always be supplied from the accumulator alone, a considerable saving can be made in the cost of cables by separating the engine and battery room. This question, therefore, can only be decided after a study of all the working conditions. In any case, it must be remembered that there should be no direct communication between the dynamo and cell room, or the cotton insulation will be found to rot off the dynamo after a few years. In selecting a type of accumulator, the main question is absence of attention, which can only be obtained by having the plates well apart—say ½in.—so that any detached portions fall away, instead of bridging across and exhausting the cell. If one or two cells are empty the light will be bad, although all the rest may be perfect. A slight increase in internal resistance is of minor importance compared with the extra reliability obtained. In the writer's opinion, a clear space between the plates is also preferable to enclosing them in any form of celluloid bags or wrappings, which soon become clogged with oxides. If space permits, arrange the stands to be accessible from both sides, as they can be more easily examined and handled.

METER.—The use of a registering meter is recommended in the engine-room as the best check on the amount of coal, oil, or gas consumed. It also shows whether the lights have been left burning, or used extravagantly.

POSITION OF ENGINE-HOUSE.—Place with due regard to prevailing wind, and not less than 50 yards from the main building.

COST.

Having considered local conditions as to smoke, smell, noise, and labour, the next question is the relative cost of working and first cost. The following data may be taken to apply to the average country-house installations, and will assist in determining the class of motive power to be adopted:

A unit = 15 lamps of 16 c.p. lit for an hour.

Fuel.—Coal required per unit	.....	12lb.
Gas required per unit	.....	50 cubic feet.
Petroleum required per unit	.....	1¾ pints.

Thus, for purposes of comparison, the cost of fuel for the engine will be equal with

Coal costing 22s. per ton.....
= Gas costing 2s. 4½d. per 1,000ft. ..... } = 1·4d. per unit.
= Petroleum costing 6½d. per gallon.....

The above is a liberal estimate providing for cost of getting up steam and contingencies. Although coal usually costs less than 22s. per ton, and is therefore cheaper in running cost than the other engines, a provision must be made for the additional labour, which usually brings the total to about the same figure for a country house of average size.

For large installations the cost per unit is naturally lower. The following are the results of a week's recent test with a modern generating plant for 2,000 lights, designed by the writer:

Coal for engine	·572d.	per unit.
Labour	·395	,,
Lubricating oil	·056	,,
Water, say	·040	,,
Repairs, say	·091	,,
Total running cost per unit	1·154d.	

Labour.—It is difficult to determine the exact provision for labour, but assuming that the man can, in the case of gas or petroleum engines, attend to other work while the engine is running, whereas he must stand by a steam-engine during the run, the following will act as a guide: a turbine will occupy one-ninth of his time, a gas-engine will occupy one-sixth of his time, a petroleum-engine will occupy one-fourth of his time, a steam-engine will occupy one-half of his time. With a well-designed installation it is no longer necessary to have a skilled engineer to work the plant, provided everything is large enough to do its work easily. With such a plant any estate hand, groom, or gardener can be taught to handle the apparatus, but if the first cost is cut down and the plant is strained, it is often necessary in the after working of the plant to spend double what should have been necessary.

Working Cost.—The total units per annum per lamp fixed may be averaged at 17 for a house inhabited for most of the year, and the average running cost at 3d. per unit, or for 150 lights fixed, which is a fair sample for a medium-sized country house, an annual cost of £37. 10s. This includes provision for labour and repairs, but not for maintenance and reserve fund, for which a sum of £37. 10s., or 5 per cent. on £750, may be laid by annually, though it should not be wanted for several years. If interest is to be added, an allowance must be made for the cost of gas apparatus or lamps that would otherwise have been required. The above are general figures which will vary somewhat in each case, but the writer has taken them from the results of several hundred installations which he has designed and laid down, and it is hoped they will form a useful guide in deciding what generating plant to adopt.

TREATMENT OF ROOMS.

Light resembles happiness; it is a matter of contrast, and must be treated accordingly. Mr. Alma Tadema has a small door to his atrium, in order that its size may be the more felt on entering; so must the degree of light be graduated throughout a building. On entering a dimly-lit hall from the dark it appears brilliant; but this, again, must be eclipsed by the light of the reception-rooms. So, too, we must, as in a good photograph, have our light and dark portions and our semi-tones, for a room lit equally throughout gives a flat effect, and is neither artistic nor restful. It should also be remembered that the pupil of the human eye has considerable power of expansion and contraction, and in the presence of a bright light an involuntary contraction takes place. When reading with the pupil contracted, a tired feeling is produced which may ultimately result in eye troubles. There is little doubt that the ignorance of electricians concerning this simple fact is responsible for the complications ascribed by oculists to the electric light itself. The filament of a lamp is the size of a thread, and the eye must not be subjected to the direct rays of this concentrated form of light. Take two lamps of equal power—one with a clear globe, the other frosted. Although we know that photometrically the frosting obstructs about 10 per cent. of the light, the remaining 90 per cent. gives more apparent light, because it emanates from a larger surface. Thus the secret of a restful light is the illumination of a large surface with an absence of any dazzling spots of small area. In a room thus lit the pupil of the eye expands to its full limit, and the weakest eyes can read with a comfort that cannot be obtained in any other way. To get this result we must either diffuse the rays by transmitting them through a large shade, or we must trust to reflection, and project the direct rays on the walls and ceiling from some hidden source. The illuminated surface is then greater than that of even the largest shades, and the effect more restful. We are, however, practically debarred from this treatment on the score of expense unless the colour of walls and ceiling is very light; in the latter case it is capable of wide adaptation. The writer believes he was the first to employ a combined shelf and picture rail containing a row of hidden lamps for reflected light. Pretty effects can also be produced with small lamps concealed in the overmantel and in china cabinets.

Fittings.—We next come to the question of fittings, which to the user is a most important item, though to the electrical engineer it is frequently considered merely a matter of selection. In old houses we are practically tied to an adaptation of the candle fittings in existence, for they are usually in accordance with the style of the room. Objection is sometimes raised to the use of imitation candles as being inartistic, but it must be remembered that the designer had the candle in view as the basis of his outline, and without it the proportions are wrong, and the drip-cups and other parts meaningless. An incandescent lamp springing direct from a candle socket is a squat abortion that has nothing to commend it. If, therefore, these fittings are to be retained, every effort should be made to get the precise effect of candles without their disadvantages, and as far as possible to conceal the fact that electric light has been employed. The writer remembers once at a dinner party a guest congratulating his host on having kept to wax candles on the table—and, by the way, he added, "What good candles they are!"

Examples are shown of the way in which old fittings may be treated without detriment to their appearance, and attention is called to the economy of shading only the front of lamps placed against a wall, for thus the full advantage of reflection is obtained, and an 8-c.p. lamp will take the place of a 16-c.p. if totally enclosed. For shades an equally pretty substitute for silk has yet to be found; but horn, glass, and beads are all capable of cleaning, and paper is cheap to replace. Celluloid is dangerous, as it is capable of being ignited by the heat of the lamp. A hint must be given as to the necessity of testing these with electric light before making a selection, for if chosen by daylight alone, the result is often disappointing. It is possible to dispense with metal fittings altogether by working the lamps into plaster-work in the ceilings; but this treatment, unless

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carefully arranged, gives a patchy appearance and lowers the rooms. There is also a risk of blackening the ceiling near the lamp, due to the currents of air produced by the heat of the filament. Care must always be taken to leave a clear space round the lamp to avoid risk of fire, for an incandescent lamp under certain conditions produces heat enough to char woodwork: for the same reason lamps must be kept clear of drapery and curtains.

The following hints on the treatment of the different rooms may be of service: as vertical lines on the walls give the idea of height, and horizontal lines dwarf a room, so lights placed low as standards or bracke s should be preferred in low rooms to pendants or electroliers hung from the ceiling.

Dining-Room.—The prominent feature should be the table, which may be lit either (1) by a shaded counterweight lamp with white inside and some art shade of pink or terra-cotta outside, so that the transmitted light may give a becoming colour; or (2) by the adaptation of the candle fittings as shown in the specimens exhibited. In the latter case the wires are distributed by a patented connector lying under the table centre, and so contrived that neither the table nor the cloth is pierced. The rest of the dining-room should be in repose, with shaded lamps to meet practical requirements. One of the best effects produced by the writer is at Chatsworth, where powerful lamps are hidden in reflectors at the base of the pictures all round the room. This not only lights the pictures, but also illuminates the ceiling, and gives a cheerful effect without that tired feeling which is a frequent source of complaint in electrically-lit dining-rooms.

Drawing-Room.—This room should be the most brilliant in the house, and must be treated for ordinary use with additional lights for receptions or dances. Where possible, the writer prefers to light principally from the walls and from standards, as a top light is unbecoming to ladies, causing dark shadows under the eyes. In order to provide for the alternative treatment required in summer and winter, a liberal use of wall attachments is recommended. Objections are sometimes raised to these on the score that they are unsuitable if the room is used for a dance, but this difficulty can be overcome by suspending side-lights from the picture rail, current being conveyed to the lamp by a silk cord lying flat against the wall.

Bedrooms.—It is usual to place two lights near the dressing-table, and it will be found that there is considerable diversity of opinion as to the most popular treatment. In lofty rooms, cords pendent from the ceiling are unsightly, although for low rooms two counterweight pendants carefully placed will usually meet all practical requirements. An alternative treatment, which has the advantage of enabling the dressing-table to be moved or placed at an angle, consists of two jointed brackets attached to the uprights of the mirror, and carrying sliding arms capable of being raised or lowered at will. The same advantage applies to the use of two standards on the dressing-table, which would preferably be made telescopic. By the bed, or in large rooms on each side of the bed, a bed-standard with a swivelling shade should be provided, with hooks in convenient positions to enable the fitting to be used as a bracket when required, the switch for this lamp being placed within easy reach. In passages and staircases two-way switches should be fixed in such positions as will avoid the necessity of traversing any part of the building in the dark. Switches should, as a rule, be fixed near the door, and in well-decorated rooms should be sunk to render them as inconspicuous as possible, which is usually preferable to any attempt to conceal their unsightliness with ornamental covers.

Picture Lighting.—For the general illumination of the room reflectors are most useful if placed at the base of the picture, for by this means the light is thrown on to the ceiling and diffused into the room. With large pictures, however, it is frequently necessary to supplement these with a top reflector, in which case the lamp must be placed sufficiently high to prevent the reflection of the lamp itself throwing a bright patch on the picture, the angle of reflection being of course equal to the angle of incidence. Side-lights can only be used where the pictures will not be seen from any position where the lights themselves will be visible.

Before concluding, the writer wishes to make a passing reference to the improvements in gas and oil which are constantly being brought to public notice as the latest rivals of electric lighting. Statistics have shown that these are an absolute benefit to the electrical industry, for frequently the most difficult problem before the electrical engineer is to educate the conservative householder to the necessity for more light than has sufficed for his ancestors. If only he can be induced to adopt a brighter light, even if produced by one of the latest forms of gas or oil apparatus, the low initial cost of which is certainly enticing, he will never be willing to return to his former condition. Then after a short time, when the absence of oxygen, the smell, and general stuffiness have become quite unbearable to him, history again repeats itself, and one more name is added to the long list of those who use and appreciate the electric light.

ELECTRIC TIMBER SEASONING AND PRESERVATION.

How to obtain a thoroughly seasoned timber at a small cost is a problem which has occupied a great deal of attention, and many methods have been tried to obtain it. Messrs. Johnson and Phillips, at their works at Charlton, Kent, have had on view this week a process by which timber is seasoned and preserved electrically. The wood to be treated is placed in a tank which rests upon insulators upon timber supports. This tank contains a solution of 10 per cent. of borax, 5 per cent. of resin, and 5 per cent. of carbonate of soda. A lath tray, upon which is the positive pole, is placed in this, and on this again the wood is placed. On top of the wood is a thin layer of felt, and on this rests the negative conductor (a sheet of lead). On this conductor a little water is placed, which has the effect of attracting the salts below the wood up through it. The solution is warmed by means of a steam-coil, this making the electrolysis easier. The wood is covered by the solution to within a distance about 2in. from the top at the commencement of the operation, and is gradually lowered towards completion of the process.

A current of about 600 amperes at 110 volts crosses the thickness of the wood, entering from the lower part, which is connected to the positive pole, and coming through the top, which is connected to the negative pole of the dynamo. The current then causes the solution to be sucked from the bottom to the top, and the whole mass of wood is permeated by the combined resin, borax, and soda, this being effected by electro-capillary attraction.

The displaced sap rises to the surface of the bath during the operation, and the resin in it mixes with that in the solution. The time required for the operation varies from five to eight hours according to the nature and state of the wood under treatment, green wood being much easier to treat than wood which is nearly dry. The solution used for the simple process of seasoning and preserving the wood is a composition called "Bororesinate de Soude," the resin of which seals the fibres of the wood after cooling, and the boric acid acts as an antiseptic. The wood after being treated is placed in a drying chamber or in the open air. The temperature of the drying chamber at Messrs. Johnson and Phillips's was 75deg., but the wood dries perfectly well even in the open air, the only difference being that a month or so is required instead of a fortnight. The current used for the process in the tank is 18 amperes per cubic foot per hour, and the dynamos are driven at 110 volts. Taking the cost of electrical energy at 1d. per kilowatt, it will be seen that the cost of the treating by this process, without considering the drying question, comes out at less than $\frac{1}{50}$d. per cubic foot.

This treatment is claimed by its inventors, Messrs. Nodon and Bretonneau, to make the wood absolutely impervious to damp, and to prevent its decay. Another advantage claimed is that few of the insects which usually attack wood do so to timber which has been treated. A site has been obtained near Charlton Station by the Electric Timber-Seasoning Company, upon which they propose to erect works. Licenses are also being granted to timber merchants, builders, etc., for the erection of suitable plant within their own premises, subject to the payment of a fixed sum for plant and annual royalties proportionate to the quantity of timber treated, which is ascertained by electricity meters. The process has made great progress in France. Last April a company was formed called La Société Anonyme pour la Senilisation rapide des bois et matières fibreuses, with a capital of £48,000 in shares of £4 each. Business was commenced in November last with orders in hand sufficient to keep the works employed at their full capacity (2,700 cubic feet per day) for upwards of two years.

Amazon Telegraph Company, Limited.—At an extraordinary general meeting of this company held this week, a resolution authorising the directors, from time to time, to create and issue debentures not exceeding £75,000, such debentures to rank *pari passu* with the existing issue of £125,000, and to be entitled to the benefit of the trust deed of Aug. 5, 1897, was carried.

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TO CORRESPONDENTS.

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COST OF MUNICIPAL ENTERPRISE.

This is the title of a paper read by Mr. Dixon Henry Davies at the meeting of the Society of Arts on Wednesday last. The paper does not bear out its title. It is rather a special pleading for limitation in municipal enterprise. We are heartily at one with the author in the moral he inculcates, but we fear his paper teems with statements easily refuted, and proved to be inappropriate by those who think municipalisation the panacea for all evils under the sun. In the paper, "cost of municipal enterprise" does not deal with concrete examples, but masses the local indebtedness, and the author exclaims, "Behold how great!" and infers, how terrible! When it condescends to touch upon concrete examples, these examples are badly selected, and will in the hands of clever opponents be made to tell terribly against the author's main contention. The broad fact that local indebtedness has enormously increased during the past twenty years, is accepted as proof of the incompetency of local authorities to deal with the various questions discussed. Let us at once state that we most emphatically agree with the desire to limit the actions of municipal bodies, and shall use whatever influence we possess to obtain legislative interference to define the limits of action of such bodies; hence, if we deal more particularly with the weaker arguments by Mr. Davies, it must not be assumed that we are against him on the general question. Let us fight the municipalisation craze from practically unassailable standpoints, and not expose ourselves to ridicule. It is quite true that during the twenty years 1878 to 1897 the Imperial debt has decreased from seven hundred and seventy-five to six hundred and forty-one millions, while the local debt has increased from one hundred and thirty-eight to two hundred and forty-five millions sterling. One half of this latter increase Mr. Davies assumes to have been warranted. As to the remaining half, he assumes it to have been incurred by municipal authorities undertaking trading and incurring risks which ought to have been left in the hands of private traders. That a considerable portion of this debt has been incurred recklessly and wastefully may be granted, but by far the larger portion has been incurred for purposes that commend themselves to the unbiassed onlooker. Before it can be said whether an expenditure is justified or not, the work for which it is incurred must be known. As samples of costly municipalities Mr. Davies pointedly calls attention to Manchester and Birmingham. In his eyes Manchester is a sinner beyond reclaim. That may be so. We will not argue the point, but surely it is but just to Manchester to explain that millions of its huge debt have been incurred because it came to the rescue of a concern initiated by private enterprise and at the point of failing because of the inability of private enterprise to carry the work through. Is there a single individual knowing the history of the Ship Canal that will not commend rather than condemn the action of Manchester? There will be no loss in the end by being just to opponents. Add to the Ship Canal loan the cost of the Thirlmere

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scheme, and you begin to see why Manchester is so indebted. The question is not so much the amount of indebtedness as its justification. Would private enterprise have supplied Glasgow with water from Loch Katrine, or Manchester from Thirlmere, Birmingham from the Elan Valley, Bradford from the Nidd Valley, and so on? Again, the question is, are such works justifiably municipalised? If so, the unjustifiable indebtedness will be largely decreased from the amount at which Mr. Davies places it. When Mr. Davies discusses electrical questions he is more at home, and we have a somewhat strong personal feeling in this matter. From the earliest indication of electrical power transmission we have always contended that that branch of the industry would completely overshadow anything connected with electric lighting. We were allowed to fight the question of municipalisation of tramways without the support of a single individual who declaims against what is now unfortunately an accomplished fact. It is now the custom to damn the legislation of 1882, but at that time men in the industry begged there should be no criticism of the Bill, and that it should be allowed to pass. Similarly, the question of profit-making by municipalities has been condemned by us again and again when there was a possibility of guiding public opinion. The fact is that men care not except when the shoe pinches their own feet; then they are eager for a remedy. The question of municipalisation is not an electrical question; that happens to form a part and only a small part of it. However, whether we agree or not with Mr. Davies in some things, as previously said, we cordially agree in his efforts to obtain limitation to the action of local bodies. His sentiments are right even if his phraseology is wrong. The following is hardly a definition, but it sums up Mr. Davies's position, and may form the ground for discussion in order in the end to obtain a really workable definition of what constitutes the "sphere and scope" of municipal enterprise. He says: "Surely, therefore, the corporations would be well advised to confine their functions to those important public matters in which all their constituents are equally interested, and which must of their nature be performed by the ratepayers in common, and which involve no taint of partiality or suspicion of class bribery; such are the administration of justice and police, the care of the public health, the provision of parks and open spaces, and so forth. Let them leave to private enterprise whatever private enterprise will undertake, keeping themselves in an impartial position, so that they may secure the unsuspicious loyalty and obedience of all the traders to the regulations which they impose upon them for the protection of the common interest. Let them adhere to the spirit of the constitution of Alabama, which declares 'that the sole and only legitimate end of Government is to protect the citizen in the enjoyment of life, liberty, and property, and when the Government assumes other functions it is usurpation and oppression.'" The sentence, "Let them leave to private enterprise," etc., needs to be greatly modified before it can be accepted. Many sanitary arrangements—water provision, roads and streets, etc.—have been left to private enterprise, till during the past century scores of private and general Acts have been passed to remedy evils we have no wish should return. Bear in mind the question of municipalisation will not be decided by reference to electrical matters alone.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE TELEPHONE SERVICE.

SIR,—In respect to the leader in your issue of the 27th ult., pray permit me to say that you have misunderstood my last letter in the *Times*, which was consecutive with six previous letters from me that the *Times* had been good enough to publish. I have not "changed my opinion"—namely, that nationalisation should go no further than the trunk lines. If you had read my letter a little more carefully, you would not have stated that I "formulated any scheme" as a consequence of change of opinion. On the contrary, I pointed out that there are three courses open to Parliament—namely: (1) to nationalise only the trunk lines and leave the rest of the telephoning of these countries free to competitors, which is the procedure I have always advocated and still advocate; (2) to confine competition to that between the Post Office and a few privileged powerful corporations on the one hand and the National Telephone Company on the other; (3) to buy up the National Company and nationalise the whole of the industry. The two latter I am against.

May I further deprecate your assertion that the "weight of opinion" is against No. 1. I believe, on the contrary, that there is a growing preponderance of public opinion in its favour.—Yours, etc., C. E. WEBBER.

[We regret in any way misunderstanding General Webber, and we are sorry that he is against the third and "bolder" alternative as put forward in his letter to the *Times*. When our differences are boiled down it will be found that both parties are agreed upon certain fundamental points—thus (*a*) that telephony is mostly local, and (*b*) that the local centres must be connected with trunk lines. We argue that both trunks and distributors should be controlled by the Government, and gather that General Webber agrees to Government control so far as trunks are concerned, but he would prefer the distributing areas to be "free to competitors." We hope some day to have him in line.—ED. *E. E.*]

ELECTRICITY AS AN EXACT SCIENCE.

SIR,—Mr. Howard Little is unnecessarily severe on me in his letter in your last issue. What I meant to say in the letter he refers to, and what I think I did say, was that, as regards "the wonders of the magnet," all that he has *yet* unearthed is a work of supererogation in view of what I had already done in 1884.

From the use of the word "unearthed" in your note I inferred that Mr. Little was exploring afresh ancient history for facts, and knowing well the (often disproportionate) expenditure of time and labour which such a task involves, I thought it would be a friendly act to show him where he would find those facts ready to hand, and so save him further trouble. *Voila tout!*—Yours, etc.,

J. J. FAHIE.

REVIEWS.

Continuous-Current Dynamos in Theory and Practice, with Details of Methods and Formulæ used in Construction. By J. FISHER-HINNEN (late Chief of the Designing Department at the Oerlikon Works). 10s. 6d. Biggs and Co., 139-140, Salisbury-court, Fleet-street.

This very valuable contribution to the literature dealing with the continuous-current dynamo from a practical point of view, and several editions of which have already appeared

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both in German and in French, has at last, thanks to the initiative of Messrs. Biggs and Co., been translated into English. The author being thoroughly conversant with the best Continental practice, his book, we feel sure, will strongly commend itself to every open-minded student and designer in this country.

The book presupposes a general knowledge of the subject. In Chapter I. will be found a brief but lucid recapitulation of the general principles involved. Chapter II. begins by briefly reviewing the principal forms of winding, admittedly with no pretence to completeness, the reader being referred to special works on the subject. We note the predilection shown for what is sometimes termed the series-parallel winding. To our mind these windings have only apparent advantages, and lend themselves best for small machines, up to, say, 40 kw. specific output. The armature reactions per pole beyond this limit become excessive. To avoid selective collection of current depending greatly on the relative pressure of the different sets of brushes on the commutator, it is necessary to use two sets of brushes only, thus doing away with one of the advantages of the multipolar dynamo by making the commutator unnecessarily large. It also becomes difficult to keep the volts between the sections down to a reasonable limit. The objection raised against parallel winding is undoubtedly correct, but is trifling compared with the above-named disadvantages of its rival; besides, whenever one armature branch yields more than its due share of current, its increased reaction automatically tends to re-establish the equilibrium. The dislike so many people show for more than two sets of brushes cannot possibly apply to a modern well-designed dynamo, where brushes give no trouble at all.

After a useful comparison between rings and drums, follows, in the same chapter, a preliminary discussion of sparking and its causes. We note that very little is said about the various more or less ingenious methods of preventing sparking and reducing the brush lead; these methods, however interesting, are of little practical use, as they all tend to materially increase the cost of the machine. Discussing the armature losses, several empirical formulæ are given; they are most useful as a guide—the actual coefficients to be used will be best determined by every designer to suit his own particular type of machine. The formulæ given for quickly obtaining the main proportions of an armature will be found reliable and most useful for estimating purposes. The chapter concludes with an interesting table of armatures executed by leading firms.

Chapter III. deals at great length with the design of the field magnets, the portions relating to tram motors and brakes being of special interest. The leakage is thoroughly discussed, and examples are given of the proportions selected for some dynamos now at work. A short chapter dealing with the determination of permeability, with special reference to workshop practice, is followed by one describing graphic methods of solution of practical problems—it is most interesting, and will find favour with the many who prefer this method to any other.

Chapter VI. comprises by far the most interesting portion of the theoretical part of the book. The author's predetermination of the sparking limit is a most ingenious one. Those not familiar with differential and integral calculus will do well to read the subject up to the slight extent necessary in order to follow the deductions. The tables given in this chapter contain an enormous amount of valuable information. It seems to us, however, that a more reliable value of $\frac{r}{L}T$ would be obtained if the mutual influence of all those slots was taken into consideration which carry the short-circuited coils. It is clear that their number varies greatly according to the winding which is selected. This would probably account for the somewhat erratic values given in column 16 of the second table.

Chapter VII. contains more useful information about arc light dynamos than is usually available. The next chapter deals with the mechanical details of the dynamo, and contains any amount of useful information on a subject which, unfortunately, is only too often neglected. A close study of this, together with Chapter IX., will be found most instructive. The very marked tendency towards the multipolar design will not fail to impress the reader.

The rest of the book contains weights and overall dimensions of various kinds of dynamos, and most useful recapitulation of all the principal formulæ arrived at. A number of tables and plates are appended, amongst which the key table is of special value. We have traced many a breakdown back to the faulty design of this particular part. A study of Plate 2 will show the hopelessness of devising a novel shape of dynamo, and may save the one or the other much brain-racking.

The illustrations in the book have a very businesslike appearance, and consist mostly of scale drawings showing section and elevation. The number of half-tone blocks has been judiciously restricted to a minimum.

Although in some points, which perhaps are open to controversy, we may differ from the author, we greatly value his very useful work. His intention has been to produce a volume acceptable to the practical engineer, and in this he has, in our opinion, thoroughly attained his object.

V. A. F.

FORTHCOMING EVENTS.

MONDAY, FEB. 6.

Society of Engineers.—At United Service Institution at 7.30 p.m. Presentation of premiums by Mr. W. W. Beaumont and inaugural address by the new president, Mr. John Corry Fell.

TUESDAY, FEB. 7.

Institution of Civil Engineers.—At 8 p.m., "The Waterworks of the Madras Presidency," by Mr. J. A. Jones, M.I.C.E.

Rontgen Society.—At 11, Chandos-street, at 8 p.m., "A Modified Form of Toepler Mercury Pump," by Mr. Wilson Noble.

WEDNESDAY, FEB. 8.

Society of Arts.—At 8 p.m., continuation of the discussion on "The Cost of Municipal Enterprise." Also a paper on "Nernst's Electric Lamp," by Mr. James Swinburne.

Liverpool Engineering Society.—At Royal Institution, Liverpool, at 8 p.m., "Electricity at the General Post Office," by Mr. W. H. Preece, C.B., F.R.S.

THURSDAY, FEB. 9.

Institution of Electrical Engineers.—At Institution of Civil Engineers, at 8 p.m., continuation of discussion on the three papers on "Wiring Rules," and, time permitting, a paper will be read by Mr. Miles Walker on "Electric Traction by Surface Contacts."

Institution of Mechanical Engineers.—At new house of institution, Storey's-gate, St. James's Park, at 7 30 p.m., annual general meeting. "Fifth Report to the Alloys Research Committee: Steel," by Sir William C. Roberts-Austen, and "Machinery for Book and General Printing," by Mr. William Powrie.

FRIDAY, FEB. 10.

Royal Institution.—At 9 p.m., "The Motion of a Perfect Liquid," by Prof. H. S. Hele-Shaw. LL.D., M.I.C.E.

Institution of Junior Engineers.—At Westminster Palace Hotel, at 7.30 p.m., joint discussion with the Architectural Association on "Factory Design," by Mr. J. H. Pearson.

Institution of Mechanical Engineers.—At 7.30 p.m., "Evaporative Condensers," by Mr. H. G. V. Oldham.

Physical Society.—At 5 p.m, annual general meeting and a paper by Mr. Benjamin Davies on "An Ampere-meter and a Voltmeter with a Long Scale."

Institution of Civil Engineers.—At 8 p.m., students' meeting, paper to be read by William Middleton, Stud.Inst.C.E., on "The Electrical Driving of Engineering Shops."

PROPOSED LONDON MUNICIPAL TELEPHONE SERVICE.

A conference consisting of delegates from upwards of 50 local authorities constituting what is known as the London telephonic area, itook place on Wednesday at the City Guildhall to consider what should be done in reference to the London telephone service.

Alderman Sir HENRY KNIGHT presided in the absence of the Lord Mayor, and welcomed the delegates to the City. Before resigning the chair to Mr. A. C. Morton, C.C., he reminded the conference that the subject they had met to discuss was, in view of the scientific progress of the age, of the greatest possible importance, not only to the City, but to every other municipality.

Mr. MORTON, in the course of a few opening observations, briefly sketched the history of the movement, which had resulted in the City inviting the co-operation of the

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County Council and the outlying authorities to secure a telephone service under the municipal control of the whole metropolitan area. Over a hundred delegates were present, and therefore it would be understood that it was a thoroughly representative conference of the London telephone area, which covered over 600 square miles. There were various reasons why the municipal and local authorities should have some control over the telephone service. What they really wanted was a cheaper and more efficient telephone service, and to secure this end they must vest the control in the hands of a public authority. A good deal might be said in favour of the Post Office being the controlling body, but as the Post Office showed no inclination to step in, the local authorities were forced to take action. Then, again, we could not have a good telephone service unless proper means were provided for laying it, and as the roads ought not to be interfered with without the consent of the local authority, it was desirable that the local authority should have control of both.

Mr. J. W. BENN, the chairman of the Highways Committee of the London County Council, proposed the first resolution: "That this conference of delegates, representing the London County Council, the Corporation of London, and the other local authorities within the London telephone area, is of opinion that a joint application should be made for a telephone license for the London telephone area, in accordance with the resolution passed by the Court of Common Council on Nov. 17, 1898—viz.: 'That application be made for a license to establish a telephone service in conjunction with the London County Council and other local authorities within the London telephone area.'" He was delighted to have an opportunity of joining hands in this matter with the City Corporation and the representatives of the various suburban authorities. Some little time ago the London County Council applied for a license, but were told by the Postmaster-General that he could not move in the matter until he had the report of the Parliamentary Committee. The report was issued some little time after that, and the Council had hoped that something would be done to give effect to the committee's recommendation. Nothing, however, had been done, and it seemed as if the Post Office did not desire to assist telephone users, but, on the other hand, to maintain the monopoly which existed for a good many years greatly to the detriment of the citizens. The charge to consumers in the provinces was about £10, but in London, even under a five years' contract, it was £17. If the London subscribers were put at 12,000 only, it would be seen that for bolstering up the National Telephone Company they were paying no less than £84,000 annually. A considerable sum had to be collected by the company in order to pay a 6 per cent. dividend on its watered capital—that is to say, the money spent in buying up competitive companies. If London only paid its just proportion on that watered capital the amount would be £17,000 a year, but it was actually paying £76,000 per annum. Why should London have to pay the dividend on this watered capital, when they were provincial companies which were purchased, though the provinces were not paying for them?

Dr. W. W. STOCKER (Willesden), in seconding the resolution, protested against any local body being sold into the hands of a private monopolist. They in Willesden had not forgotten the action of the Telephone Company who wanted to dig up the streets and lay their pipes without any hindrance from the local authority whatever, and they would give no promise at all as to the charges they would make. Mr. Fischer in 1895 stated that the telephone companies had spent about £2,000,000, but already they were getting together all the rights they could, and when the question of purchasing them came on, they would be met with a demand for some £6,000,000 or £7,000,000. An independent company was asked to come into Sheffield, but then arrangements were come to with the National Telephone Company stipulating that the service should not cost more than £8 per annum.

Mr. G. BERRIDGE (London) said that the service charged ordinarily was £20 a year, but by contracting for five years it was supplied at £17. He was quite confident they were treated much better 17 years ago than now.

Mr. THORNTON, L.C.C., asked what length of time the license would be granted to the municipalities? Would it go beyond 1911? If not, what alternative had they? He liked compromises, and it was possible a compromise might be made with the Telephone Company. No doubt in 1911 the company would go out, and the Post Office or the municipalities would come in.

The CHAIRMAN explained that the resolution did not pledge them to any particular period for the license. They certainly would not be willing to have it limited to a few years.

After some further discussion the motion was unanimously passed, and

Mr. CORRIE GRANT (Acton) moved: "That this conference is of opinion that the London telephone service should be managed by the London County Council and the Corporation of London, and the other local authorities within the London telephone area."

Mr. H. COOKER (Edmonton) seconded this, which was also carried unanimously, as was the following resolution proposed by Mr. SEEX (Reigate): "That this conference recommends a joint application to the Postmaster-General for the telephone license, in accordance with the foregoing resolutions."

It was also decided to forward copies of all the resolutions to the various authorities represented for their confirmation.

QUESTIONS AND ANSWERS.

QUESTIONS.

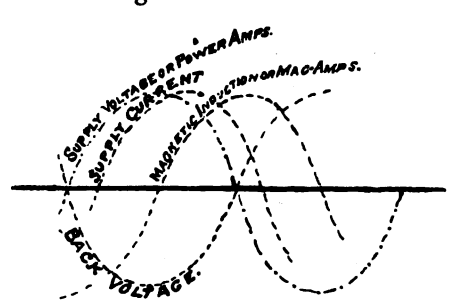
138. An electrostatic voltmeter takes no current when connected to a continuous-current system, but takes a current when connected to an alternating-current supply. Why is this?—J. C. R.

139. Describe fully some form of independent jet condenser, giving details as to the steam it will condense and the quantity of condensing water required.—W. W. A.

ANSWERS.

Question No. 132.—Explain precisely and clearly what the *power factor* of an alternating-current motor is, and why it varies with the load on the motor.

Best Answer to No. 132 (*awarded* 10*s.*).—The power factor of a motor is the ratio of the input measured in true watts on a wattmeter to the input measured on a voltmeter and an ammeter. If the curves of supply E.M.F. and current are sine curves, this ratio is the same as the cosine of the angle of phase difference between the volts and the amperes, but for the practical case where the curves differ widely from the sine form the angular phase difference becomes a rather uncertain quantity, and the only way to get at the power factor is to take simultaneous ammeter, voltmeter, and wattmeter readings.



To understand why the power factor varies with the load it is only necessary to consider what causes difference of phase between volts and amperes. In most motors this phase difference is a lag of the current behind the voltage and is due to the presence of the magnetising current. The whole input current may be conveniently considered as divided into two parts—one being the magnetising current and the other the power current. The magnetising current is just sufficient to produce a magnetic induction through the coils corresponding to a back voltage nearly equal to the supply voltage. The magnetising current is practically 90deg. in phase behind the supply voltage, for when the induction is a maximum the rate of change of induction, or the back voltage, is a minimum, and the back

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voltage is practically in exact opposition to the supply voltage. The other part of the supply current—the power current—is in phase with the supply voltage.

The accompany curves show roughly the phase relations of the various voltages and currents, though, of course, the actual shapes of the curves would be decidedly different.

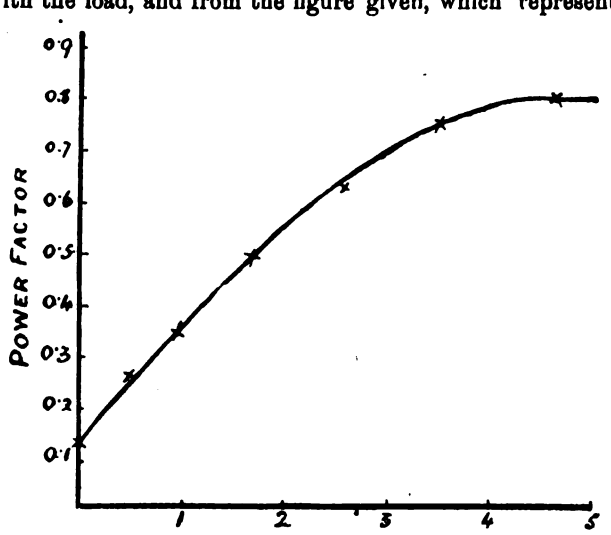
The supply current as measured on an ammeter is the vector sum of the magnetising and the power current, or

$$\text{Supply current} = \sqrt{(\text{magnetising amps.})^2 + (\text{power amps.})^2}.$$

$$\text{And the power factor} = \frac{\text{power amperes} \times \text{supply volts}}{\text{supply amperes} \times \text{supply volts}}.$$

Now, at no load the power amperes (representing hysteresis, friction, and a small number of $C^2 R$ watts) are a very small proportion of the supply amperes, even when the magnetising amperes are kept as low as possible by good design, whilst at full load they form the principal part of the supply current. For the magnetising current (the amount of which depends on the smallness of the air gap between rotor and stator, on the number of turns of wire on the stator, and on the nature of the magnetic circuit generally), is almost exactly the same at full and at no load. It is obvious, therefore, that the power factor, or ratio of power amperes to supply amperes, will gradually increase as the load increases.—Q.

Answer to No. 132 (*awarded* 5*s.*).—If we read the watts that an alternating current motor is taking (W) by means of a wattmeter, and also the current supplied to it in amperes (A), and the volts across its terminals (V), then the power factor for that load is $\frac{W}{V A}$. This expression can, of course, never be greater than 1, and in practice is generally much less than unity. The power factor varies with the load, and from the figure given, which represents



Power Factor of a 4-h.p. Langdon-Davies Alternate-Current Motor.

tests on a Langdon-Davies 4-b.h.p. motor, and is typical of the best class of alternating-current motors, it will be seen that the power factor changes rapidly with the load, and is very small at no load. From the theory of the alternating-current motor we know that we may regard the stationary part (the stator) as the primary of a transformer, and the revolving part (the rotor) as the secondary. When the rotor is revolving rapidly there is a large E.M.F. induced in the stator windings, which makes the stator current out of step with the applied volts, and hence the apparent watts the stator is taking is much larger than the true watts, for the stator current is sometimes flowing against the applied E.M.F., and thus restores some of the apparent watts back to the circuit. The power factor is, therefore, very small at no load. As the load is increased the speed of the rotor falls slightly, the induced E.M.F. in the stator is therefore smaller, and the stator current gets more nearly into step with the applied E.M.F., and hence the difference between the apparent watts and the true watts gets smaller, and so the power factor increases. In the figure it will be noticed that it increases from 0·13 to nearly 0·8 at full load. In larger alternating-current motors a higher value of the power factor is obtained. It does not, however, follow that the higher the power factor the higher the efficiency, for in the theory the effect of magnetic leakage, which is often very large, is entirely neglected. In the motor experimented on above, for example, when the brake horse-power was 2 the power factor was 0·57, and the efficiency was 74 per cent., but when the brake horse-power was 4 and the power factor 0·79 the efficiency was only 71 per cent.—J. C. R.

Answer to No. 132 (*awarded* 5*s.*).—The power factor of a circuit is the ratio of the real watts given to the circuit to the apparent watts. Thus if

V = virtual value of impressed E.M.F.;
i = virtual current;
W = watts given to circuit (measured by a wattmeter);

$$W = K\, i\, V = i\, V \cos \phi,$$

where ϕ = angle of phase difference between current and E.M.F., and $K = \cos \phi$ = power factor.

In the case of an induction motor, we supply alternating current of two or more phases to the primary or stator coils, producing a rotating magnetic field, the lines of force of which cut the stationary, secondary, or rotor conductors and induce in them a secondary E.M.F. and current. By Lenz's law the armature conductors tend to move in such a way as to stop the relative motion—*i.e.*, they rotate in the same direction as the field. The motor will try to run synchronously. The greater the load, the higher the frequency of the secondary current. Let

N_0 = frequency of primary;
N_1 = frequency of secondary;
$k = \frac{N_1}{N_0}$ = the slip. Let
r_1 = ohmic resistance of secondary;
S_1 = secondary reactance = $2 \pi N_1 L_1$ (where L_1 = inductance of secondary)

then it can be shown that the power factor of such a motor is

$$K = \frac{r_1}{\sqrt{r_1^2 + k^2 S_1^2}}.$$

This explains why the power factor varies with the load, since the slip, k, appears in the denominator. The slip of an induction motor is a maximum at the instant of starting, being equal to the primary frequency. As the rotor runs up to speed, k diminishes until the friction just balances the torque. When the motor is loaded the slip is, therefore, greater than when running light, and hence the power factor is greater (since k is a fraction). An induction motor running light is like a transformer on open secondary, a transformer, too, with an air-gap in its magnetic circuit, and requiring a relatively large magnetising current. The no-load current may be 20 or 30 per cent. of full-load current, and the power factor about ·1 (at no load). The power factor of ordinary types of motors varies from ·65 to ·85, and its effect in the distribution of power by alternate current is that we practically have to instal generator, transformers, and mains of a capacity of 1 kw. for every 1 e.h.p. we require.—E. M.

Question No. 133.—What is the specific resistance of india-rubber and the prepared paper compound as used for cablemaking? Give a calculation of the predetermined insulation resistance, and compare it with the actual cable as manufactured.

Best Answer to No. 133 (*awarded* 10*s.*).—Prof. Fleeming Jenkin gives the specific resistance of indiarubber as $1{\cdot}09 \times 10^{25}$ C.G.S. units at 24deg. C. If we use Mr. Preece's unit—namely, the resistance of a quadrant cube of the material in megohms—then the specific resistance, or "specific insulation," as Mr. Preece calls it, is 10 9 As it is very difficult to obtain indiarubber that is chemically pure, this result of Jenkin's can only be taken as approximately true in practice. For example, Messrs. Siemens Bros. give 16·17 as the specific insulation of their high-insulating rubber, and 2 28 as the specific insulation of their ordinary pure and vulcanised rubber.* The specific insulation of Siemens's

* See the *Journal* of the Institution of Electrical Engineers, vol. xx., p. 611: Mr. Preece on the "Specification of Insulated Conductors for Electric Lighting and other Purposes."

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specially high-insulating fibrous material (paper compound) is 11·90 at 15deg. C.

In Mr. Preece's paper the following formula is given for predetermining insulation resistance:

$$R = \frac{\sigma \log \frac{D}{d}}{4{\cdot}39} \times 10{,}000.$$

In this formula, R is the resistance in megohms of a statute mile of the cable, σ is the specific resistance in terms of the quadrant cube (the specific insulation), and D is the outer and d the inner diameter of the insulating sheathing.

Examples.—I. Cable $^{61}/_{15\frac{1}{2}}$, made by Messrs. Siemens Bros., and insulated with ordinary pure and vulcanised rubber, D = 0·949in., d = 0·612, and taking Jenkin's value of σ (10·9), we find

$$R = 4{,}726 \text{ megohms.}$$

The actual measured insulation resistance was only 824 megohms per statute mile. For other similar examples see the *Journal* of the Institution of Electrical Engineers, vol. xx., p. 616.

II. Ferranti concentric main, d = 0·812in., D = 1·844in.; insulating material, compressed brown paper and black wax; specific insulation, nearly 1·5 at 20deg. C. (Fleming).

$$R = \frac{1{\cdot}5 \log \frac{1{\cdot}844}{0{\cdot}812}}{4{\cdot}39} \times 10{,}000,$$

$$= 1{,}217 \text{ megohms.}$$

The insulation resistance between the inner and outer conductor, as measured by Dr. Fleming, came out 720 megohms (see the *Journal* of the Institution of Electrical Engineers, vol. xx., p. 386). In testing-room experiments on the insulation resistance of cables, the calculated results often come out closely to the observed values, but in the above two examples the insulation resistance was measured *in situ*, and in both cases, as might have been expected, it comes out considerably lower than the calculated value.—J. C. R.

ELECTRIC LIGHTING IN BECKENHAM.

The following is the report by the electrical engineers and Mr. J. A. Angell, the surveyor, on the tenders received:

In accordance with the Council's instructions, we beg to submit a list of the tenders for the electric lighting of the district, together with a brief report thereon.

Boilers.—Babcock and Wilcox, Glasgow, £1,450; Hornsby and Sons, Grantham, £1,675; Mechan and Sons, £1,687. Messrs. Babcock and Wilcox, whose tender is the lowest, is a firm of high repute, their boilers being in use in many of the largest and most important electric lighting stations in this country.

Alternators, Transformers, and Switchboard.—Fowler and Co., Leeds, £5,934; Electric Construction Corporation, Wolverhampton, £6,000; Johnson and Phillips, Charlton, £6,180; Siemens Bros. and Co., Woolwich, £6,367; British Thomson-Houston Company, London, £6,570; Brush Electrical Engineering Company, Loughborough, £7,184 (plant to be coupled to "Universal" engines); Ferranti and Co., Hollinwood, near Oldham, £7,835 (Willans engines). In addition, Messrs. Crompton and Co. submit a tender (in the sum of £5,593) which is irregular, the type of alternator not being in accordance with the specification. The three following firms—viz., Messrs. Mather and Platt, Helios Company, and British Electrical Transformer Company—submit incomplete tenders, which, owing to omissions, have not been included in the above list. Under the specification the engines were to be of the high-speed Willans or Belliss type, "or other equally high-class" make. Most of the firms have tendered for one or other of the two specified types of engines. Where otherwise, however, we have obtained their prices for a similar type, so that the tenders might be more readily compared. With the exception, therefore, of Messrs. Ferranti's tender (which is for a Willans engine), all the tenders are for a Belliss engine. The times of delivery are as follows: Messrs. Siemens, 14 months; Brush Electrical Company, 12 months; Fowler and Co., 9 months; other contractors, 9 months. The steam consumption is as follows: Messrs. Fowler, 32lb. per kilowatt-hour; British Thomson-Houston Company, 32·8lb.; Electric Construction Corporation, 33lb. All other tenders indicate a higher steam consumption, the highest being those of Messrs. Siemens and Messrs. Ferranti with 38lb. In respect to steam consumption, therefore, Messrs. Fowler and Co. guarantee the best results. Under the specification, a bonus at the rate of £50 per pound (maximum bonus £100) is to be paid to the contractor for each one-tenth pound of steam reduction per kilowatt-hour below that guaranteed. On the other hand, the contractor is to make a similar *pro rata* deduction for any increased steam consumption over that guaranteed by him. In the case of Messrs. Crompton's alternative tender (referred to previously), the steam consumption guaranteed is 36lb., as against 32lb. in the case of Messrs. Fowler and Co. As will be seen, therefore, Messrs. Fowler and Co.'s tender is not only the lowest in amount for the Belliss type of engine, but they also guarantee the lowest steam consumption. We are of opinion that their tender might be safely accepted.

Steam, etc., Pipes, Feed Pumps, and Tanks.—Babcock and Wilcox, Glasgow, £1,584; Wenham and Waters, Croydon, £1,593; Spencer and Co., Wednesbury, £1,800; Mallett and Co., London, £1,927. Messrs. Babcock and Wilcox's tender under this section should obviously be accepted if their tender for boilers is accepted.

Arc Lamps and Posts.—Gilbert Arc Lamp Company, £499; Blahnik Arc Lamp Company, £510; Lucy and Co., £543; Crompton and Co., £555; Oliver and Co., £568; Johnson and Phillips, £612; Brush Company, £646; Brockie-Pell Arc Lamp Company, £661; Siemens Bros., £736. Messrs. Macfarlane and Co.'s tender for the supply of lamp-posts only and their designs may be of interest. The tenderers (as required by the specification) fill in a number of details with regard to their lamps. On the merits of the tenders we should be inclined to recommend that that of Messrs. Lucy should be accepted. Messrs. Crompton and Co. and Messrs. Ferranti submit alternative suggestions for the arc lighting, which might be of considerable interest hereafter. Messrs. Crompton and Co.'s alternative tender amounts to £446, but they, however, ignore the extra cost of cables, or rather pass it over with the remark that "we do not think it would materially alter the cost of your mains, if anything it would probably reduce this item." With this latter statement we cannot agree. On the contrary, we estimate that the increased cost of cables involved in their alternative tender would be about £350 (giving a total cost of £796 under this alternative tender for arc lighting). Without going carefully into the matter again, however, we are not prepared to say that our figure is more than approximate. Apart from the increased cost, Messrs. Crompton and Co.'s proposal has merits, which might be considered later on. Messrs. Ferranti also submit an alternative scheme, which scheme we should ourselves have specified if the number of arc lamps had been somewhat greater. Even with the limited number included in the specification (and notwithstanding the great increase in capital cost) we think that their proposals merit serious consideration. The system suggested by them has of late been very largely used in dealing with questions of arc lighting from an alternating-current station, and was the system we recommended to you in our report dated May, 1898. We there estimated that the cost of arc lighting on this system would be £1,262, but Messrs. Ferranti state that they estimate it at £1,574. These figures are inclusive of the necessary cable, Messrs. Ferranti's estimated cost of which being, in our opinion, too high. We believe that on going into the question more fully we should be able to reduce their figures, and are of opinion that the Council would do well to consider this scheme at a later date. In view, however, of the fact that your policy with regard to arc lighting might, and probably will, undergo some change, we think that it should be well not to accept any tender at all for this section at the present time. For the purposes of the loan, however, a sum of £1,500 might be included for arc lighting.

Cables and Street Work.—British Insulated Wire Company, Prescot, concentric £11,763, triple concentric £13,116, drawing in system, £11,763; Callender and Co., Erith, concentric £13,596, triple concentric nil; Henley's Telegraph Works Company, North Woolwich, concentric £13,777, triple concentric £15,284, drawing-in system £12,917; Felten and Guilleaume, Germany, concentric £13,982, triple concentric £15,612; Siemens Bros., South Woolwich, concentric £15,940, triple concentric £18,075; Western Electric Company, North Woolwich, concentric £16,573, triple concentric £18,538; Glover and Co., Salford, concentric £16,657, triple concentric £17,977. The British Insulated Wire Company, whose tender is the lowest for concentric and triple concentric cables, as well as for the drawing-in system, state that they will guarantee the whole of the work (under the guarantee clause on p. 2 of the specifications) for three years from date of completion without charge, for 10 years from date of completion at the rate of ½ per cent. per annum on the cost of the work, and for 20 years from date of completion at the rate of 1 per cent. per annum. This firm's cables are in very extensive use in this country, and a list of their installations accompanies their tender. Messrs. Callender, the second lowest,

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submit an alternative tender (as permitted by the specification) for a more extensive class of cable in the sum of £15,537. This alternative cable is undoubtedly one of the highest class. In addition to their alternative tender for cables on the drawing-in system, Messrs. Henley submit a further alternative tender in the sum of £11,037 for armoured concentric cables laid in direct contact with the ground. This alternative is, however, outside the specification, which requires cables to be laid in conduits or troughs. As the adoption of the triple concentric cables, in lieu of concentric cables, has the effect of doubling the carrying capacity of the low-tension distributing mains, and the extra cost is but comparatively small, we recommend the adoption of the latter cable—viz., triple concentric, lead covered.

Travelling Crane.—Southgate Engineering Company, Southgate, £141; Chatteris Company, Chatteris, £145; Spencer and Co., Hollinwood, £188; Bolton, Fane, and Co., London, £187; Carrick and Ritchie, Edinburgh, £192; Carrick and Sons, Edinburgh, £192; Sellers and Co., America, £507. As the designs for these cranes vary considerably we are in communication with the several contractors, and hope to be able to advise in respect to the acceptance of a tender in the course of a few days. In view of the fact that the alternative tenders for the working of the installation have not yet been received, we assume that the Council will not at the present moment accept any of the above tenders. In any case, the Council are not bound to accept the lowest or any tender, and in any case acceptance is subject to the Local Government Board's sanction to the loan.

The total amount of the lowest tenders for machinery, cables, etc., is £23,734. As it is not possible to obtain tenders for the engine-house until a contract for the machinery has been actually accepted, the estimated cost must be included in the amount of loan for which application will be made to the Local Government Board. The total amount will then be as follows: tenders for generating machinery and cables, etc., £23,734; engine-house (estimated cost), dust destructor, approach road thereto and retaining walls, and pump well, £7,000; add for contingencies, legal, and engineering expenses, etc., say £5,265. Total, £36,000.

At the meeting of the Beckenham Urban District Council held last week it was ordered that the matter stand over until the alternative tenders, unopened then, had been considered. At the same meeting a letter was read from the Bromley Electric Light and Power Company, Limited, stating that they propose to supply South-hill Park without the Council's consent by means of private wayleaves or overhead wires. The letter having been acknowledged, it was ordered that no further action be taken until after the above-mentioned tenders were reported on, when the Council will be in a position to accept or decline the offer of a temporary supply from the Bromley Company.

CABLE RENEWALS IN DUBLIN.

The policy of the Local Government Board with respect to renewals of faulty electric cables or machinery is indicated in the letter addressed by the Local Government Board in Dublin to the Dublin Corporation, and dated Jan. 13, 1898. The letter reads as follows:

I am directed by the Local Government Board for Ireland to state, for the information of the Corporation of Dublin, that they have received the report of their chief engineering inspector (Mr. Cotton) on the local enquiry held by him on the 8th ult. into the application of the Corporation for sanction to a loan of £20,000 for works in connection with electric lighting.

With regard to this application, the Board wish to observe that in November, 1891, a loan of £32,800 was sanctioned for machinery, cables, posts, lamps, etc., for electric lighting, and £4,200 for buildings at the generating station. In November, 1893, a further loan of £16,837 was sanctioned for additional and extra cost of machinery, and £7,563 for cables, pipes, and laying. Of this latter loan only £6,000 was advanced. Recently, it appears, there have been many failures in the cables, and it was resolved by the Corporation to apply for a loan, which, among other things, would provide for laying these cables *de novo*. The Board observe that on Sept. 23, 1897, the Electric Lighting Committee recommended that a new generating station should be provided at the Pigeon House Fort, at a cost of £100,000, and also (2) that a system of sub-transformer stations be adopted; (3) that the entire system of cables or mains, so far as it may be found necessary by the borough surveyor, be altered or renewed; (4) that for the purpose of such renewal the sum of £20,000 be provided.

The Council, at their meeting on Oct. 8, adopted a report of the committee of the whole house slightly varying the recommendations of the Electric Lighting Committee, including the following: "That a system of sub-transformer stations be adopted, as such will ultimately prove a saving to the Corporation; that the entire system of cables and mains, so far as it may be found necessary, be altered or renewed; that for the purposes of such renewal the sum of £20,000 be provided, but that no portion of this amount be expended, or orders given, until the description of cable be reported on by the consulting engineer, with the borough surveyor, to a committee of the whole house, to be called for that purpose, and approved by them; that the Electric Lighting Committee be empowered to apply to the Local Government Board for their sanction to a loan of £20,000, the law agent and the town clerk to take whatever steps are essential for this purpose."

On Nov. 10, 1897, the town clerk wrote to say that "the Municipal Council have, on a representation from the Electric Lighting Committee, decided that it is absolutely necessary to have the cables renewed with as little delay as possible, and have therefore directed me to make application for the sanction of your Board to a loan of £22,000 to enable the Corporation to proceed with the proposed work." This letter, of course, indicated that £20,000 was required to be spent in replacing "cables" which had failed, and the town clerk was informed that a loan to replace failures would not be sanctioned while the loans under which the works were constructed are running. The town clerk wrote again on Nov. 23, 1897, to the effect that only a small portion of the £20,000 was required to purchase "cables" to replace those that failed.

Under these circumstances the Board considered it desirable to order the local enquiry which, as already mentioned, was held by Mr. Cotton on the 8th ult. The town clerk's letter of Nov. 23, 1897, and the evidence given at the enquiry, show that the £20,000 is proposed to be applied to two purposes:

1. For forming sub-transformer stations and costs incident on the change of system, say	£6,500
2. For new cables and laying	13,500
	£20,000

From the wording of the report of the committee of the whole house it might naturally be inferred that the whole £20,000 was required simply for the renewal of the "cables" which had failed.

As regards the portion of the loan destined for sub-transformer stations, and costs incident thereon, the Board find that this change of system was recommended by Mr. Ruddle in his report of Sept. 18, 1897, and was adopted by the Electric Lighting Committee and by the committee of the whole house, and approved by the Council on Oct. 8, 1897. It was also recommended by Prof. Kennedy in his report of Oct. 25, 1897, which report, the Board are informed, has been approved of by a committee of the whole house. The estimate for this work contained in the town clerk's letter of Nov. 23, 1897, appears to be approximate only. The Local Government Board will be prepared to consider a loan for this purpose when full particulars, specifications, and detail estimate are submitted and approved. As regards the rest of the loan which is required for new cables and works in connection therewith, the estimate is also approximate only, and no particulars or specifications have been submitted. The present cables, insulated with vulcanised rubber, are laid in pipes, and cost, so far as the Board can ascertain—

For cables	£3,300
For pipes and roadwork (about)	8,000
	£11,300

The evidence shows that it would not be possible to draw out the present damaged cables and replace them in the same pipes with new cables without dislocating or stopping entirely the lighting arrangements over the whole area at present supplied. This circumstance, in the opinion of the Board, points to the advisability in future works for providing for duplicate mains. There appears, therefore, to be no remedy for the present state of things but to provide new cables, as suggested by Prof. Kennedy in his report, which, as stated above, has been before the committee of the whole house and approved by them, in accordance with the resolution of the Council of Oct. 8, 1897. It is stated that the rest of the work—the pipes and works incident thereto—will not be rendered useless, but are available, and will be used for extensions to the further parts of the city outside the present lighting area, and to provide duplicate means of supply as required in consequence of increased demands in future. The Local Government Board consider that a further loan for these cables may be entertained, but the amounts should be limited by deducting from the amount required the sum properly outstanding in respect of the portions of the original loans appertaining to the cables which have to be replaced, the cost of which appears to be £3 300, of which about £2,600 is now properly outstanding. The balance (£2,563) of the second loan, not drawn, should be considered as cancelled. The Board do not consider that the suggestion that the present cables can be removed, and when repaired be again used, ought to be taken into consideration. When full particulars, specifications, and detailed estimates are submitted and approved, the Board will be prepared to sanction a loan for new cables and works connected therewith.

(Signed) D. J. MACSHEAHAN, Assistant Secretary.

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PHYSICAL SOCIETY.

At the ordinary meeting held Jan. 27, 1899, Mr. G. Griffith, M.A., vice-president, in the chair, a mathematical paper was read by **Dr. E. H. Barton** on "**The Equivalent Resistance and Inductance of a Wire to an Oscillatory Discharge.**" Maxwell's treatment of the self-induction of cylindrical conductors was extended by Lord Rayleigh, in an article published in the *Phil. Mag.* for May, 1886, to alternate currents that follow the harmonic law at constant amplitude. Dr. Barton now modifies the analysis and further extends it to include the decaying periodic currents obtained in discharging a condenser, and to the case of damped trains of high frequency—*i.e.*, to Hertz waves in general. The theoretical value (R″/R′) for the ratio of equivalent resistances to waves, respectively with and without damping, agrees very well with Mr. Barton's experimental results.

Mr. Oliver Heaviside, in a communication (here abstracted), said that he had by another method of mathematical analysis arrived at the same value as Mr. Barton for (R″/R′). In addition to the causes hitherto suggested as affecting the attenuation factor, it was possible that the conductivity of the wires to vibrations millions per second, might be less than with steady currents, and that the voltage at the beginning of the wave-train might be large enough to cause some leakage. Both resistance and inductance become infinite with infinite damping, and they differ somewhat from the corresponding quantities for undamped waves.

Mr. Rollo Appleyard then described (1) some experiments upon dephlegmators, in which he has attempted to replace the platinum-gauze valves of the ordinary fractionating tubes by bends in the tubes. The general form of the apparatus consists in a series of elongated bulbs, the top of each being connected to the bottom of the one above it by a horizontal S-shaped tube. The vapour condensed in any intermediate bulb falls back into the preceding S-bend. The first portions of the distillate are thus returned to the boiling flask, leaving a little at each bend to act as a wash for the ascending vapour. At the early stage of distillation the bulbs and bends behave as required, but it is found that at the later stages certain of the bulbs become completely filled with liquid sustained by the upward pressure of the vapour, and unless the heating is very carefully managed "geyser" actions may take place. Some arrangement of overflow tubes is therefore required for the bulbs. Mr. Appleyard also exhibited (2) a temperature tell-tale, to be used in connection with vats, and for other purposes where an alarm is to be sounded, by making electric contact when temperature rises or falls beyond certain limits. A J shaped glass tube has its short limb sealed and its long limb open. Water, or other suitable liquid, is poured in, completely filling the short limb. Mercury is then made to displace nearly all the water in the short limb, the surplus water in the long limb is removed by a pipette, and mercury is also adjusted to a convenient level. Two platinum contact wires are sealed into the glass at a short distance above the free surface of mercury in the long limb. The tube may be ½in. in diameter, with a long limb of 5in. and a short limb of 2½in. The quantity of mercury in the tube is generally arranged so that at temperatures below the boiling point of the contained liquid the mercury level is lowest in the long limb. In this case, if the temperature is raised to the boiling point of the contained liquid, the mercury assumes approximately a common level in both limbs, for at the boiling point of the liquid, under these conditions, the vapour pressure is equal to the barometric pressure. Hence the liquid and the mercury are not spurted out.

Mr. Whipple said that when working with an ordinary thermometer tube the contacts were inefficient owing to oxidation. Moreover, the mercury column broke up, and in some cases mercury clung to the contact wire. He asked if these difficulties occurred in Mr. Appleyard's apparatus.

Mr Watson suggested that in some cases the long limb might with advantage be closed. With regard to the dephlegmator, he thought that the bends should each be duplicated by a short tube, so as to provide one path for the descending liquid and another for the ascending vapours. This seemed to be the object of the platinum gauze in fractionating tubes

Mr. Appleyard in reply, explained that the change of level in the "tell-tale" was a sudden rise of about 1in. of mercury in a tube ½in. in diameter. This rise was able completely to envelope the contact wires, surface oxidation could not affect the working, and there could be no such thing as failure of contact. Moreover, the tube was too wide for mercury to be held up by capillarity. The large area of contact enabled the instrument to be used for strong currents. The cost was small, and the only adjustment consisted in choosing a liquid of suitable boiling point, for the platinum wires could be sealed in anywhere in the long limb; about 2½in. from the bottom was a good position for them. The sudden rise occurred when the temperature was 1deg. or 2deg. above the boiling point of the contained liquid.

The Chairman proposed votes of thanks, and the meeting adjourned until Feb. 10 (annual general meeting).

LEGAL INTELLIGENCE.

TELEPHONE RENTS.

Sheriff Rampini issued, on the 26th ult., an interlocutor in the action, at the instance of the National Telephone Company, Limited, against Alexander Austin, baker, Elgin, for £8. 10s., rent of a telephone for year 1898. Defender averred that by his agreement the rent of the telephone should only be £6. 10s. per annum, as he averred his agreement was that he was to get the use of the trunk telephone for £8. 10s., whereas he could not get that without paying fees in addition. The Sheriff upholds defender's contention, as the pursuers had not implemented their contract.—*The Scotsman.*

THE VESTRY OF ST. MARY, BATTERSEA, v. THE COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING COMPANY.

In the Court of Appeal, before the Master of the Rolls and Lords Justices Rigby and Vaughan Williams, on Monday last, this case was heard, and was an appeal against a decision of Sir F Jeune, president of the Probate Division, sitting as an additional judge of the Chancery Division, which is reported in the *Times* of April 22 last. The defendants had opened and broken up the footpath in Trinity-road, Battersea, within the plaintiffs' district, for the purpose of laying their cables (at a depth of about 2ft.). It was at first denied by the defendants that they had acted wrongfully in breaking up the footpath, but they ultimately admitted that they had, and the only question remaining was whether, the work having been completed, the plaintiffs were entitled to a mandatory injunction. This depended upon whether, by reason of their wires being in the subsoil, the defendants were trespassers upon an interest of the plaintiffs. This raised the question whether the plaintiffs had any property in the subsoil of the street, whether their property extended beyond the surface, and so much below it, as was necessary to the maintenance of the street as a street. By Section 96 of the Metropolis Local Management Act, 1855, "all streets being highways, and the pavements, stones, and other materials thereof, and all other things provided for the purposes thereof by any surveyor of highways, or by any person serving the office of surveyor of highways, or by any vestry or district board under this Act, shall vest in and be under the management and control of the vestry or district board of the parish or district in which such highways are situate." The learned President held, on the authority of Goodson *v.* Richardson (9 Ch. App., 221), that the plaintiffs were entitled to a mandatory injunction. The defendants appealed.

Mr. Cripps, Q.C., and **Mr. Shaw**, for the defendants, contended that the subsoil of the street was not the property of the plaintiffs, but remained vested in the owner of the adjoining land. There was no continuing trespass as against the plaintiffs, and the adjoining landowner made no complaint.

Mr. Bray, Q.C., and **Mr. Lyttelton Chubb**, for the plaintiffs, urged that the subsoil where the wires were laid was vested in the plaintiffs. But it was not necessary for them to show that they were the owners of the subsoil; they had a right of control over it, and it was necessary that their consent should be given to the placing of the wires under the street, and if their rights were interfered with they were entitled to a mandatory injunction independently of any ownership of the subsoil.

Mr. Cripps replied.

The Court allowed the appeal, and dissolved the mandatory injunction, but gave no costs of the appeal.

The **Master of the Rolls** thought that the Court was not in a position to grant a mandatory injunction, as it did not appear that the plaintiffs had taken any proceedings under Section 109 of the Act of 1855. That was an important section, and he would not say what the result might have been if the plaintiffs had proceeded under it. But as matters stood, he thought the argument for the appellants was well founded as regarded the mandatory injunction. It appeared that the defendants, after failing to come to terms with the Vestry, and knowing that they would not consent to their laying their wires under the footpath, took the law into their own hands, and in a high-handed way, without any statutory power to do so, broke up the path, and laid their wires under it. This was utterly illegal and wrong, and it was a temptation to the Court to be equally high-handed with the defendants. But the duty of the Court was to see what rights of the plaintiffs were interfered with by the continuance of the wires in the place where they had been laid. It was contended that the subsoil in which they were laid was vested in the plaintiffs. The answer to this was to be found in the decision of the House of Lords in Mayor, etc., of Tunbridge Wells *v.* Baird (1896, A.C., 434), in which the House considered the question to what extent the soil of streets is vested in a local authority. And they held, to use the words of Lord Herschell (p. 442): "It seems to me that the vesting of the street vests in the urban authority such property, and such property only as is necessary for the control, protection, and maintenance of the street as a highway for public use." If that was all which the plaintiffs had vested in them they could not maintain this action as owners of the subsoil. It was said, however, that they had some statutory right of control. Section 13 of the order which they had obtained did not apply to the present case, and no right of control which they had under any sections of the General Acts was interfered with by the defendants' wires. His Lordship was bound to come to the conclusion that the plaintiffs had not made out that any rights of theirs would be interfered with by the continuance of the defendants' pipes and wires where they were.

Lord Justice Rigby was of the same opinion.

Lord Justice Vaughan Williams also concurred. He agreed that the company appeared to have taken a very high-handed course, such as made him regret that the Court could not deprive them of any advantage they had gained by their lawless conduct. It did not appear what the action of the plaintiffs had been, but

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if they had not recollected throughout that they existed only for the public good, and had refused to give permission to the defendants to lay their wires, when it might have been given without any injury to the plaintiffs' own constituents, this would remove any regret which his Lordship would otherwise feel in consequence of the action of the company.—*The Times.*

CABLE-LAYING AND THE BUILDING ACT.

At the Southwark Police Court, on Tuesday, William Coat, surveyor of roads to the Newington Vestry, was summoned by Mr. Bernard Dicksee, district surveyor, for failing to give a building notice in respect to two structures under the footway in Newington-causeway. Mr. Ricketts defended.

The Vestry have obtained a provisional order to supply electric light in the neighbourhood. Trenches have been dug along the main thoroughfares, including Newington-causeway, for the electric light cables and the wires of the National Telephone Company. An inspection chamber has been constructed under the footway every 150 yards, and **Mr. Dicksee** contended that under Section 105 of the Building Act he was entitled to the usual notice. The Vestry, on the other hand, submitted that if this contention was right the district surveyor would be entitled to a fee in respect of every sewer inspection chamber. Mr. Dicksee pointed out that the chambers in question were much larger than sewer inspection chambers, and, further, that part of the roof was under the footway.

Mr. Paul Taylor said he considered these chambers were covered by the words "building, structure, or work" contained in Section 145, and he therefore gave a decision in favour of the surveyor. Defendant would have to pay a nominal penalty of 1s. and 2s. costs on each of the two summonses. In reply to Mr. Ricketts the Magistrate declined to state a case, on the ground that it was purely a question of fact.—*The Times.*

CABLE-LAYING.

At the Hampstead Police Court, on Wednesday, Messrs. Gerald Carlyle Allingham and William Fennell, electrical engineers, of Harrow-green, Leytonstone, were summoned by order of the Hampstead Vestry for laying or causing to be laid, at 15, Thurlow-road, a certain electric line to communicate with a line or apparatus belonging to the Vestry without their consent.

Mr. A. P. Johnson, solicitor, the vestry clerk, appeared for the Vestry.

The defendants were represented by Mr. Gerald Carlyle Allingham, who pleaded guilty.

Mr. A. P. Johnson stated that on Dec. 15, when the meter fixer in the employ of the Vestry went to 15, Thurlow-road, the residence of Mr. J. A. Murray Macdonald, M.L.S.B., to connect the wires of that house on to the main, he found that the defendants had already made the connection without the Vestry's knowledge or consent. To do so they had had to break open the Vestry's fuse-box, which was sealed. This temporary connection had been made for a week, and when the installation was tested it was found to be defective, and the connection was cut off. It was a very bad case, and there was danger of fire through it. By the connection having been made without the knowledge of the Vestry all precautions which were laid down were rendered null and void. By the action of the contractors the consumer of the light was also made liable to prosecution, but as this was the first time such a case had happened the Vestry had not proceeded against the consumer. At Marylebone Police Court last Friday the defendants were fined three guineas and costs for a similar offence in another house. That being so he did not press for a heavy penalty in this case, but only for a conviction and the payment of costs.

Mr. Allingham said the light had only been put on for a short time in order to test the lamps. He denied that the fuse-box was sealed.

The Bench imposed a fine of three guineas and 23s. costs.

Sir Henry Harben, J.P., chairman of the Vestry, who was on the Bench, did not adjudicate in this case.—*Hampstead and Highgate Examiner.*

COMPANIES' MEETINGS AND REPORTS.

AMAZON TELEGRAPH COMPANY, LIMITED.

The fourth ordinary general meeting was held this week at the offices, Blomfield House, London-wall.

Mr. W. S. Andrews presided, and, in moving the adoption of the report, stated that their receipts were not so discouraging as they might have been, because, notwithstanding interruptions in the principal revenue-producing section of the system, they had amounted to £29,446, or £4,148 more than they were for the previous year. The working expenses had been £18,494, as compared with £20,164. They were doing all they could to reduce expenses. The directors were taking no fees, with the exception of Mr. Keith, who had been giving special attention and so much time to the Company's affairs that it was felt that it would be unfair to ask him to submit to this sacrifice while they continued to make such demands upon his time and energies. The question of wireless telegraphy had been under their consideration in connection with their difficulties.

The motion was carried unanimously.

WATERLOO AND CITY RAILWAY COMPANY.

Directors: Wyndham S. Portal, Esq., Malshanger, Basingstoke, Hants (chairman); Lieut.-Colonel the Hon. H. W. Campbell, 44, Charles-street, Berkeley-square, W. (deputy chairman); A. F. Govett, Esq., Laleham Staines, and 18 Albert Hall-mansions, S.W.; Lieut.-General Sir F. Marshall, K.C.M.G., Broadwater, Godalming; P. Mortimer, Esq., Ashe Park, Overton, Hants; W. W. Portal, Esq., Southington Overton, Hants; Sir Chas. Scotter, Surbiton Hill Park, Surbiton, Surrey; Right Hon. Sir A. West, K.C.B., Wanborough Manor, Guildford, Surrey.

Report of the directors for the half year ended Dec. 31, 1898, to be submitted to the shareholders at the tenth half-yearly general meeting of the Company, to be held at Waterloo Station on Thursday, 9th inst., at 2 p.m.:

The railway was opened for traffic on Aug. 8 last, since which date the train services have been carried on by the London and South-Western Company in accordance with the agreement of March 8, 1894. The City terminus subways and connecting approaches are being proceeded with by the Central London Railway Company, and will, it is hoped, be completed by the end of the current year. The capital account shows a total outlay of £549,456. 15s. 9d. at Dec. 31 last. The further estimated expenditure of £52,000 is amply provided for by the capital powers of the Company. It will be seen from the revenue account that the gross receipts of the line amounted to the sum of £10 887. 11s. 9d. From this amount the London and South-Western Company have retained £4,119. 1s. 1d. in respect of working expenses, leaving the sum of £6,768. 10s. 8d. payable by them in order to provide, under the agreement of March, 1894, for a dividend at the rate of 3 per cent. per annum from Aug. 8 to Dec. 31, 1898, on the Company's ordinary and borrowed capital. To this sum has been added bankers' and general interest and a portion of the profit on the sale of consols representing the parliamentary deposit, which enables the directors to recommend the payment of a dividend at the rate of 3 per cent. per annum for the full half-year. It is proposed to make the dividend payable on Feb. 18. The London and South-Western Railway Company have given notice of a Bill for the ensuing session of Parliament, including powers over property of this Company at the Waterloo Station, with respect to which there is every assurance of terms being satisfactorily arranged between the two companies. The Baker-street and Waterloo Railway Company are seeking powers by their Bill of this session for a deviation of their railway at the southern end which may affect the Waterloo and City Railway, and care will be taken to see that the rights and interests of this Company will be duly protected. The directors retiring by rotation are Mr. W. S. Portal, Mr. P. Mortimer, and Sir A West, who are eligible, and will offer themselves, for re-election. The much regretted death of Mr. A. E. Guest caused a vacancy on the Board, which has been filled by the election of Lieutenant-General Sir F. Marshall. Mr. F. Hartnell, one of the auditors, also retires, and will offer himself for re-election.

Engineers' Report.—On July 7 last we reported that the works of the railway, with the stations and signals, had been examined and passed by the Board of Trade. We have now to state that since the opening for traffic in August last the railway and station works have been well maintained, and are in good working order. The whole of the boilers, engines, and dynamos in the generating station have been fixed complete for some time, together with the corresponding electrical apparatus. The railway is worked by the London and South-Western Railway Company with four trains, and a fifth complete train with two additional motor carriages is held in reserve. The plant in the generating station and the electrical equipment of the line have been in continuous work for nearly six months. The power provided at the station, and the capacity of the motors on the trains, continue to be found amply sufficient. Some electrical difficulties occurred in the initial stages of working the line, but these have been overcome, and the plant is now working regularly and satisfactorily. The construction of the Mansion House subways of the Central London Railway is proceeding steadily, but, owing to the difficult nature of the work, somewhat slowly. It is expected, however, that a staircase in Mansion House-place will be ready for use about the end of March. The engineers of the Central London Railway Company assure us that every effort will be made to bring additional communications with the streets into use at the earliest possible date.—WM. R. GALBRAITH; ALEX. B. W. KENNEDY.

ANGLO-AMERICAN TELEGRAPH COMPANY, LIMITED.

The report of the directors of the Anglo-American Telegraph Company, Limited, for the half-year ended Dec. 31 last, to be presented at the ordinary general meeting to be held in London to-day, gives the total receipts for the six months, including the balance of £17,580 brought forward, at £212,493. The traffic receipts show an increase of £14,418 as compared with the corresponding half of 1897. The total expenses of the half-year, including the repair of cables, etc., amounted to £63,405, being an increase of £5,033 over the corresponding period of 1897. The sum of £12,000 has been put to the renewal fund, leaving a balance of £137,088. Interim quarterly dividends of 15s. per cent. on the ordinary stock and £1. 10s. per cent. on the preferred stock were paid in November last, and final dividends of £1. 4s. per cent. on the ordinary stock, £1. 10s. per cent. on the preferred stock, and 18s. per cent. on the deferred stock are now recommended, making a total distribution for the year ended Dec. 31, 1898, of £3. 9s. per cent. on the ordinary stock, £6 per cent. on the preferred stock, and 18s. per cent. on the deferred stock.

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CITY AND SOUTH LONDON RAILWAY COMPANY.

The twenty-ninth ordinary general meeting of this Company was held at Winchester House on Tuesday, Mr. Charles Grey Mott, the chairman of the Company, presiding. The report and statement of accounts for the half-year ending Dec. 31, 1898, (already published by us), was adopted, and the dividend declared.

With reference to the Great Northern and City Railway, which is now being actively proceeded with, the **Chairman** said he believed that its terminus would join the terminus of this Company at Moorgate-street Station in Finsbury-pavement, and he hoped that they would be able to arrange with that railway company to construct a subway from their platforms to the platforms of this Company down below, and also the Chingford, Walthamstow, and Epping Forest line would have a terminus at almost the same place.

EDINBURGH STREET TRAMWAYS COMPANY.

The fifty-fifth ordinary meeting of the shareholders was held on the 30th ult. in Dowell's Rooms, Edinburgh, Sheriff Vary Campbell presiding.

The **Chairman** said, according to the *Scotsman*, that there was no doubt that the Company had been considerably ill-used, but it was not their doing, and all they could say was that if the Leith people preferred electricity and the Edinburgh people preferred cabling, what they had to do was to work their lines with horses On the comparatively level roads they had in Leith, horses were very much the cheapest method of haulage. He would not say anything more about the relations of the Corporations. All these were matters of high policy which it was for them to adjust between themselves. All he wanted to indicate was that the Company held its own, and intended to hold its own, and had no fear that it would hold its own, they believed quite successfully and prosperously, with what remained to them of the undertaking.

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY, LIMITED.

Directors: Eustace J. A. Balfour, Esq., chairman; Sir John H. Morris, K.C.S.I.; Bennett Fitch, Esq., M.I.C.E.; Walter Leaf, Esq; Marlborough R. Pryor, Esq. General manager and secretary: Frederic J. Walker. Chief engineer: S. T. Dobson, A.M.I.C.E., M.I.E.E.

Report of the directors with abstract of accounts for the year ending Dec. 31, 1898, to be presented to the ordinary general meeting of the shareholders to be held at the offices of the Company, Carnaby-street Central Station, Golden-square, W., on Feb 7 at 12 noon:

The Carnaby-street and Mason's-yard stations have been working satisfactorily throughout the year, but to enable the Company to meet the growing demand for electrical energy in the most efficient manner, it has become necessary to further extend the Carnaby-street station. For this purpose the directors are promoting a Bill in the ensuing session of Parliament authorising the Company to acquire by compulsory purchase certain adjacent property. To meet future requirements the directors have by agreement arranged with the Westminster Electric Supply Corporation, Limited, for the promotion in the ensuing session of Parliament, under the title of the Central Electric Supply Company, Limited, of a Bill authorising the establishment of a station on certain property to be acquired in the parish of St. Marylebone. This will secure to the two companies an ample supply of electrical energy in bulk. In pursuance of special resolutions passed at extraordinary general meetings held on Jan. 18 and Feb. 8, 1898, 20,000 new ordinary shares of £5 each were created, making the capital £300,000, and 12,000 of these shares were issued at par to the holders of the 100 founders' shares of £1 each. These founders' shares are now vested in a trustee for the Company. The Company has since by special resolutions passed at extraordinary general meetings held on Jan. 3 and 19 increased the capital to £300,100 by the creation of 20 new ordinary shares of £5 each. Steps are now being taken to reduce the capital of the Company by cancelling the 100 founders' shares, and a notice for an extraordinary general meeting, to be held at the conclusion of the ordinary meeting, confirming this reduction is enclosed with the report. So soon as further capital is required, the directors propose to issue the balance of 8,020 ordinary shares to the shareholders in proportion (as nearly as conveniently may be) to the shares held by them, at a premium. This will enable a substantial addition to be made to the reserve fund. In accordance with the terms of the trust deed, six months' notice of redemption was given to the holders of the £50,000 4 per cent. debenture stock of the Company, and this stock is now being paid off as on Jan. 1 last. The net earnings of the Company during the past year have amounted to £29,889. 19s. 1d. Of this sum, £11,495 was distributed in August last in payment of an interim dividend at the rate of 10 per cent. per annum for the half-year ending June 30, 1898, on the ordinary shares, and at the rate of 7 per cent. per annum on the preference shares. The balance, £18,394. 19s. 1d., together with the undivided profit of £384. 10s. from last year's account, leaves £18 779. 9s. 1d. now to be dealt with. The directors propose to divide the amount as follows: by payment of a dividend at the rate of 7 per cent. per annum on the preference shares for the second half of the year, £3,500; by payment of a dividend on the ordinary shares for the second half-year of 7s. 6d. per share, and a bonus of 2s. per share, making, with the interim dividend paid on Aug. 1 last, a total distribution of 14½ per cent. for the year, £15 190. 10s.; amount to be carried forward, £88 19s. 1d.—total, £18,779. 9s. 1d. The directors deeply regret the loss by death of their esteemed colleague, Mr. Latimer Clark, F.R.S., the vice-chairman of the Company. Mr. Marlborough R Pryor has been elected a director during the year, and, in accordance with the articles of association, he now retires, but, being eligible, offers himself for re-election. Mr. Walter Leaf retires by rotation under Clause 79 of the articles of association, and, being eligible, offers himself for re-election. The auditors, Messrs. Deloitte, Dever. Griffiths, and Co., also retire, and, being eligible, offer themselves for re-election.

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1898.

Dr. To Generation and Distribution of Electricity.		£	s.	d.
Coal, including dues, carriage, etc.	£7 307 6 1			
Oil, waste, water, engine room stores	948 15 11			
Salaries of engineers and officers	1,595 14 11			
Wages at generating and distributing stations	3,832 15 3			
Repairs and maintenance as follows: Buildings (including alterations), £409. 16s. 8d.; engines and boilers, £1 547. 12s. 2d.; dynamos, £180. 11s. 6d.; other machinery, instruments, and tools, £473. 16s. 4d.; accumulators, £74. 5s; lamps (at stations), £78. 14s. 5d. —£2,764. 16s. 1d.; less credit on main exhaust and chimney shaft, £404. 17s. 10d.	2,359 18 3			
Attending and repairing public lamps	422 9 8			
Repairs and maintenance of mains	1,149 3 7			
Miscellaneous expenses	141 0 6			
		17,757	4	2
To Rents, Rates, and Taxes.				
Rents payable	245 0 0			
Rates and taxes	2,564 1 6			
		2,809	1	6
To Management Expenses.				
Directors' remuneration	2,500 0 0			
Salaries of manager and secretary, engineer, clerks, canvasser, etc.	3,512 0 1			
Stationery, printing, and advertising	207 13 6			
General establishment charges	395 11 10			
Auditors of Company	78 15 0			
Trustee for debenture stockholders	52 10 0			
		6,746	10	5
Law expenses		237	15	8
Special Charges.				
Insurance	623 19 2			
Fees for testing meters	11 2 0			
Board of Trade audit	60 0 0			
Expenses *re* conversion of founders' shares	55 18 2			
Ditto, quotation of ordinary shares (new issue)	26 5 0			
Expert fees *re* valuation for assessment	52 10 0			
		829	14	4
To Depreciation.				
Depreciation on buildings	487 16 8			
Ditto, plant, machinery, etc.	9,636 7 7			
		10,124	4	3
		38,504	10	4
Net loss on sales of old plant		393	5	0
Balance carried to net revenue account		31,387	1	5
		£70,284	16	9

Cr.	£	s.	d.
Sale of current, after deducting provision for bad and doubtful debts (at 6d. per unit, less rebates)	65,596	9	4
Ditto under contract	573	14	6
Public lighting	1,832	5	6
	68 002	9	4
Rental of meters on consumers' premises	1,760	15	11
Rents receivable	140	14	3
Transfer fees	57	17	6
Discounts on purchases	97	11	3
Sale of old materials, stores, etc.	54	8	0
Sundry fees, shareholders' lists sold, etc.	11	18	0
Sale of steam	159	2	6
	£70,284	16	9

Cr. GENERAL BALANCE-SHEET, DEC 31, 1898.	£	s.	d
Capital amount—amount received	£310,000	0	0
Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, etc.	2,007	12	11
Sundry creditors on open accounts	3,227	3	7
Debenture stockholders, for interest accrued, less tax payable Jan. 1, 1899	966	13	4
Unclaimed dividends	31	9	10
Capital reserve fund	15,000	0	0
Balance at credit of net revenue account, £30,274. 9s. 1d.; less interim dividends paid on preference and ordinary shares, £11,495	18,779	9	1
	£350,012	8	9

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Cr.	£	s.	d.
Capital account—amount expended for works, less depreciation to date	263,046	2	10
Expenditure on freehold site, etc.	23 306	3	6
Stores on hand—coal. £226. 18s. 3d.; lamps, £40. 6s. 1d.; meters and switches, £1,802. 0s. 3d.; general, including oil, waste, etc., £1,330. 0s. 8d.	3,399	5	3
Sundry debtors for current supplied, £18,473. 14s. 6d.; other debtors, £596. 13s. 3d.	19,070	7	9
Cash at bankers (including deposit of £20,000), £26,102. 4s. 5d.; cash in hand, £88. 5s.	26,190	9	5
Capital reserve fund investments, cost of Canada 3 per cent, Cape 3½ per cent., and India 3 per cent. stock	15,000	0	0
	£350,012	8	9

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC., YEAR ENDING DEC. 31, 1898.

Board of Trade units generated			3,847,204
Quantity utilised	Private supply	3,314 492	
	Public lighting	134,366	3,507,024
	Used on works	58,166	
Quantity expended in distribution			340,180
Number of lamps on circuit, Dec. 31, 1898			142,853

LIVERPOOL OVERHEAD RAILWAY COMPANY.

Report of the directors to be presented to the twenty-first ordinary half-yearly general meeting of the shareholders, to be held at the Law Association Rooms, 14, Cook-street, Liverpool, on Tuesday, Feb. 14, 1899:

In presenting the half-yearly statement of capital and revenue accounts to Dec. 31, 1898, the directors have to report that the gross revenue receipts amount to £40,840. 3s. 2d. and the working expenses to £24,717. 15s. 4d. The number of passengers carried during the last two years is as follows:

	Half-year ending June 30, 1897.	Half-year ending Dec. 31, 1897.	Half-year ending June 30, 1898.	Half-year ending Dec. 31, 1898.
First-class	608,278	621,392	637,547	663.177
Second-class	2,618.844	2,790 768	2,686 651	2,962,827
Workmen (special return tickets)	1,042,138	1,055,330	1 148,743	1,268,917
Total	4,269.260	4 467,490	4 472,941	4,894,921

Revenue Account.

Receipts from passenger traffic amount to	£40,071	10	4
Miscellaneous receipts and interest	768	12	10
	£40,840	3	2
Less working expenses	24,717	15	4
	£16,122	7	10
Deduct interest on mortgage debentures	3,400	0	0
	£12,722	7	10
Add balance brought forward, June 30, 1898	3,863	13	7
Leaving available for dividend	£16,586	1	5

Out of this balance your directors recommend the declaration of dividends at the following rates (less income tax), payable on and after Feb. 16 next: 5 per cent. per annum on preference shares, £3,000; 4 per cent. per annum on ordinary shares, £9,000; leaving a balance of £4,586. 1s. 5d. to be carried forward to next half-year. Your directors have arrived at a basis of agreement with the Waterloo-with-Seaforth and Great Crosby District Councils (subject to the sanction of the shareholders and confirmation by Parliament) for the Company to equip and work the tramways already authorised within those districts. The directors retiring by rotation at this meeting are Sir Wm. B. Forwood and Mr. H. Brocklebank, who, being eligible, offer themselves for re-election. The auditor retiring by rotation is Mr. J. S. Harmood Banner, who is also eligible for re-election.

REVENUE ACCOUNT.

Expenditure.	£	s.	d.
Maintenance of way, works, and stations	4,827	7	2
Locomotive power	6,085	2	3
Repairs and renewals of carriages	822	8	3
Traffic expenses	8,672	9	1
General charges	2,185	1	4
Law charges	201	14	0
Compensation	76	3	3
Rents, rates, and taxes	1,767	7	1
Government duty	80	2	11
	24 717	15	4
Balance carried to net revenue account	15,938	4	5
	£40,655	19	9

Receipts.	£	s.	d.
Passenger traffic	40,071	10	4
Parcels, etc.	51	5	5
Rents	514	17	8
Transfer fees	18	6	4
	£40,655	19	9

DIRECT UNITED STATES CABLE COMPANY, LIMITED.

The half-yearly meeting of the shareholders was held on Tuesday last at Winchester House, Mr. Underdown, Q.C., presiding.

The report and statement of accounts, already published by us, was adopted. The question of amalgamation with the Anglo Company was discussed, and the **Chairman** advised the shareholders not to go in for amalgamation.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Harwich.—The Corporation are prepared to enter into negotiations for the transfer of their electric lighting provisional order. Tenders by May 16.

Belfast.—Tenders are required by the Belfast and Northern Counties Railway Company for the supply of telegraph ironwork, batteries, signal fittings, etc. Tenders by Feb. 13.

Gloucester.—The Electricity Supply Committee are prepared to receive tenders for the supply and erection of various plant at the municipal electricity works. Tenders by Feb. 28.

Edinburgh.—The Magistrates and Council invite tenders for an overhead travelling crane and storage batteries for their electric lighting station in Macdonald-road. Tenders by Feb. 20.

West Hartlepool.—The Corporation invite tenders for feeders, mains, arc light leads, with road work, particulars of which appear in our advertising columns. Tenders by Feb. 13.

Nelson.—The Gas Committee of the Corporation invite tenders for the supply and erection of various plant, particulars of which appear in our advertising columns. Tenders by Feb. 14.

Leyton.—The Urban District Council invite tenders for a motor-generator, etc. Further particulars may be obtained from Mr. H. C. Bishop, Cathill-road, Leytonstone. Tenders by Feb. 6.

Buxton.—The Urban District Council invite tenders for work in connection with their electric light station in Buxton, particulars of which appear in our advertising columns. Tenders by Feb. 6.

Glasgow.—The Corporation are prepared to receive tenders for the reconstruction of tramways in Crown street and Cathcart-road, particulars of which appear in our advertising columns. Tenders by Feb. 6.

San Severa (Italy).—Tenders are invited for the electric lighting of the town. Particulars are to be obtained from, and tenders addressed to, the Corporation (Syndaco) of San Severa, Province of Foggia, Italy, by Feb. 25.

Lowestoft.—The Mayor and Corporation of the borough of Lowestoft are prepared to receive tenders for the supply and erection of various plant, all details of which appear in our advertisement columns. Tenders by Feb. 6.

Shoreditch.—The Guardians are desirous of receiving tenders for materials and for wiring and fitting the Shoreditch workhouse, infirmary, casual wards, dispensary, nurses' home, porter's lodge, offices, etc., at Kingsland-road and Hoxton. Tenders by Feb. 15.

Kingston-on Thames.—The Guardians of the Union invite tenders for the provision of telephonic communication between the various buildings upon the workhouse premises, Kingston-on-Thames. For particulars see our advertising columns. Tenders by Feb. 14.

Hull.—The Corporation are prepared to receive tenders for the electric light wiring and fittings for the tramways power station, Osborne-street. The contract will include four arc lamps and about 40 incandescent lamps. For particulars see our advertising columns. Tenders by Feb. 8.

Edinburgh.—Tenders are required by the Corporation for the steelwork of roofs required in the construction of the McDonald-road electric lighting station. Specifications, etc, may be obtained on deposit of a crossed cheque for £2 (which will be returned on receipt of a bona fide tender) to Mr. John Cooper, burgh engineer, 1, Parliament-square, Edinburgh. Tenders by Feb 3. The same applies to tenders for the iron and steel works (exclusive of steel roofing) required in the construction of the McDonald-road electric lighting station, comprising boiler-house, coal store, chimney stalk, engine-room, battery room, pump and tank rooms, offices, stores, etc., and other relative works.

London, E.—The Electrical Committee of the Whitechapel Board of Works invite tenders for the supply and erection of the following plant: (Section A) armoured and unarmoured cables; (B) arc lamps and posts; (C) steam dynamo and balancing booster; (D) storage batteries; (E) boilers and fittings, feed pumps, pipes, and heater. Persons tendering are at liberty to tender for any section or sections, or for the whole of the sections, but not for part of one section. Specifications can be obtained from Mr. Arthur Wright, 26 and 27, Bush-lane, Cannon-street, London, E.C., on payment of £5. 5s. each, which sum will be returned on receipt of a bona fide tender. Tenders must be delivered by 12 noon on Feb. 7.

Shanghai.—The Shanghai Municipal Council invite tenders for a concession for constructing and working about 23 miles of electric tramways on the trolley system in the streets of Shanghai. The special attention of tenderers is drawn to the fact that the tender (if any) recommended by the Council will require ratification by the ratepayers. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-

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square, St. Mary-axe, London, E.C., on a Bank of England note for £100 being deposited with Messrs. Pook and Co., which sum will be retained by the Council, and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China (telegraphic address Dynamo, Shanghai; "ABC," fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Tramway Concession," must be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, and received by 12 noon on March 15.

Shanghai.—The following resolution in reference to the telephone system in Shanghai was passed at the last annual meeting of the ratepayers of the Foreign Settlements at Shanghai, north of the Yang-king-pang: "Resolution VIII.—That the Council be and is hereby authorised to enter into negotiations with the China and Japan Telephone Company or any other company, and in its discretion grant a franchise with a view to the community being supplied with an adequate and efficient telephone service at a fixed maximum charge." In accordance with the above resolution the Shanghai Municipal Council invite tenders for a concession for a period of 30 years for the exclusive right of establishing and working a telephone system in Shanghai. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 sterling being deposited with them, which sum will be retained and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China. Telegraphic address, Dynamo, Shanghai (ABC, fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Telephone Concession," to be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, by 12 noon on March 31.

RESULTS OF TENDERS.

Sunderland.—The Electric Supply Committee have accepted the tender of the India Rubber, etc., Company, for Belliss engines.

Derby.—The Council have accepted the tender of S. Z. Ferranti, Limited, at £7,090, for a new steam alternator, consisting of a pair of vertical enclosed compound engines, etc.

Colchester.—The Estate and Cattle Market and Executive Committee have received three tenders for installing electric light at the temporary municipal offices. The tender of Mr. J. A. Kuner, at £26. 5s., has been accepted.

London.—The London County Council have received the following tenders for the supply of dynamos, etc., required in connection with the electric lighting of the Victoria-embankment:

McClure and Whitfield	£3 726	5	0
Mather and Platt, Limited	4 600	0	0
Crompton and Co., Limited	4 949	0	0
Electric Construction Company, Limited	5 535	0	0
Safety Concentric Wiring Company, Limited	5,625	0	0
Electrical Company, Limited	6,877	0	0

London.—The London County Council have received the following tenders for the supply of gas-engines, etc., required in connection with the lighting of the Victoria-embankment:

J. E. H. Andrews and Co., Limited	£1,900
Campbell Gas-Engine Company, Limited	2,176
Premier Gas-Engine Company, Limited	2,260
Safety Concentric Wiring Company, Limited	2 260
Crossley Bros., Limited	2,300
Fielding and Platt, Limited	2,378
J. Taylor and Sons, Limited	3,457

BUSINESS NOTES.

Herne Bay.—The electric car on the pier is now in working order.

Hartford.—The Parish Council are about to introduce public electric lighting.

Poplar.—Tenders are to be invited for part of the electric plant required for the workhouse.

Exeter.—The electric street lamps are to be charged at the rate of £22 per annum each.

Bury St. Edmunds.—It is expected that the electric light will be installed by next Christmas.

Bedfordshire.—The electric light is to be installed in the muniment room of the shire hall.

Kensington.—The Vestry concur with the Westminster Vestry in the question of underground railways.

Ealing.—The total number of lamps applied for is 21,698 (8 c.p.), of which 20,470 have already been connected.

Tipton.—The Urban District Council have decided to oppose the South Staffordshire Tramway Company's Bill.

St. Helens.—After discussion, the construction of a double line was agreed to at Wednesday's meeting of the Council.

Colchester.—The Electric Light Committee intend at the earliest possible date to reduce the price to small consumers.

Bromley.—The Urban District Council intend to petition against the Bills proposed by the National Telephone Company.

Waterloo.—It is expected that the installation of the electric light will be completed next week. In all some 16 standards will be erected.

Grangetown.—The extension of the Tees-side electric tram system into the South Bank and Eston districts is being considered.

Southport.—A Local Government Board enquiry has been held into an application of the Council to borrow £3,500 for electricity supply works.

Hanwell-Uxbridge Light Railway.—The Board of Trade have now given their decision in favour of the construction of this much discussed line.

Blackpool.—The Improvement Bill, which provides for an extension of the tramway service, has now been approved by the Town Council.

Manchester.—The City Council have again affirmed that the overhead system is that best suited to the immediate requirements of the city and district.

Hastings.—The poll of ratepayers on the electric tramways has been declared, with the result that the votes recorded are about ten to one in favour of the same.

Leeds.—The electric equipment of the Becket street route is to be proceeded with at once. Various increases have been made in the salaries at the electric lighting station.

Sleaford.—The Electric Lighting Committee have decided to submit to the Urban District Council the names of three applicants, from whom a consulting engineer will be chosen.

Wrekenton.—The Parliamentary Committee are in negotiation with the tramways company with the object of having the proposed new tramway to Sheriff Hill extended to Wrekenton.

Carlisle.—The electric light at the Citadel station has been switched on as a trial, and the final opening may be expected shortly. There are two arc lamps still to be erected in Court-square.

Farnborough.—Negotiations are still proceeding between the Urban District Council and Power and Traction, Limited, with regard to their electric railway. Certain amendments are proposed by the Board.

Removal.—We are informed by Mr. Alec A. Beadle, A.M.I.E.E., F.C.S., that he has now transferred to 57, Chancery-lane, his laboratories for electrical, chemical, and metallurgical investigations and tests.

Swansea.—The trams worked by the Swansea Improvements and Tramways Company, which are now being electrically equipped, will probably be running by electricity about the end of the present year.

Hart Accumulator Company, Limited.—We are informed that, owing to considerable increase in business, this Company have extended their premises by taking over a large adjoining factory, covering 13,000 square feet.

Eastbourne.—The Mayor has refused to call a public meeting to consider the application of the Town Council for an electric light provisional order, and the Council's offer to purchase the works of the electric light company.

Westminster Electric Supply Corporation.—The directors will recommend a dividend for the past half-year at the rate of 14 per cent., making, with the interim dividend already paid, 12 per cent. for the year 1898, payable on March 1.

Dumbarton.—Amongst the various Bills to be opposed by the County Council we note the Glasgow Corporation (Telephones); National Telephone, No. 1; National Telephone Company, No. 2; and Telegraph Act, 1892 Amendment (National Telephone Bill).

City and South London Railway.—Negotiations are in progress with the London, Brighton, and South Coast Railway for the construction of the subway connecting the electric railway company's new station at Denman-street with the London Bridge Station.

Althorp House.—At the ball given by Earl Spencer, K.G., and the Countess Spencer at Althorp House last week, a special installation of the electric light was provided, when 120 lamps were arranged around the cornice of the large dining-room in which the dancing took place.

Camborne.—We learn that as the electric light order regarding this town does not comply with the proposal of the District Council in its clause referring to the power of that body to purchase the works, objection is to be lodged to the order unless a satisfactory clause is inserted.

Pontypool.—An offer to light the main streets of the town has been made by the electric light company. The Council has resolved that before the offer is accepted the gas and water company are to be invited to give suggestions as to a better method of lighting, and also as to a modification of their terms.

Opposed Bills.—The Coatbridge and Airdrie Light Railway Bill has been before Mr. Martin Thomas, one of the examiners of the House of Commons. The Examiner will report non-compliance to the Standing Orders Committee, with whom it will rest to decide whether the Bill shall be allowed to proceed.

Melksham.—Messrs. Tilke and Smith (Melksham), having asked for permission to lay an electric cable underground to the workmen's club, and also for permission to erect a 2,000-c.p. arc lamp at the entrance to their works, the former matter was deferred and the latter acceded to by the Urban District Council last week.

Barking.—The District Council have decided to apply to the Board of Trade for a provisional order to construct tramways throughout the town to be worked by electricity. The total expense of equipping the whole system, including the necessary plant, power, and cars, exclusive of buildings, is estimated at £73,284.

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Dublin.—The following have been appointed a committee in charge of matters relating to the construction and equipment of electric tramways: the Lord Mayor, Alderman Meade, Alderman Sir R. Sexton, Mr. Beattie, the High Sheriff, Mr. Downes, Mr. Jones, Dr. Kennedy, Alderman Dowd, Alderman Cox, and Mr. Gibbons.

Annual Dinner. — The employés of Messrs. Rosling and Appleby held their annual dinner on Friday, Jan. 27, at the Talbot Hotel, Bradford, when a party of about 150 did good justice to the excellent fare provided, and enjoyed the songs, quartets, and glees which interspersed the toasts usual upon such occasions.

Gillingham.—The Survey Committee has recommended to the District Council that the terms of the electric lighting company for the lighting of High-street should be accepted. The whole matter has now been referred back to the committee to consider the advisability of acquiring the present supply or to provide the light itself.

Oswestry.—The Town Council are arranging for some modifications of the proposed electric tramway scheme. Mr. W. H. Trentham has been engaged to advise the Council on the proposed electric lighting and refuse destructor, and as to whether it would be to the advantage of the Council to provide motive power for the tramway work.

Worcester.—At the monthly meeting of the Chamber of Commerce it was decided that a deputation should wait on the City Council to urge the necessity for an extension of the tramways in the city and the immediate district outside on the lines of the electric tramways which have proved so successful in the northern part of the county.

Doncaster.—The West Riding County Council have agreed to support the Doncaster Corporation scheme of electric tramways, subject to certain conditions as to the County Council roads, and to oppose the scheme of the British Traction Company, Limited, and they suggest that some joint action should be taken by all the authorities concerned.

Owens College.—A donation of £2,000 has been received from Captain Partington towards the cost of building the new physical laboratory at Owens College, and Dr. E Hopkinson has sent a sum of £1,884, contributed by the relatives of the late Dr. John Hopkinson for the erection of a wing of the laboratory to be devoted to electro-technical work.

Broadstairs and St. Peter's.—The Urban District Council are availing themselves of the privilege of the time limit up to the 22nd inst. before definitely settling their attitude with reference to the proposed application for a provisional order to empower the Isle of Thanet Light Railways Company to supply electricity for lighting purposes within the district.

Plymouth.—At a recent conference held with the object of arranging for the joint working of the tramway services of Devonport, Plymouth, and Stonehouse, the Corporations agreed to ask the Board of Trade for permission to serve notices upon the existing company. A united light, power, and traction service for the three towns is being looked forward to.

Liverpool.—The Town Council have decided upon several large increases in the salaries of the tramway staff. Twenty additional cars are to be ordered from the British Thomson-Houston Company, Limited. In the month of January 1898 the tramways carried 2 910.000 passengers, whilst this January the number has risen to 3,960 000 The receipts, too, have increased to £1,639.

Southampton.—The Council have instructed Messrs. Kincaid, Waller, and Manville to at once prepare and submit for the consideration of the committee detailed specifications and conditions for tenders for the whole work referred to in the adopted report on electric traction. The Electric Lighting Committee have been requested to forthwith take steps for providing the necessary plant.

St. James's.—With reference to an application by Mr. G. D. Martin of 3, Pall-mall East, for permission to erect six electric light column lamps on the footway of Regent-street in front of premises erected on Hanover Chapel site, it appears that, although the Vestry is not prepared to grant the same, they will consider an application for the erection of bracket lamps in lieu of column lamps.

Rotherham.—The Corporation have adopted the report of Prof. Kennedy with regard to an electric lighting scheme whereby the whole of the principal streets of the borough will be lighted by electricity. Prof. Kennedy is to be requested to prepare the necessary specifications. It is also proposed that application be made to the Local Government Board for sanction to borrow £25 000.

Lee.—The District Board of Works have decided that Mr. Albion Snell, electrical engineer, should be temporarily appointed to answer certain questions put to the Board by the Board of Trade in reference to the electric lighting by the Blackheath and Greenwich Company. It has also been resolved to advertise for a consulting engineer at a salary of £100 per annum to advise the Board as to the laying of the mains and works.

Shoreditch.—The Guardians have agreed that advertisements be inserted in the lighting papers inviting tenders for carrying out the work and supplying materials for the wiring, etc., of the workhouse infirmary, casual wards, dispensary, and offices for the installation of electric light from the mains of the Shoreditch electricity works in accordance with the specification prepared by Mr. C. H. Doughty and approved by the Guardians.

Central London Railway Company, Limited.—The seventh ordinary general meeting of this Company will be held at 16, Great George-street, Westminster, S.W., on Feb. 15, at 3 p.m., for the purpose of receiving the report, etc., after which an extraordinary general meeting will be held with the object of considering a proposed Bill in Parliament, to be entitled "a Bill to extend the time for the completion of the Central London Railway, and for other purposes."

Glasgow.—A temporary breakdown on the electric tramway route to Springburn, which took place last week, caused about an hour's stoppage. A sub-committee is to take expert advice as to whether the tramway department should continue to generate its own electric power or purchase from the electricity department. The committee have approved of the general manager's scheme, previously referred to by us, for the extension of the system to the other routes in the city.

Edinburgh.—The Electric Light Committee resolved on the 31st ult. to recommend to the Town Council that authority be given for the provision of additional water storage accommodation at Dewar-place station, at a probable cost of £550 as also for the extension of the storage batteries, to cost £1,500, and retorts, to cost £700. The committee also recommended the acquisition of ground adjoining the station for additions to the works, at a probable cost of £15 000.

Huddersfield.—The tramway extension from Salendine Nook to Outlane was inspected by Colonel Sir F. A. Marindin on the 31st ult. The new line is about 1¼ miles in length, the terminus being four miles from St. George's-square, Huddersfield. It was opened on the following day to the public. The committee have under consideration the introduction of electric traction in the place of steam power, the rails of the new extension having been laid to suit such a change.

Small Storage Cells.—In our note last week respecting the Q and V types of E.P.S storage batteries, we regret to find that no mention was made of Mr. J. W. Barnard. As has been referred to in our columns, and repeatedly announced in the advertisements, Mr. J. W. Barnard is now sole agent for these small sizes of accumulators. In consequence of the increased demand he has found for these, he has personally equipped the larger premises at 13, Brownlow-street, Holborn, W.C.

National Telephone Company.—The directors recommend the following dividends for the half-year ended Dec. 31 last: at the rate of 6 per cent. per annum, less income tax, on the first and second preference shares: at the rate of 5 per cent. per annum, less income tax, on the third preference shares; at the rate of 6 per cent. per annum, free of income tax, on the ordinary shares, carrying £50,000 to reserve and about £8,000 forward. The transfer books will be closed from to-morrow to Feb. 17, both days inclusive.

Darlington.—Mr. Clifton Robinson, manager, and Mr. Holmes, engineer, of the Imperial Tramways Company, have had a conference with the sub-committee of the Streets Committee of the Corporation, when the question of the extension of the tramway line from 2½ miles to six miles was considered. The work, it was stated, would occupy four months. It was stated that the cable might be brought along from Stockton, and in that case a service of trams to that town might be introduced, either casually or otherwise.

Walker (Newcastle).—The Local Government Board have written to the Council, *re* the electric lighting question, stating that the Walker authority had made it appear as if the company not only asked for powers for the exclusive right to supply electrical energy for the township, but to prevent any other company or person from doing the same thing. It followed that the company was endeavouring to get a local monopoly. The Board of Trade could not, and would not, sanction such a procedure.

Kinver.—The construction of light railways from Stourbridge to Kinver, in the counties of Worcester and Stafford, has been agreed to by the Board of Trade. The promoters are the British Electric Traction Company. A new clause has been inserted putting upon the promoters all the reasonable expenses which the County Council of Worcester and the Stourbridge Urban District Council may incur for superintendence of the construction and maintenance of the line, but limiting these expenses to £10 on the part of each authority.

Charing Cross and Strand Electricity Supply Corporation. The directors of the Charing Cross and Strand Electricity Supply Corporation, Limited, after providing £7 000 for depreciation, carrying forward £3,500 and subject to audit, have decided to recommend a dividend for the half-year ended Dec. 31, 1898, at the rate of 10 per cent. per annum, making, with the interim dividend distributed for the half-year ended June 30, 1898, at the rate of 6 per cent. per annum, a dividend payable for the year 1898 of 8 per cent. on the ordinary share capital.

Leicester.—The Parliamentary Committee of the Corporation on Saturday published an emphatic protest against the proposal of the Warwickshire, Derbyshire, and Leicestershire Electric Supply Company to obtain a Bill to enter Leicester and other boroughs in order to compete with the municipal authorities in the supply of electric energy. It is specially objected that the proposal would take the sole control of the streets out of the hands of the Corporation, and revive the difficulties which were common when the gas and water undertakings were controlled by private companies.

Stockport.—The Town Council have decided to oppose Bills promoted by the General Power Distribution Company, Lancashire Electric Power Company, South Lancashire and Cheshire Electricity Company, Leicestershire and Warwickshire Electric Supply Company, Midland Electric Power Distribution and

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Lighting Provisional Order, Manchester Corporation Tramways and General Powers Bills, National Telephone Company's Bills, Telegraph Act (1892) Amendment Bill, and the electric lighting provisional order promoted by the Heaton Norris Urban District Council.

New Companies. — The Trafford Power and Light Supply, Limited, has been registered with a capital of £100,000, in £1 shares, with the objects of acquiring a concession for the sole and exclusive privilege to supply electricity and fuel-gas for lighting, traction, heating, motive power, or other purposes to the whole of the roads, streets, and premises in Trafford Park Estate.—A company has been registered, under the title of the Electric Canal Haulage Company, Limited, with a capital of £3,000, in £1 shares, with the object of constructing and maintaining rail and tram roads, wharves, docks, electric works, etc.

Personal.—Mr. Alfred R. Sillar, formerly the resident electrical engineer at the Blackpool Winter Gardens, has been appointed to a similar position by the borough of Colchester. Mr. G. Hulme, of the Blackpool electricity works, has been appointed secretary to the Blackheath and Greenwich Electric Lighting Company, Limited. Mr. Johnston, the electrical engineer of Lancaster, has resigned, having secured an appointment under the Corporation of Shrewsbury. Mr. F. B. Spencer, engineer and manager of the Woolwich Electric Light Company, has been appointed electrical engineer to the Wimbledon District Council.

Sheffield.—It has been decided that the vicinity of the town hall in Pinstone-street and New Surrey-street shall be lighted with electricity as soon as possible. To this end special standards for the holding of electric lamps are to be erected. Special designs are to be prepared and submitted to the Improvement Committee. Several enquiries have been made by private citizens who desire to secure electricity for their places of residence or business, both for motive power and lighting purposes. A direct-current supply for power purposes is to be given, and the conversion from alternating current will be effected by a rotary converter.

Crewe.—At the meeting of the Council on Wednesday it was stated that the Electric Light Committee were rushing through a partial scheme for lighting the town without giving adequate information to the Council. They proposed to borrow £32,000 for the scheme, but according to the report they proposed only to light four miles out of the 32½ miles of streets within the borough. The Chairman of the Electric Lighting Committee said the sum which they proposed to borrow was £26 000, and this would be sufficient to lay down all the plant they would need for many years to come. The minutes of the Electric Lighting Committee were agreed to.

Perth.—A special meeting of the Police Commission was held on Tuesday for the purpose of considering a letter from Messrs R. and J. Robertson and Dempster requesting the consent of the Commission to a Board of Trade application by the Perth and District Tramway Company, Limited, for authority to use electric traction in connection with the tramways. The Commission resolved to give their consent to the use of electric traction on the Perth tramways, but declined to consent to the extension of the time specified in the Act, and also that the plans and specifications of the electric system should be first of all submitted for the consideration and approval of the Commission.

St. James's and Pall Mall Electric Lighting Company, Limited. — An extraordinary meeting of this Company is announced to take place after the ordinary general meeting on the 7th inst. in order to confirm a resolution to the effect that the capital of the Company be reduced from £300,100, divided into 20 000 preference and 40,000 ordinary shares of £5 each and 100 founders' shares of £1 each, to £300 000, divided into 20,000 preference and 40,000 ordinary shares of £5 each, by cancelling the 100 founders' shares of £1 each. Another resolution to be confirmed is one approving of the Bill to be submitted to Parliament in the coming session. The share transfer books of this Company are closed until Feb. 15 inclusive.

Cardiff.—The Corporation Tramways Committee have adopted the report of the sub-committee appointed to make enquiries as to the best system of traction, recommending the Council to adopt the overhead electric trolley system as being the most suitable for Cardiff. Mr. Harpur is about to visit Bristol to see an invention of Mr. R. Weight's, of 365, Church-road, St. George's, which is claimed to have advantages over the overhead system, besides costing £1,000 a mile less to lay down. The Tramways Committee have decided not to consent to the doubling of any lines until the tramways come into the hands of the Corporation under the Act of 1898. They have also resolved that the company should be asked to lay down a rail of not less than 100lb.

Hull.—At the last meeting of the Corporation Electric Light Committee the electrical engineer submitted estimates of the income for 1899, which showed a probable output of 809,000 units, which, estimated on the average of 4½d. per unit, should produce a revenue of £15.000 In addition, it was estimated that the meter rents should produce £570 The profits were estimated at £1,545 net or over £3,000 gross. The estimates will be discussed at the next meeting. The permission of the Local Government Board to a loan for £26 000 was received; the committee adopted the expenditure of several sums of money in connection with extensions. The Board of Management at the infirmary have under consideration the question of installing electric light.

Appointments Vacant.—The Lee Board of Works require a consulting engineer to advise upon the electric lighting at £100 per annum. Applications close Feb. 7.—The Corporation of King's Lynn invite applications for the appointment of an electrical engineer to take charge of their electric lighting works in the borough, which are now approaching completion. The commencing salary will be £150 a year, with quarters. Applications close Feb. 15.—The Electric Lighting Committee of the Islington Vestry require the services of a clerk of works at £4. 4s. per week. Applications close Feb. 8.—A foreman is required at the Poplar electric lighting station. Wages £4. 4s. per week. Applications to be sent to Mr. Oliver B. Winter, A.M.I.C.E., chief surveyor, before 7th inst.

St. Pancras.—The Vestry received a deputation on Wednesday last from the National Telephone Company, Limited, with reference to their application for permission to lay their wires underground in Gower-street, for a distance of 450 yards, to connect their system in the western district of London with that in Euston road. The Vestry decided to take no action in the matter. The Midland Furnishing Company, of Judd-street, W.C., have asked for the Vestry's consent to their placing four arc lamps outside their premises, upon condition that they provide a pilot light to the lamp nearest Leigh-street, and asking that instead of such proviso that the Vestry will agree to fix an ordinary gas-lamp at the corner of Judd and Leigh streets for which the company will pay the cost of gas.

Drake and Gorham.—The yearly report of the firm states that during the past year they have been entrusted with the lighting of a large number of both country and town houses. The Jandus lamp still maintained its prominent position in the enclosed arc industry, which had been developed to a phenomenal extent during the past year. The multiple-series 2½-ampere lamps, and other new types for constant-current working, had been developed during the year. As the firm recommends that to deal with electric traction on a sound basis a separate organisation, with a large capital, was required, they formed the Drake and Gorham Electric Power and (Pioneer) Traction Syndicate, Limited, and have a number of Bills going before Parliament next session, and have already secured valuable concessions where orders are already acquired.

Light Railways.—The Light Railway Commissioners have decided in favour of the scheme promoted by the Penzance, Newlyn, and West Cornwall Light Railway, to cost £150,000, designed to connect Penzance with the Land's End district. The Great Western Railway Company have successfully opposed the proposed light railway between Camborne, Redruth, and Portreath. The Light Railway Commissioners have held an enquiry into the application of the Southend Corporation for permission to promote a tramway scheme through Southend to Southchurch and Leigh, at a roughly estimated cost of £75,000. The Chairman intimated that in all probability the order would be granted, subject to various alterations either already agreed upon or to be settled between the town clerk and the clerk to the Leigh Urban District Council.

Southampton Tramway Dispute.—In the Queen's Bench Division of the High Court of Justice, Mr. Justice Bruce and Mr. Justice Ridley, sitting as the Divisional Court, heard evidence upon questions submitted with reference to the award of the umpire in the arbitration between the Southampton Tramways Company and the Southampton Corporation. The case arose out of the proposal of the Corporation to purchase the tramway company's undertaking. Under the terms of Section 43 of the Tramways Act, 1870, the umpire awarded that the price to be paid under the Act of 1897 was £51,505. The company claimed that the undertaking should be treated as enjoyed by the company free from all obligation to part therewith other than the obligation created by the Act of 1897 itself, in which case the price to be paid under the Act of 1897 was £109,963, or more than double the award. Judgment was reserved.

Bath.—At the last meeting of the Surveying Committee, notice of motion was given to the effect that the Street-Lighting Sub-Committee of that committee should be united with the Electric Light Committee, but the chairman declined to receive it, saying that the duties had been defined by the Council, who therefore were the proper authority to deal with it At the last meeting of the City Council, it was reported that the tests of the new machinery which had been put in had been equal to anything that Mr. Hammond or anyone else could have expected. They would be continued next Sunday and afterwards, and when they were finished there would be a report. The question of the transfer of the works to the city's electrical engineer appears still to be causing considerable friction. It has been again discussed, but no definite action will be taken until the reports of both engineers have been considered. The British Electric Traction Company propose in May to apply for an order authorising them to construct three lines in the city.

Blackburn.—Sir Francis Marindin, R.E., K.C.M.G., has held an enquiry into the application of the Darwen Town Council to the Board of Trade for sanction to borrow £26,400 for the purpose of purchasing so much of the undertaking of the Blackburn and Over Darwen Tramways Company as is situate within the borough of Darwen, including the option of the company to take a lease of so much of the undertaking as aforesaid, for such term of years as would make up the aggregate term of 21 years from the date of the passing of the Blackburn and Over Darwen Tramways Act, 1879; also into an application of the Blackburn Corporation for power to borrow £23,337 for the purpose of purchasing so much of the undertaking of the Blackburn and Over Darwen Tramways Company as is situate in the borough of Blackburn. Sir Francis Marindin remarked that a resolution by the Darwen Town Council authorising the alteration in the application would be necessary. Subject to a resolution to that effect he would submit the last named sum to the Board of Trade.

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Lancashire.—The Parliamentary Committee of the County Council have had under consideration the Bills which are being promoted by the Lancashire Electric Power Company and the South Lancashire and Cheshire Electricity Company. The committee have, according to the *Manchester Guardian*, no desire to interfere with the objects of the promoters of these Bills, being of opinion that, in the interests of the country districts, every facility should be afforded to the inhabitants to obtain the benefits derived from the application of electricity for the purposes of power, lighting, etc., provided that similar protection is given to the ratepayers as appears in all Bills relating to tramways, waterworks, etc. As the county of Chester is equally interested in the Bills, the committee is in communication with the clerk of the Council with the view of agreeing upon and submitting to the promoters of each of the Bills clauses for the protection of the county interests, and pending the negotiations the committee recommend that petitions should be presented against both Bills for the purpose of preserving the *locus standi* of the County Council.

Wrexham.—At the monthly meeting of the Town Council on the 31st ult., the question of the proposed electric tramways through certain streets of the borough was again discussed. A letter was read from Messrs. Evan Morris and Co., the solicitors to the promoters of the scheme, stating that if the Corporation had any clauses to suggest, and would submit a draft, they would be considered, assuming the Council consented to the scheme going on. Several petitions, some in favour and one adverse to the proposed scheme, were read. Finally, the General Purposes Committee were instructed to prepare, and to endeavour to agree thereupon with the promoters of the tramways, such modifications of the Board of Trade draft order as might be necessary in the interests of the Corporation and of the inhabitants of the borough, including a condition that tramway No. 3 should not be constructed, unless consented to by the Corporation after tramways Nos. 2, 4, and 5 have been in work, without objections on their part, for at least two years. Subject to such modifications being agreed to by the promoters and approved of by the Council, the latter will be prepared to assent to the proposed routes of the tramways within the borough.

Automatic Telephone Company.—The troubles of this Company are evidently not over yet. At the recent meeting the shareholders objected to hear the chairman and held a subsequent meeting, at which Mr. Barlow presided. Mr. J. M. White explained the nature of the action that had been tried. The Chairman said (according to the *Financial News*) that Mr. Seligmann-Lui absolutely declined to go on until some different position was taken up by the Company; but that, so far as he could see by his theoretical working out, his machine was perfect, and if that were so, it could readily be seen what great advantage would accrue to the business communities all over the country when by simply turning a handle they could speak to anyone else in London. Mr. Bernard Parker moved, and Mr. James White seconded, the following resolutions, which were carried: "(1) That the report and balance-sheet be not adopted; (2) that this meeting records its want of confidence in Mr. Margowski as chairman and managing director, and calls upon him to resign both those positions at once; (3) that a committee of shareholders be appointed to examine the affairs of the Company, and to arrange for more satisfactory working conditions; (4) that the auditors be instructed to prepare a balance-sheet up to Dec 31 last; (5) that this meeting be adjourned until the first Thursday in April at 12 o'clock."

New Issue.—The County of London and Brush Provincial Electric Lighting Company, Limited, announces a first issue of £200,000 4½ per cent. debenture stock at £108 per cent. This forms part of the authorised issue of £400,000, and is redeemable at £115 per cent. in the case of the voluntary liquidation of the company, or if the company give six months' notice in writing at any time after Dec. 31, 1923. The debenture stock will be secured as a first charge upon the whole undertaking and property of the company, both present and future. The prospectus states that the assets of the company amounted on Dec. 31, 1898, in the aggregate to £736,080. 9s. 7d., made up as follows: expenditure on undertakings within the county of London, £566,199. 1s. 1d.; lands, buildings, etc. (other than those in the county of London), and investments in and advances to associated provincial electricity supply companies, £148,741. 18s. 11d.; provisional orders (at cost), stores, sundry debtors, etc., £21,139 9s. 7d.—total, £736,080. 9s. 7d. The proceeds of the present issue after deducting outstanding liabilities, will amount to £63,834. 8s. 3d.; making a total of £799 914. 17s. 10d., while the annual gross income of the company (excluding profits on investments realised) has risen from £4,941 in 1895 to over £25,000 (estimated) for 1898. The equivalent of 8-c.p. lamps applied for was 7,000 in 1895 and 79,295 in 898.

Wigan.—At a recent meeting of the Electric Light Sub-Committee it was resolved that the attention of the member of Parliament for the borough be called to the following Bills with a view to offering a strenuous opposition thereto on the second reading—namely, General Power Distribution Company, Lancashire Electric Power Company, South Lancashire and Cheshire Electricity Company, Leicestershire and Warwick Electric Supply Company, Midland Electric Power Distribution and Lighting Provisional Order. It was also resolved that the Corporation seal should be affixed to a petition in opposition to and praying to be heard against Bills promoted by the Lancashire Electric Power Company and the South Lancashire and Cheshire Electricity Company. It was stated that with regard to the provisional order sought by the neighbouring township of Pemberton for the supply of electric light in that district, the Council had not grounds for any strenuous opposition to the order itself, but they were desirous that nothing should be inserted which would be detrimental to the interests of Wigan. Two of the applicants for the post of electrical engineer—viz., Messrs. Bishop and Jeckell—have been asked to attend a meeting of the committee which was to be held yesterday. The Town Council has been recommended to empower the committee to appoint an electrical engineer.

London County Council.—At Tuesday's meeting the Highways Committee reported as follows: "Section 22 of the North Metropolitan Tramways Act, 1897, empowers the company to use mechanical power on the tramways authorised by the Act, or any tramways for the time being leased to the company, subject, however, to regulations to be made by the Board of Trade for securing to the public all reasonable protection against danger from the use of mechanical power on the tramways, and for regulating the use of electrical power, but Section 24 contains a proviso that the powers given to the company by that section with regard to the use of electrical traction shall not be exercised in any place within the administrative county of London. The agreement for lease to the company of the Council's northern tramways, which agreement is confirmed by and forms the first schedule to the Act, contains provisions for experiments with electrical traction on a part of such tramways to be selected by the Council, and the proviso above referred to appears to be somewhat inconsistent with the provisions of the lease in this respect. There appears to be no doubt that under the Act mechanical traction, other than electrical, may be used upon the lines leased to the company; and it seems desirable that the proviso in Section 24 should be annulled, in order that the Council may, if it feel so disposed, exercise the powers reserved to it in the lease as regards the use of electrical traction also. We therefore recommend that, notwithstanding anything in the Council's standing order, No. 342, to the contrary, the Parliamentary Committee be instructed to take the necessary steps for the annulment of the proviso in Section 24 of the North Metropolitan Tramways Act, 1897, prohibiting the service in any place within the administrative county of London of the powers conferred by that section as regards the use of electrical traction."

St. Marylebone.—At yesterday's meeting of the Vestry a report was submitted recommending that the Vestry concur in the principle suggested by the Vestry of Westminster for provision being made, in Bills before Parliament relating to underground electric railways in London, for inter-communication between the various systems, and that the London County Council be informed accordingly. There was also a resolution on the agenda to the effect: "That the Electric Lighting Committee be instructed (1) to enquire and report (*a*) whether the Metropolitan Electric Supply Company has power to sell, and, as vendor, can make a good title to that part of its undertaking which is situated in or supplies with electricity the parish of St. Marylebone, including the benefit of any provisional orders and confirming Acts, and whether the Vestry can legally purchase; (*b*) what is comprised in the company's undertaking, so far as it is situated in or supplies, or was intended and is adapted to supply, St. Marylebone, and whether what is specified or referred to in the report of the committee is wholly separate (or capable of being wholly separated, and, generally, by what work and at what approximate expense) from that part of the company's undertaking which is not situated in or used for supplying St. Marylebone. (2) If the company has power to sell and make a good title to what is, or can, at small expense be made a wholly separate, independent, and exclusive undertaking for the supply of St. Marylebone with electricity, then before report to enter into a provisional contract with the company in the name, and on behalf, but subject to the approval of the Vestry, for the purchase of the benefit of such part of the company's provisional order, works, and undertaking, including a covenant not to compete with the Vestry, and not to use any part of its purchased or added plant (or to do so, subject to such limits, and on such terms as may be agreed, at a price to be hereafter agreed on between the company and the Vestry, or, in default of agreement, to be settled by submission of both parties to an arbitration under the Arbitration Act, 1889, or as may be otherwise agreed). (3) The committee to be at liberty to employ such experts or obtain the benefit of such professional advice as they may consider necessary for the purposes of this reference to the committee."

Islington.—At the Vestry meeting to-day the Electric Lighting Committee will submit a report, stating that a reduction in the price for public and private lighting is recommended in the joint report from the electrical engineer and the treasurer, which is as follows: "We are of opinion that the business is now in a sufficiently sound financial position to justify a reduction in the cost of street-lighting from 5d. hitherto charged to 3½d. per unit, being a reduction upon the present price of 30 per cent. It must always be borne in mind that this charge includes not only the cost of producing electrical energy, but also the cost of carbons, trimming, attendance, repairs, maintenance, and the proportion of interest and redemption on capital properly chargeable to street-lighting. While there is no doubt, in our opinion, that the street-lighting should be first considered, we also think that the interests of the private consumers should not be overlooked. The reduction made in October, 1897, gave great satisfaction to the consumers, and the fact mentioned in the engineer's report which is attached to the accounts that, notwithstanding this reduction, the percentage increase in revenue went up, is a proof that it was not only appreciated, but was advantageous to the business. The inevitable result of cheapening the supply must be not only to attract new consumers, but also to increase the demand of existing consumers. We are of opinion that the sliding scale principle of charging is the correct one, and would suggest that 7d. per unit for the first hour's consumption of the maximum

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demand should be maintained. We suggest, however, that the charge of 6d. for the second hour should be eliminated. The revised scale would then be as follows: 7d. per unit for the first hour's consumption of the maximum supply demanded, and 4d. per unit for all current consumed after the first hour. Under this scale a customer whose consumption averages two hours per day of his maximum demand during the quarter will obtain his electrical energy at an average of 5½d. per unit, for three hours 5d. per unit, and for four hours 4¾d. per unit, which scale compares most favourably with all the London municipalities and companies. We therefore suggest that as from Jan. 1, 1899, the price for street-lighting be reduced from 5d. to 3½d. per unit, and that the 6d. rate to the private consumer be eliminated as from April 1 next." The Electric Lighting Committee will report with regard to the suggested extension along New North-road to parish boundary that the engineer's estimate of the cost of carrying out the work, including all conduits, cables, street work, etc., for both public and private supply with 31 arc lamps complete, is £5,200; and recommend that the scheme be adopted, and that it be referred to the Finance Committee to raise the necessary funds by loan as usual.

Newcastle.—At a meeting of the new Tramway Committee of the Corporation held on the 31st ult., the report of the Visiting Committee was read in relation to the inspection of trams in several towns, and, after discussing the report, it was eventually unanimously adopted for recommendation to the City Council. A special meeting of the Council will be held on the 14th inst. for the purpose of considering the same. The report, for particulars of which we are indebted to the *Newcastle Daily Chronicle*, recites everything that has taken place in connection with the enquiry from the appointment of the committee by the Council down to the present time, giving a full *résumé* of everything that has been reported by both experts—Mr. Coleman, on behalf of the cable system, and the late Dr. John Hopkinson, and since that gentleman's death by his brother, Mr. Charles Hopkinson, on behalf of the electrical system. The committee's report then proceeds to give an account of what the deputation saw at Middlesbrough, Bradford, Halifax, Leeds, and the cable tramway at Brixton. They report that at Bradford there was a steep gradient of 1 in 14, and in Halifax a single line of tramway leading through narrow streets and sharp curves, and having a gradient of 1 in 12½. This section of the Halifax tramway is two miles in length, and runs to no less a height than 700ft., which is equal to an average gradient of 1 in 15 over the distance. The steepest gradient in Westgate-road is 1 in 13½ for a short distance only. In both Bradford and Halifax the members reported that they found the cars under complete control on the steepest gradients. At the inspection of the cable tramways at Brixton the members were disappointed with the slow rate of speed at which the cars travelled. After inspecting the lines, etc., the committee were of opinion that the cable system may be advantageous for straight runs, but that they would not be suitable for Newcastle, where there are so many crossings and junctions. The committee also thought that in case an agreement was come to with authorities outside the city the cable system would not be so useful as the electrical. Therefore, the electrical system should be employed as the motive power. The committee, after considering the question fully, recommended the Council to adopt that system of tramways. The committee also asked for the appointment of an electrician to advise and prepare the necessary plans and specifications. They further recommended that the roadway in the principal streets between the tramlines should be paved with wood, and proposed to ask the Town Improvement Committee to pave the remaining portions of the streets with wood also. The committee were of opinion that, as in other towns, the poles of electrical cables should be utilised for lighting the streets. They, therefore, recommended the Council to approve of the principle of lighting the streets by electricity in connection with the tramway system, and to authorise them to confer with the Watch Committee on this subject. Subject to the approval of the lessees of the tramways, the committee propose to commence certain portions of the work where the present tramways are in the worst condition and require attention at once; the city engineer being of opinion that this would save six months in the ultimate construction of the system. The report was unanimously adopted. This report was presented to the City Council on Wednesday, and will be discussed at a special meeting.

PROVISIONAL PATENTS, 1899.

JANUARY 23.

1487. **Improvements in electric light wire casing.** Albert Davidson, Bank-buildings, George-street, Sheffield.

1492. **Apparatus for heating by electricity.** Philip John, 2, Camden-terrace, Cotham-road South, Bristol.

1502. **Improvements in electric igniters and vaporisers for internal-combustion engines.** Walter Howley Derriman and William Ernest Philbrow, 22, Bath-street, Huddersfield.

1513. **Improvement in electrical insulating cement.** Fewster Player and Philip Holmes, 57, Charterhouse-street, London.

1529. **Improvements in electric measuring instruments.** Francis Henry Nalder, Ernest Thompson, and Richard Frank Curtis, 34, Queen-street, London.

1532. **Improvements in dynamos and electric motors.** Frederic O'Connor Prince, Campbell-street, Silvertown, London.

1536. **Improvements in or relating to electric meters.** George Walker Walker, 27, Martin's-lane, Cannon-street, London.

1553. **Improvements in secondary or storage batteries.** William Moore McDougall, 45, Southampton-buildings, Chancery-lane, London.

1554. **Improvements in the manufacture of secondary battery plates.** William Moore McDougall, 45, Southampton-buildings, Chancery-lane, London.

JANUARY 24.

1598. **Improvements in adjustable flexible metallic supports or arms for electric lights.** George Howson and Walter Barnes, jun., Bank-buildings, George-street, Sheffield.

1620. **Improvements in trolley connections for transmitting electric power from overhead wires to tramcars and the like.** Robert Baird, 12, Percy-street, Paisley-road West, Glasgow.

1627. **Improvements in insulators for fastening electric wires.** John Trealeaven, Vancouver, British Columbia, Canada. (Complete specification.)

1643. **Improvements in speed indicators for electric tramcars.** Horace Field Parshall, 83, Cannon-street, London.

1673. **Improvements in portable telephones, applicable also for testing purposes.** Henry Field Blackwell, jun., and Maude Alice Blackwell, 53, Chancery-lane, London.

1683. **Combined electric arc lamps and fans.** Joseph Melzer, Frederick Haffner, and Martin Koch, 46, Lincoln's-inn-fields, London. (Complete specification.)

1697. **Improved electrical apparatus for operating mechanism at a distance.** William Phillips Thompson, 322, High Holborn, London. (John Smith Thompson, United States.)

JANUARY 25.

1758. **Improvements in portable hand dynamos, parts of which improvements are applicable to small power dynamos and motors for other purposes.** Evershed and Vignoles, Limited, and Sydney Evershed, Woodfield Works, Harrow-road, London.

1765. **A surface contact electric traction system.** Silvanus Phillips Thompson and Miles Walker, Morland, Chislett-road, West Hampstead, London.

JANUARY 26.

1810. **Improvements in electrical weaving frames or looms.** Henry Boulangé and Emile Frégnac, 18, Fulham-place, Paddington, London. (Complete specification.)

1819. **A means of recording messages as they are received through the telephone, or an easy method of taking a record of messages as they are received through the telephone.** Thomas Williams and Thomas Lloyd, Heathfield, Risca, Monmouthshire.

1834. **Improvements in rail bonds for electric traction systems.** Hugo Hirst and Ivor Victor Zealander, 73, St. Stephen's-road, Upton Park, London.

1835. **Improvements in switches for starting and controlling electric motors.** Hugo Hirst and William Mead, 73, St. Stephen's-road, Upton Park, London.

1839. **Improved method of solidifying the contents of electric accumulators by chemical means.** Lothar Fiedler and Emil Jäckel, 102, Burdett-road, Bow, London.

1841. **Improvements in and relating to collectors for trolleys for electric tramways and the like.** Robert Naudin Tweedy, 70, Chancery-lane, London.

1844. **Improvements in the manufacture of plates for secondary batteries.** Léon Champagne, 45, Southampton-buildings, Chancery-lane, London.

1862. **Electric telegraphy by means of condensers and induction coils.** Ferdinand Braun, 322, High Holborn, London.

1863. **Wireless electric transmission of signals over surfaces.** Ferdinand Braun, 322, High Holborn, London.

1865. **Method of and apparatus for controlling the operating gears of rudders, signals, and the like by means of heat, light, or electrical waves.** Axel Orling and Carl Gustaf Georg Braunerhjelm, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Oct. 26, 1898, being date of application in Sweden.)

1866. **An improved receiver for waves of light, heat, or electricity.** Axel Orling and Carl Gustaf Georg Braunerhjelm, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Oct. 27, 1898, being date of application in Sweden.)

1867. **Improvements in apparatus for regulating the sensitivity of receivers for waves of light, heat, or electricity.** Axel Orling and Carl Gustaf Georg Braunerhjelm, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Oct. 27, 1898, being date of application in Sweden.)

1868. **A device for regulating the distance between objects hermetically enclosed.** Axel Orling and Carl Gustaf Georg Braunerhjelm, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Oct. 27, 1898, being date of application in Sweden.)

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1869. Improved electrical condenser and apparatus for producing powerful electric waves. Axel Orling and Carl Gustaf Georg Braunerhjelm, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Nov. 25, 1898, being date of application in Sweden.)

JANUARY 27.

1895. Improved electric switch. Robert Milne Murray, 154, St. Vincent-street, Glasgow.

1902. Improvements in the manufacture of secondary battery plates. Vittorio Giovanni Lironi, Luna Electric Works, Harpurhey, Manchester.

1921. Improvements in electric arc lamps for stage and the like purposes. John Webster, 8, Quality-court, Chancery-lane, London.

1927. A new or improved magnetic clutch. Charles William Higgs, 17, Ironmonger-lane, London.

1941. Improvements in incandescence electric lamp pendants or brackets. Hugo Hirst and James Murphy, 73, St. Stephen's-road, Upton Park, London.

1960. Improvements in electric railways of the sectional conductor type. James Grieve Lorrain, Norfolk House, Norfolk-street, Strand, London. (Frederick Carleton Esmond, United States.)

JANUARY 28.

1978. Improvements in electric glow lamp sockets or holders. Vittorio Giovanni Lironi and Oliver Moon, Luna Electric Works, Harpurhey, Manchester.

2006. Improvements relating to telegraphic receiving instruments and relays. Oliver Joseph Lodge and Alexander Muirhead, 323, High Holborn, London.

2017. An improvement in electric igniters for gas or oil motors. Paul Auguste Decam, Birkbeck Bank-chambers, Southampton buildings, Chancery-lane, London.

2023. An improved manufacture of carbons for electric arc lamps. Emil Frischaner and Anton Othmar Simonnier, 4, South-street, Finsbury, London.

SPECIFICATIONS PUBLISHED.

1898.

143. Electric arc lamps. Davy and Thomas-Davies.

462. Electric mains. Nisbett.

591. Telephone transmitters. Graham.

848. Galvanic battery. Von der Poppenburg.

2723. Electric arc lamps. Crudgington.

3032. Steering torpedoes electrically. Jamieson and Trotter.

3219. Electrical measuring instruments. Heap.

3905. Suspension devices for electric and other lamps. Pasquet.

4046. Distribution of electricity on the three-wire system with the neutral wire at earth potential. Blackburn, Spence, and Moore.

4075. Methods and apparatus for electrothermally treating materials, more particularly for the manufacture of calcium carbide and other carbides, and the reduction of ores. Maxim.

4678. Insulation of wire for electrical purposes. Hearson.

4819. Method of electrically heating materials in closed chambers and apparatus for that purpose. Electric Reduction Company, Limited. (Gibbs.)

5133. Electric lamp fittings. Huisman and Gover.

9105. Apparatus to be used in connection with the electro-deposition of metals. Greenfield.

12839. Apparatus for electrically signalling on railways. Muschamp.

14614. Electric energy meters for alternating currents. Laarmann and Brockelt.

18475. Electric meters. Mills. (Edison.)

18557. Motor trucks for electric and other railways. Capewell.

19940. Circuit breakers for three-wire electricity distribution systems. The British Thomson-Houston Company, Limited. (Hewlett.)

20532. Electrically-propelled vehicles. Blackwell.

22079. Carbon brushes for dynamo-electric machines or motors. The British Thomson-Houston Company, Limited. (Rohrer.)

22130. Electric railways and tramways on a sectional conductor system. Heys. (Heilmann.)

22959. Telegraphic apparatus. Golby. (De Constant.)

23430. Electric controller mechanism primarily adapted for railway motors. Thompson. (Von Zweigbergk.)

23532. Electric brakes for electric railway cars and other electrically-operated mechanisms. The British Thomson-Houston Company, Limited. (Case.)

24052. Electric railway systems. Murphy.

25023. Method of heating electrically-propelled tramway cars and other vehicles. Brennecke and Timar.

25363. Radiating axles for electrically-propelled railway or tramway cars. Siemens Bros. and Co., Limited. (Siemens und Halske Aktien-Gesellschaft.)

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1899.	Corresponding week 1898.	Increase or decrease.	Total receipts for half-year. 1899.	1898.
		£	£	£	£	£
Birmingham Tramway	Jan. 28	3 689	3,547	+ 142	15,040	14 070
Blackpool and Fleetwood Tramroad	,, 28	154	—	—	564	—
Bradford City Trams	,, 29	247	—	—	6,485‡	—
Bristol Tramways and Carriage Co.	,, 27	2 382	2,344	+ 38	—	—
City and South London Railway	,, 29	1,131	1,059	+ 75	5,553	5,393
Dover Tramways	,, 28	132	103	+ 29	586	437
Dublin U.T., elec. cars	,, 27	997	922†	+ 75	2,986	2,823†
Dublin S.D. Electric Tramways	,, 27	604	454	+ 150	2,354	1,669
Halifax Corporation Tramways	,, 11	238	—	—	7,356*	—
Liverpool Overhead Railway	,, 29	1,258	1,337	- 79	6,551	6,847
South Staffordshire Tramways	,, 27	542	568	- 26	2,368	2,353

* Since June 29, 1898. † Including horse cars. ‡ Since July, 1898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	20-21
Bournemouth and Poole Electric Supply, Limited, Ord.	10	12½-13½
—— 4½ per cent. Cum. Pref	10	10½-11½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	17½-18½
—— 6 p. c. Cm. Pf., 30,001-40,000 (all paid)	10	13½-14
—— 5 per cent. Perpetual Debenture Stock	100	120-122
Brush Electrical Engineering, Limited, Ordinary	2	1¾ 2¼
—— Non. Cum., 6 per cent. Pref.	2	2¼ 2⅝
—— 4½ per cent. Debenture Stock	100	111-115
—— 4½ per cent. 2nd Debenture Stock	100	101-104
Callender's Cable Company, Debentures	100	110-113
—— Ordinary	5	9½-10½
Central London Railway, Ordinary	10	9½-10½
——	8	7¾ 8¼
—— Pref. Half-Shares	8	3¾-4
—— ,, ,,	5	4-4½
Charing Cross and Strand	5	11-12
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	9-10
—— 4½ per cent. Debentures	100	113-115
City of London, Ordinary	10	23½-24½
—— ,, 90,001-100,000	10	23-24
—— 6 per cent. Cumulative Pref.	10	15½-16½
—— 5 per cent. Debenture Stock	100	125-130
City and South London Railway, Consolidated Ordinary	100	69-71
—— Ordinary	8	3¾-4
—— 4 per cent. Debenture Stock	100	133-135
—— 5 per cent. Pref. Shares	10	14½ 15½
—— ,, ,, '96	10	14-15
County of London and Brush Prov. Elec. Light Co., Ord	10	12½-13½
—— ,, ,, No. 80,001-40,000	10	12-13
—— 6 per cent. Cum. Pref.	10	14½-15½
Crompton and Co.	8	2½ 3
—— 5 per cent. Debentures	—	98-101
Crystal Palace District, Ordinary 5 per cent. Stock	100	127 132
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2½-3
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	97-99
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5-5½
Electric Construction, Limited	2	2½-2¾ xd
—— 7 per cent. Cumulative Pref.	2	3-3½
—— 4 per cent. Perp. 1st Mort. Deb.	100	103-105
W. T. Henley's Telegraph Works, Ordinary	10	24½-25½
—— 7 per cent. Preference	10	18½ 19½
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9-10
—— 7 per cent. Preference	5	9½-10½
Imperial Tramways, Limited	6	20-21
India Rubber, Gutta Percha, and Telegraph Works	10	22-23
—— 4 per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	13-14
London Electric Supply, Ordinary	3	3¾-4½
—— 6 per cent. Pref.	5	6½-7
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	103-105
Metropolitan Electric Supply, Limited, Ord., No. 1-62,500	10	19-20
—— ,, ,, No. 62,501-85,000	4	12-13
—— 4½ per cent. First Mortgage Debenture Stock	100	118-121
National Telephone, Ordinary	5	5¾-6
—— 6 per cent. Cum. First Pref.	10	14-16
—— 6 per cent. Cum. Second Pref.	10	13-15
—— 5 per cent. Non. Cum. Third Pref.	5	5¾-5½
—— 3½ per cent. Deb. Stock, Red.	100	99-102
Notting Hill Electric Lighting Company, Limited	10	17-18
Oriental, Limited, 1879	1	1½-1¾
—— £5 Shares	5	7¼-7¾
—— £4½ Shares, New	4½	6¼-6¾
Oriental Telephone and Electric Company	1	¾-1
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6¾-7½
Royal Electrical Company of Montreal	½	16½-16⅝
—— 4½ per cent. First Shares Mortgage Debentures	100	106-107
South London Electric Supply, Ordinary	3	3¾ 3¾
St. James's and Pall Mall, Limited, Ordinary	5	17-18
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	37-41
—— 5 per cent. Bonds	100	103-105
Waterloo and City Railway, Ordinary	100	109-112
Westminster Electric Supply, Ordinary	5	15½-16½

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NOTES.

Exhibition in Japan.—The Japanese Government is proposing to organise its first international exhibition in the year 1902. Every endeavour will be made to attract exhibitors from all countries. Invitations to the different Governments are likely to be dispatched in the spring.

Cantor Lectures.—The next course of Cantor lectures at the Society of Arts will be on "Cycle Construction and Design," by Mr. Archibald Sharp. The course will consist of four lectures, commencing Monday, Feb. 20. The first lecture will deal generally with the frame, the second with various parts of the machine, including ball-bearings, wheels, pedals, and steering arrangements, the third with driving gear, and the fourth with tyres, brakes, saddles, etc.

The Salford Deputation.—The presentation of the report of a deputation sent by the Electric Lighting Committee of Salford to Hamburg last September has caused a stir on the Council. One unkind critic went so far as to say that there was nothing in the report not found in that of the Manchester deputation except the statement that "the fuel used was small Welsh coal, this being delivered by boat." He evidently did not think this was worth the £100 spent by the deputation.

Tramways at Hastings.—Now that the inhabitants of Hastings and St. Leonards as a whole have had a chance of voting on the tramway question, there is every possibility that good travelling facilities will in future be obtainable in those towns. We are glad to know that the majority in favour of having tramways was no less than 3,519 on a poll of 8,340. The curious thing is that the strongest opponents to the tramways in these towns have been those who would benefit most by their introduction.

Behr's Electric Expresses.—The Liverpool Electric Power and Lighting Committee at their meeting this week considered a letter requesting the committee to appoint representatives to confer with other representative gentlemen on the subject of the proposed electric express between Liverpool and Manchester. It was decided that the Lord Mayor, the chairman of the committee (Mr. C. Petrie), the electrical engineer (Mr. A. B. Holmes), and the town clerk (Mr. Harcourt E. Clare) should represent Liverpool at the proposed conference.

Windsor Castle Lighting.—We are glad to hear that the electric lighting in Windsor Castle is being extended, and also that supply for the extension is to be taken from the mains of the Windsor and Eton Electric Lighting Company. The present plant will, no doubt, be still used for the bulk of the lighting, but the company's mains form an excellent stand-by, such as is required for all isolated plants. The connection with the town mains is to be completed by the end of this week, so as to be quite ready before the Queen arrives.

Phonograph Litigation.—The Edison-Bell Consolidated Phonograph Company, Limited, has inserted a warlike advertisement in several of the daily papers to the effect that it has commenced lawsuits against all manufacturers of gramophones in this country. It seems, however, that innocent users of infringing instruments will only be charged a royalty, and will not, as is often the case, have their instruments confiscated and destroyed. All this presumes, of course, that the claims of the company are confirmed by the English law courts.

Electric Traction System.—We gather that Mr. Albert Weight, of Bristol, has also joined the list of advocates of underground systems of electric traction, and he has invited a deputation from the Cardiff Corporation committee to inspect his model at Bristol. Mr. Weight makes the rather extravagant claim that his system is £1,000 cheaper per mile than the overhead trolley system. This seems to be rather an exaggeration, even with no knowledge of the system in question. We gather from a newspaper report that the overhead trolley system is likely before long to be introduced into Cardiff.

Overhead Telegraph Wires in Towns.—A curious example of the objections to overhead telegraph and telephone wires in big towns has arisen in Brussels. In this case the disadvantage lay with the owners of the wires, and not with the unfortunate owners of houses on which they were attached. It seems that a gang of thieves have made a regular practice of stealing long lengths of copper wire used for telegraphic and telephonic purposes. Fortunately, the bulky nature of the spoil, which, of course, was removed under cover of the night, proved a trifle inconvenient to the miscreants, and police-court proceedings are the result.

Cable Cutting.—We understand from a Reuter's telegram from Washington on Saturday last that Mr. J. W. Griggs, the Attorney-General of the United States, has given his decision in favour of his Government on the cable-cutting question. He holds that the military commander has the right to cut cable within the territorial waters of the enemy without making his country liable for damage. The case laid before him was that of the Eastern Extension Telegraph Company. We take it, however, that Mr. Griggs's decision is merely the opinion of the defending counsel on behalf of the United States, and that it is not binding on the telegraph company.

Electricity and Plant Life.—We gather from the daily papers that Dr. E. S. Cook, F.I.C., F.C.S., of the Clifton Laboratory, Bristol, delivered (under the auspices of an horticultural society) an interesting lecture on this subject last week. We have not at present seen the full text of the paper, but we understand that some successful experiments were described. The action of electricity on the fertility of seeds was one of the main points raised by the lecturer, who suggested that in order to increase the range of experiments seeds should be sent to him to be treated electrically. These would then be returned to the sender, so as to enable him to make comparative tests with seeds which had not been so treated.

Civil Engineers' Conference.—The Institution of Civil Engineers is organising another conference, similar to that held two years ago, for June 7, 8, and 9 in this year. The conference will, as last time, be arranged in seven different sections, in order that the time of those attending may be saved. The visits to the various works of interest in and around London will be reserved for the afternoon of each day. The full details of these visits and of the papers to be read for discussion will be given in due course. The annual conversazione of the institution will be held on the evenings of June 8 and 9. The large number of country visitors attending the engineering conference should make the social functions a great success.

The British Association of Draughtsmen.—We have received from Mr. Gillaird some information as to the objects proposed to be aimed at by the formation of an association of draughtsmen in Great Britain. The idea is that membership of the association shall be restricted to draughtsmen who have served at least seven years in the offices or works of architects, civil engineers, consulting or mechanical engineers, or shipbuilders. The associates may be improvers or apprentices who are serving their time in any of the above departments, and these by-and-by will

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become eligible for membership. The aim of the proposed association is to draw together the various draughtsmen for mutual help in their profession by the reading and discussion of papers. It is hoped that in this way their status may be raised and other advantages secured. It may be added that any draughtsman desirous of becoming connected with the new association should write to Mr. Gillaird, at 34, St. Mary's-road, N., as he is acting as secretary *pro tem.*

The Elgin Telephone Verdict.—The National Telephone Company has lost an important test case in connection with their telephone rates in Scotland, particulars of which will be found reported somewhat fully in our legal column. The gist of the whole matter is this: A subscriber signed an agreement by which he paid £6. 10s. per annum for the use of a telephone, and the agreement provided also that the increase to £8. 10s. was to be made when the trunk connection with other towns and the district had been completed. The company before the expiration of the agreement claimed the £8. 10s. rental, although what trunk lines there were available were in the hands of the Government, and could only be used when certain additional fees were paid to the Government. From what we have read of the case, the impression that £8. 10s. was to cover all trunk fees was quite justified, and we are glad to know that in Scotland, at least, telephone subscribers are able to get all their local communications transmitted at the low rate of £6. 10s. per annum.

Heavy Motorcars in America.—We gather from the columns of the *Electrical Review* of New York that the speculation in stocks and shares in motorcar companies progresses at a much faster rate than the actual development of the cars themselves. Thus one company which is being boomed very much at present makes a special feature of autocars to carry 10 tons at a rate of 10 miles per hour. The editor of our contemporary remarks that these cars have not yet come on to the streets, and raises a question as to what the streets will be like after they have done so. Still, it remarks, "while streets could not stand under such burdens, the public will stand anything in the way of promises; it is a life of hope we lead, truly." The same fault may be found with most of our English companies devoted to the manufacture and sale of motorcars. If the moving spirits of these concerns would only undertake the improvement of the motorcars with as much zest as they do the booming of their undertakings, much good would result to the community at large.

Telephonic Fire Calls.—The firemaster of the Edinburgh Town Council has, in his last report to the Plans and Works Committee of that town, complained that the operators at the telephone exchange do not answer expeditiously communications with regard to the outbreak of fire. When the report came up before the Town Council the town clerk was instructed to write to the manager of the company on the question, and "to impress upon him the absolute necessity, in the interests of the protection of life and property, of issuing such instructions forthwith as would ensure immediate attention being given to communications of the kind described." Precedence over all other messages at the exchange should be given to those relating to fires, even if important conversations are interrupted in the middle, much in the same way as traffic in the streets of London is interrupted in order to make a passage for the fire-engines. In this case it is to be hoped that the National Telephone Company will have no difficulty in meeting the requirements of the Edinburgh Corporation.

The Police as Lamplighters. — As has been frequently mentioned in our columns, the electrical engineer at Tunbridge Wells has until recently pressed the police into his service as lamplighters. The only lamp-lighting they were required to do was at midnight, when the arc lamps are switched out from the central station. The policemen on duty were then required to switch on all the incandescent lamps, which are attached to the arc-lamp pillars. The Watch Committee at Tunbridge Wells has now, however, resolved that this obligation is not consistent with the best protection of the borough. They say that it necessitates the constables devoting a not inconsiderable portion of their time to a matter incompatible with their office as guardians of the peace. In fact, they think it is *infra dig.* for constables to be used as lamplighters. The other side of the question was stated to be as follows: that the better lighting of the streets had reduced crime in Tunbridge Wells so much that there was next to nothing for the police to do at night; hence the lighting of the lamps came almost as a boon to the constables on duty.

Electric Lighting Notices.—The lawsuit between the County of London and Brush Provincial Electric Lighting Company and the Battersea Vestry was reported somewhat fully in our issue last week. While recognising that at times the local authorities in London are exceedingly unreasonable in delaying their consent to notices that electric light mains are to be laid under the electric lighting provisional orders, we cannot support the company in question in their high-handed action reported Their procedure in proceeding with the work against the wishes of the local authority has raised some opposition to certain of their Bills now before Parliament, which we think would not have been otherwise forthcoming. Thus we notice that in the agenda of St. George-the-Martyr, Southwark, the Vestry is considering the Bill to enable the company to lay mains through certain portions of the district for their own convenience and not for supplying light. The opposition which is to be brought against this, as far as is stated at present, will be wholly on the question of the penalties to be enforced should the company repeat the offence of laying mains without notice.

The Police Telephone System.—Our American contemporary, *Electrical Engineering*, has in its January number a complete description of the recently installed police telephone arrangements at Chicago. It seems that at the main office a communicating board providing for 30 different lines has been equipped, and that these lines in the majority of cases are connected with call stations in the public streets. These stations consist of a small iron erection arranged round one of the lamps at the edge of the pavement, and contain the usual telephone instruments in a well-arranged weather-proof case, and a large call-bell. This is used to call the policeman on that beat to the box in case the central office requires to transmit instructions. In an ordinary way the policeman reports himself by means of the telephone at ordinary intervals. The key admitting anyone to the telephone is kept by the policeman on the beat, but anyone of the general public can signal from outside the call-box to the exchange in case police assistance is needed. All the batteries required for the telephone are placed at the central office, so that there is no chance of their freezing, as they would do if placed in the streets.

Electricity Direct from Coal.—Prof. H. A. Rogers read a paper before the North-Western Electrical Association of America at Milwaukie on the 19th ult. on the above subject. From what we have seen of the paper it consists more of a *résumé* of what has been done rather than a record of any special work carried out by the author, who falls into the old error as to the wastefulness of the steam-engine. Thus he states that only 5 to 10 per cent. of the energy given by the coal is at present

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utilised by the steam-engine. Unfortunately only too many writers on this subject insist on considering the theoretical efficiency of steam-engines only. As everyone knows, the efficiency is taken on a comparison between the absolute temperatures of admission and exhaust, and could be extended to a reasonable figure if an absolute zero was obtainable for the exhaust temperature of a steam-engine. The author concludes his interesting summary of the various methods of obtaining electricity direct from coal by an expression of opinion, that the chance of success in inventing means to this end is much better if one attempts to oxidise hydro-carbons or carbon monoxide than if one attempts to act direct on coal.

Volenite.—Manufacturers of insulating materials have, of course, in a free country the right to name their wares as they please, but we regret to say that only in too many cases the name is chosen without any consideration of the character of the substance in question. At the present time a correspondence war is going on in the *Financial Times* between the representatives of "volenite" and "oxoline." We must confess that before we read this correspondence we thought that "oxoline" was some fluid extract of beef. We find that $\frac{1}{8}$in. of oxoline will stand a pressure of 35,000 volts. The supporters of "volenite" claim that $\frac{1}{8}$in. of their material will stand 80,000 volts. Of course all these claims for high resisting powers to disruptive discharges are quite valueless unless the mechanical and hygroscopic properties of the substances are suitable for use in electrical apparatus. In this respect we would remind the gentlemen in question that the craze for high insulation per mile of cable, has led to more faulty cables being produced than would otherwise have been the case. The makers of such cables may be compelled to attain the high insulation tests in their factory by means which have shortened the life of the insulation. In all such matters permanent rather than excessively high resistance is to be preferred.

The Electric Lighting of Trains.—Mr. Robert A. Ross contributes to the January number of the *Canadian Engineer* an interesting *résumé* on the electric lighting of trains. He divides the various systems which have been tried into five sections which he arranges in order of first cost, commencing with the cheapest. These headings are as follows: (1) a steam dynamo in the guard's van; (2) engine and dynamo in the luggage van, with a battery and accumulator in each coach; (3) a similar arrangement with a dynamo in the guard's van, the dynamo being driven off the axle; (4) accumulators in each car with charging stations at intervals along the line; and, lastly, a small dynamo and battery on each car, the dynamo being driven from the axle. The last two headings represent systems which Mr. Ross considers most useful in general practice. He advocates, however, in the fourth system that the charging stations should not be established for that purpose only, but that the required current should be taken from a lighting plant already in use. He considers that the chances of failure are greatest where the power is taken from an axle of a carriage, but even then the breakdowns recorded are very few indeed. Mr. Ross points out the difficulty of obtaining any correct figures as to the cost of the work, but considers it proved that the interest and depreciation account will be the largest item in the cost. Where the battery system is used and the batteries are charged at intervals, he advocates the use of high-efficiency lamps in order to reduce the weight and cost of the accumulators.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on Monday, Sir James Crichton-Browne, M.D., F.R.S., treasurer and vice-president, presiding. Nine new members were elected. The special thanks of the members were returned to Prof. Dewar for his donation of £100, and to Mr. Frank Clowes for his donation of £10. 10s. to the fund for the promotion of experimental research at low temperatures. The special thanks of the members were returned to Mr. C. E. Melchers for his donation of £50 for alterations in the lecture theatre. At the same meeting the following resolution was passed: "The members of the Royal Institution of Great Britain in general meeting assembled desire to express to his Grace the Duke of Northumberland their sympathy with him and his family in the loss which they, as well as the Royal Institution and the country at large, have sustained by the death of his father, the late Duke. They desire also to record their grateful sense of the invaluable services rendered to the Royal Institution by the late Duke during his membership of 48 years' duration; during seven terms of office as visitor and manager, and as president for 26 years; by his active and unfailing interest in its affairs, and in the progress of science, which it is its object to promote; by his generous benefactions to its funds; and by the true nobility of his character, which has lent distinction to its proceedings during an eventful period of its history." There was a large attendance at the Royal Institution last Friday night, when one of the regular conversaziones was held. A number of distinguished scientific gentlemen were present. The exhibits which were on view included the magneto telegraph recorder now being used by the Exchange Telegraph Company. This machine, which can be easily duplexed, delivers a message neatly printed on tape. The transmitter is of the Wheatstone A B C type, and may be easily worked by anyone.

Birmingham Association of Mechanical Engineers.—At a meeting of the above association, held on Saturday last, Mr. G. Conaty, of the Birmingham and Midland Tramways Company, read a paper on "Electric Traction, its Application in Large Towns." After a brief reference to the historical side of the subject, and an expression of opinion in favour of the municipalisation of tramways in large, self-contained towns, the author proceeded to compare the relative value and utility of the systems now before the public from the standpoint of cost and of mechanical efficiency. The open conduit system, he said, seemed to meet with most approval from local authorities, but the only advantage claimed was that poles and overhead wires were not required. Mr. G. Conaty expressed his opinion that with the extra cost of the conduit system, the best-paying lines must more than double their present earnings per mile of single track before they could, under such a conversion, pay their working expenses and pay interest and sinking fund. He also stated that the closed conduit system had not up to the present received many supporters, it having barely passed the experimental stage. The cost was said to be much less than the open conduit system, but to mechanical engineers the difficulties attendant upon keeping the delicate switching parts in satisfactory order must be apparent. On the general question of system, the conclusion of the author was that the Dickinson side contact system was the most suitable, and that its general adoption would remove all objection to overhead wires. The paper concluded by references to costs of electric traction, in which many useful figures were given in favour of the proposed change in Birmingham.

Staff Organisation.—On the organisation of a staff of an electric lighting station the success of the whole undertaking depends. In this matter two extremes are to be

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avoided: The first is that in which the chief electrical engineer will not allow his assistants any initiative in working the station, but insists on superintending every detail of it himself. However good a chief engineer may be, the time at his disposal is too short to enable him to do all this satisfactorily. The other extreme is that in which the assistants are made responsible, each for his own department, and are not properly ruled by the chief. In this case endless disputes arise between the different departments of the works, and each man fights for his own department alone. The happy medium is one in which, while the assistants are made directly responsible to the chief engineer for the work under them, all important changes are directly organised by the chief. Mr. J. F. C. Snell, the borough electrical engineer of Sunderland, adopts the following plan in the arrangement of his staff: the first assistant is entirely responsible for the whole of the work inside the generating station, and has under him the shift engineers, electricians, engine drivers, stokers, cleaners, etc.; the other assistant engineer under the chief has charge of the distribution system, and controls all the meter staff, the foreman of the mains, his men, and the trimmers of the public arc lamps. The other departments, such as the clerks, storekeepers, and also the drawing office, come directly under the chief electrical engineer. Each of the assistant engineers is made responsible for the time kept by the men under them, and for the ordering of all materials and stores necessary for the regular working of their departments. The head assistant also has to be in the station at the times of heavy load. By this system of organisation the individual employés are made responsible to one man only, and the whole staff works together as a harmonious whole, conducing to the efficiency of the working and maintenance of the electric lighting system.

Machine-Shop Management in Europe and in America.—Mr. H. F. L. Orcutt contributes to the January number of the *Engineering Magazine* an article on the above subject, in which he discusses the distinctive differences between the machine-shop management in Europe and in America. In this article he devotes himself almost entirely to the question of factory organisation and equipment, and does not discuss the great troubles which occur in some cases over the labour question. He states that the American manufacturer visiting Europe is invariably astonished at the great variety of work undertaken even by small shops. Thus, in one works, he would find the manufacture of boilers, engines, shafting, hangers, pulleys, small tools, and many other machines. The very opposite is followed by American manufacturers of machinery. Many concerns there devote themselves entirely to the manufacture of a machine, and sometimes only make one size of that. The result is that they produce such valuable machines as turret lathes in great perfection, and also at prices which defy competition. Another firm which the writer mentions devotes itself entirely to the manufacture of milling machines for the automatic reproduction of small parts. He points out that these machines, which are more or less automatic, can never entirely replace the hand tool, but that when worked together great economies are produced. The key-note, as far as the labour question is concerned, is inadvertently mentioned by the author when he refers to the fact that one workman will attend to a number of machines, varying from six up to ten, which are working in the automatic production of bicycle parts. The labour unions prevent this sort of thing being done here, with the result that certain parts of machines can be purchased in America and imported at about one-fourth the cost of similar articles in England. We have in our mind particularly the case of the gearing wheels used for electric tramway motors. The whole of this work in the United States appears to be done by one firm, and the low prices quoted can only be explained by the fact that the number of gear-cutting machines are worked by one man.

Financial Results from Electric Tramways.—We are please to note that the directors of the Blackpool and Fleetwood Tramway Company are able to recommend a dividend at the rate of 8 per cent. per annum for the past half-year. When it is considered that the company only commenced to carry passengers on July 14, this result is particularly noteworthy. During the period from this date to the end of the year over 734,000 passengers were carried, while the gross receipts amounted to almost £15,000. As the accounts show a profit of over £8,500, shareholders are to be congratulated in every way on their undertaking. We are also pleased to know that these results were obtained in spite of a deficiency in rolling-stock, which will be rectified by the purchase of more cars for the forthcoming season. The electric tramway between Blackpool and Fleetwood derives at present the greater amount of its traffic from visitors who flock in such numbers into Blackpool. We are sure, however, that in course of time the traffic between that town and Fleetwood for business purposes will be by no means inconsiderable. We regret that the same congratulations cannot be extended to the shareholders of the Waterloo and City Railway on the presentation of their balance-sheet for the first half-year of working. The accounts of this company when analysed show that the present earnings will not average more than £25,000 per annum, whereas a traffic value was expected of £40,000 or £50,000. We are sure, however, that the present number of passengers will be increased when the Central London is opened, and when the City and South London Company have completed their extension to Moorgate-street. Apart from all this, we fear that the cost of working the line is coming out more than was expected. The reason for this is not associated with any fault in the electrical plant, which has given great satisfaction in every way, but in the civil engineering work on the line. The sharpest curve which has to be negotiated under the river is so severe that the Board of Trade have cut down the permissible speed at this point to 15 miles an hour. This prevents any advantage being gained from the down grades, which were constructed to aid the trains in getting up speed. The corresponding up grades consequently call for a large amount of extra energy, which seriously increases the cost of the working.

Restricted Competition.—We have already referred to the proposed action at Fulham with respect to electrical supply companies. The Vestry is advised by its electrical engineer that tenders should be only asked from the following eight firms: Messrs. Siemens Bros. and Co., Limited, Messrs. S. Z. de Ferranti, Limited, The Brush Electrical Engineering Co., Limited, Messrs. Johnson and Phillips, Messrs. Mather and Platt, Limited, British Insulated Wire Company, Limited, Messrs. Crompton and Co., Limited, Messrs. John Fowler and Co., Limited. While we quite agree with the electrical engineer that any of the above firms could safely supply certain parts, or, in some cases, the whole of the work required in connection with the electric light station in the parish of Fulham, we still adhere to our previous conclusion, that to limit enquiries to these firms is unfair, both to the general ratepayers in the parish and to manufacturers as a whole. We do not consider it wrong in this case to refer to one or two of the prominent manufacturing firms who are not included in the above list. For instance, only two manufacturers of

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electric cables are included, and there is no reason why such well-known firms as Callenders, the India Rubber, Gutta Percha, and Telegraph Works Company, Limited, should not have equal courtesy paid to them as the firms mentioned. Then, again, as regards electrical plant, we see no reason why The Electric Construction Company, Messrs. J. H. Holmes and Co., Messrs. T. Parker, Limited, and others should not have the option of tendering for those parts of the work which they are quite capable in every way of carrying out. As to the inadvisability of restrictive competition on the part of the Vestry, it may quite easily happen with the number of firms which it is suggested shall be asked to tender that, in consequence of the exceedingly crowded state of their factories, only one or two will be able to quote in accordance with the terms of the specifications as regards the delivery. If this sort of thing is carried to excess there would not really be much advantage derived in asking for tenders from any but one firm, and in that case the engineering of the undertaking should also be left in the same hands. We gather that the report of the consulting engineer is to come before the Vestry for confirmation, and we trust the Vestry will insist on the specifications being sent to anyone who is willing to pay the usual deposit.

A Switchboard Breakdown. — The full report of Mr. William Johnson, the electrical engineer to the Corporation of Sheffield, on the breakdown in the supply which occurred in January is of great interest, and the promptitude shown in continuing the supply is a great credit both to Mr. Johnson and all his staff. It seems that at 6.23 p.m. four steam alternators (three of 500 h.p. each and one of 1,000 h.p.) were running together smoothly in parallel. Without a moment's warning one of the fuses connecting one of the 500-h.p. sets to the switchboard melted. At the same instant an electric arc flew out on the board, showing that the outgoing and the incoming part of the entire system of distribution had become electrically connected on the switchboard by means of the arc. The immediate effect of this was to divert from the supply mains all the current that was being generated by the machines, and to confine it within the limits of a circuit represented by the machines, switchboards, and conductors inside the station. The enormous energy thus pent up and restrained immediately caused three other fuses to melt on the switchboard, and at the instant of doing so two additional arcs were set up. The long tongues of flame and molten metal thrown out of the arcs naturally swept the platform of the attendants for a moment or two, but they succeeded in opening such switches as tended to minimise the destruction that was rapidly taking place. Steam was immediately shut off all the engines, and the power being removed, the arcs were stopped. The beginning to the end of this phase of the disaster occupied 20 seconds. As soon as the arcs were stopped the switchboard was found to be on fire in several places, due to the ignition of oil and sulphur used for insulating purposes, and these fires were smothered as soon as possible with sand and canvas cloths. The switchboard was seriously injured, and it was uncertain to what extent the electrical machines had been affected; but at 6.30 p.m. (seven minutes after the outbreak) the 1,000-h.p. machine was overhauled and cautiously run up on the Norfolk-street, High-street, Fargate, and Pinstone-street circuits, and was found to be all right. The same process was followed with all the machines, and one by one they were brought into use and found to be uninjured. At 6.45 p.m. the Haymarket, Angel-street, Exchange-street, and Wicker circuits were restored. At 7 p.m. Sheffield Moor, Sharrow, and Heeley were lighted, at 7.10 p.m. Division-street, Glossop-road, and all the western districts were connected. Messrs. Ferranti, Limited, the makers of the switchboard, are reconstructing the same to prevent, if possible, a recurrence of the accident.

A Company Meeting.—A correspondent who signs himself "H. B. L." sends us the following: "At an extraordinary general meeting of the shareholders of the 'Bad Light and Broke Company,' the report of the directors was received with jubilation, and, as a natural consequence, carried unanimously. It may be well to state that the meeting was not advertised as an extraordinary one, but it somehow 'went that way.' The chairman, in his opening remarks, stated that the joy of his existence was a meeting such as this, and that look where they would they could find but one ground of complaint in the conduct of their affairs and the financial position to which that management had brought them. (Prolonged cheers and cries of 'Let 'em all come.') Continuing, he remarked: 'I will at once mention this one little trouble to which I have alluded, and then indicate the manner in which we trust that it may be overcome, if not entirely, yet to so great an extent that it will not call for further mention. Our ground of complaint, then, lies in that we have not got, nor can we get, statutory powers similar to those enjoyed by that public company which collects its rates whether it has or has not sent anything through its pipes during the previous quarter. Could we but obtain such powers (and I may tell you that we have spared no effort in the attempt), we should indeed be in a proud position. However, after expending much thought on the matter, it has occurred to my colleagues and myself that we can obtain practically the same end by different means, and means which have the merit of greater simplicity. In short, we propose to acquire the sole rights controlling the use of the new "Ananias" meter, and once we can put these instruments in general use our standing will indeed be the envy of all. We know the old cry, "Cotton is king." To-day we may paraphrase it, and exclaim "Competition is king." Going yet one step further, we may confidently look forward to a time in the very near future when we shall have no competitors.' (Loud and prolonged ——.) 'Nor is this all. I would urge upon you the fact that your directors are a body of peculiarly able men. Another new departure, to be inaugurated in the coming year, has been most carefully arranged by the board. Briefly, it is our intention to offer handsome premiums to shareholders and the entire public.' The speaker paused here. And the pause was eloquent. The appearance of the assembled philanthropists was in itself enough to make the most ignorant realise the increased enlightenment of humanity. The silence was rendered even more impressive by the sobs of the emotional. One hoary-headed shareholder, leaning back in his seat and gasping, was distinctly heard to murmur, through his scarce parted lips, 'Rats.' The chairman went on: 'The details of this scheme it is now my pleasant task to unfold to you. The premiums to which I have alluded will in all cases be awarded for the best, longest, most mendacious, and widely circulated accounts of any accident or failure, connected however remotely with any electrical undertaking.' At the termination of the proceedings the enthusiasm reached its height. All the cheering accorded to all the sirdars in all times and in all places would have been as nothing to this. The chairman and directors were well-nigh torn limb from limb by the shareholders in their natural eagerness to embrace them." Our correspondent adds that he will be laid up for some time. He tells us that this is because it is his good fortune to resemble the chairman in appearance!

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THE PRACTICAL TESTING OF ELECTRICITY METERS FOR CENTRAL STATIONS.

BY C. A. L. PRUSMANN, A.I.E.E., ASSISTANT ELECTRICAL ENGINEER, BRADFORD.

(*Continued from page 105.*)

[The author desires to say that the forms, etc., given in the last article as in use at Bradford are similar to and founded upon forms he found in use at Manchester, arranged and introduced there by Mr. Wordingham.]

Connections and Terminals.—With reference to connections and terminals, more choice may be exercised in the arrangements of the meter department than in regard to any other matter. Several important points, however, will have to be taken into consideration when designing and arranging the connections and terminals. Of course, it is obvious that the number of meters to be dealt with, the amount of money to be spent, and the type of meter to be tested will very largely influence the decision. In the first place, we must remember that there are two great classes of supply stations — namely, continuous-current and alternating-current. Commencing with the continuous current station, let us proceed to see what connections and terminals are necessary, and then point out those differences which have to be made where alternating currents are employed. There are some towns which have adopted both systems of supply, and, of course, in these cases the test-room becomes much more difficult to arrange and design. But as these cases are comparatively few, we do not propose to consider our subject separately in regard to a combined station meter-room; but from details which will be given relating to the two classes of stations, there should be no difficulty whatever in so combining the two as to enable an efficiently-equipped meter-room to be the result.

The first question to decide before commencing the connections is, what general system is to be adopted? Having finally settled this point, all connections should, as far as it is possible, be carried out on those lines. There are three systems of running the leads, etc.—namely (1) bare copper rod or strip connections on insulators; (2) insulated wires cleated with wood cleats; (3) insulated wires run in wood casing in the usual manner. No doubt the first of these possesses very many advantages, and when properly arranged there is very little risk of accident. Perhaps in the case of stations using meters of large ampere capacity, it would be wise to adopt this method. But here again the introduction of the high-voltage lamp makes itself felt, and now in stations using the higher voltage a distinct advantage makes itself manifest in the meter-room in the smaller leads, connections, etc., while also the weight and often size of meter for a certain number of lamps are reduced. For the average supply station, however, insulated wires cleated by means of wood cleats are the best, and when neatly and carefully carried out, look very well. This applies to the leads only, copper strip being used along testing racks and such like places. In the section dealing with "The General Arrangements of the Meter-Room," it was stated that four testing circuits will generally be found to suffice for stations of an average size. Bearing this in mind and keeping before us the plan of the meter-room set forth in Fig. 1, we will trace each of these circuits from its source to its termination. In that way we shall see what is required in each case, as regards regulation, measuring, controlling, etc., and what terminals and connections will be required on each. Two of these circuits are set aside for the testing of ampere-hour meters, two for watt-hour meters. Commencing with the two ampere-hour meter circuits, and assuming that 40 meters is the maximum number ever tested in series at one time, a voltage of 50 volts should be obtainable. How is this to be obtained, and what is to be the source of energy? This question is of the most vital importance. The primary thing to be secured is a source of energy at the terminals of which the pressure remains practically constant. Secondary batteries answer this requirement admirably, and, whenever possible, a small battery of cells should be put down for meter testing exclusively; the number of cells, of course, depending on the number of meters to be dealt with, the 50 volts taken above meaning a battery of 25 cells. Even if only two or three cells can be obtained, they should be made the most of, as it is a great deal more satisfactory to carry out all meter testing from cells completely cut off from the town supply. The method of testing meters from a town supply, and direct from the lighting mains, cannot be too strongly condemned, on the grounds of expense, unreliability, and risk; in fact, the time spent in attempting to do so is, as a rule, so much time thrown away, the results nearly always proving worthless. If, however, special secondary batteries cannot be put aside, the next best thing is to obtain the necessary current from the cells across the town mains, using only the number of cells required. In this case a word of warning, however, is necessary. If it is required to have a batch of meters running near their top load capacity, great care must be taken to see the meters are disconnected. If the voltage should rise from any cause, such as when charging the cells, certain makes of meters at present used are seriously affected if overloaded, even to the extent of 3 or 4 per cent. Assuming now that we have set aside a certain number of cells, our next concern is as to their capacity. Considering for a moment the number of amperes required for the average installation, it becomes apparent that a maximum of 10 amperes at 230 volts will cover the majority of cases. If, therefore, we have our cells so as to give 100 amperes for some time we are provided with a source of supply, both as regards voltage and current, that will meet all ordinary meter testing. This, as already stated, supplies a means of testing meters up to 100 amperes capacity, a requirement which is sometimes met with in ordinary work. The question of testing meters of a much larger capacity, such as 1,000-ampere meters, used on station generators, etc., so seldom comes within the ordinary routine of work that one would not be justified in arranging the meter-room leads, terminals, etc., permanently to deal with currents of this magnitude. Greatly as the system of temporary connections in the meter-room is to be condemned as a general practice, yet in cases of the above kind temporary leads are quite justifiable, and the cells also may temporarily be connected in parallel to give the required current. The voltage needed is, of course, very low, due to the very small amount of resistance in the circuit. This disposes of the question of the capacity of the cells. The cells must be fixed in the room set aside for them, as shown in Fig. 1. Of course, all the usual precautions must be taken as regards the fixing and management of them, which are always observed in any well-kept battery of accumulators. On no account must the cells be fixed in the meter-room or near the testing instruments, as the acid spray given off would in a very short time prove detrimental to the instruments. The charging of the cells is most conveniently performed by means of a small motor-generator fixed near the cells and driven from the town mains. On the motor side of this arrangement should be fixed a double-pole switch and fuse, and also a wattmeter, of some satisfactory type. The speed of the motor must be capable of regulation, so as to enable the generator volts to be regulated as the charging of the cells proceeds. The generator side of the transformer, which should be shunt wound, must also be provided with a double-pole switch and fuse; an automatic battery cut-out should also be provided, together with an ammeter and voltmeter, the latter being connected by means of a two-way switch so as to enable the pressure to be taken across the battery and across the generator terminals. For charging the cells, the generator volts should be capable of being raised to 60 or 70 volts. The position of all the above switch gear may either be in the transformer-room or in the meter-room, thus keeping the whole of the switch gear of the department on one side of the meter-room. Overcrowding, however, must be carefully avoided, and if there is any likelihood of this happening, these switches, etc., should in that case be fixed in the transformer-room. Turning now to the watt-hour meter circuits, we find a pressure circuit is required besides the main circuit. This is best obtained from the battery across the town mains. Suitable resistances are connected in circuit with both

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series and pressure circuits to enable the proper values of current and E.M.F. to be obtained, and for keeping those values constant during a test. Suitable resistances for these purposes will be described later.

(To be continued.)

NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

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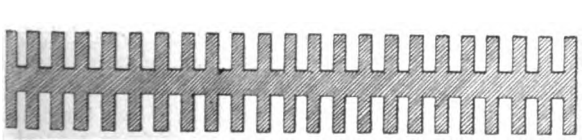
CXLVI.

Curve E embodies results which may be considered favourable in the case of an Epstein cell as heretofore constructed. Fig. 3 (p. 135) shows that, for the period of discharge of six hours, the storage capacity per pound of cell is 2·23 ampere-hours, the maximum storage capacity being about 2·3 ampere-hours. For the minimum period of discharge, it will be seen that $\frac{\text{ordinate}}{\text{abscissa}} = 1$ (nearly), this being the highest safe rate of discharge per pound of *cell*. It is to be feared that this form of accumulator, which does not appear to be now advertised for sale, affords an illustration of the danger attending the use of nitric acid to "open the pores of the metal," etc., as a preliminary to the process of formation (Sections IX. and XXVI.). This use of nitric acid, by which the surface of the lead plates is roughened and obtains a deposit of basic nitrates of the metal, is a very old process. It was essayed and speedily condemned by Planté, and was adopted in the original form of the Elwell-Parker accumulator. It is also, in a modified form, adopted in some of the newer forms of battery; the temptation being that it seems, *primâ facie*, to render unnecessary the lengthened period of formation which produces so perfect a layer of active material in the case of the Tudor peroxide plates, or, on the other hand, to dispense with any process for depositing peroxide from a solution of alkaline plumbate—a process which, in a perfected form, seems likely to afford excellent results. The ultimate dangers consequent upon the use of nitric acid for the purpose in view cannot, I think, be too strongly impressed upon both manufacturers and users of secondary cells.

Apart from the use of nitric acid, the Epstein plate is closely analogous in construction to the Tudor peroxide element. It is a plate of lead deeply grooved on both sides, so as to greatly augment the extent of active surface. The latest form of the plate is represented in section below.



The batteries constructed with grooved plates—including the Willard accumulator, that of Khotinsky, that manufactured in America by the Electro-Chemical and Storage Battery Company (Madden and Chamberland's patent) and those of the New York Accumulator and Electric Company and the American Battery Company — constitute an important section of the accumulators of the Planté type (with greatly extended surface). The other representatives of the Planté type are for the most part built up of laminated metal; they are represented by the old De Meritens and Kabath accumulators, by the "D.P." or Dujardin-Planté, the Rooney, in America, to which the Pritchetts and Gold accumulator in this country bears a strong family likeness, the Elieson "Lamina" and the Blot accumulators. As might be expected, the grooved Planté plates, in skilled and careful hands, are greatly superior in durability to those of the lamina type. Some of the latter will be referred to below.

CXLVII.

The Epstein cell, as recently manufactured by the Epstein Electric Accumulator Company, was preceded by the cell of the same name as manufactured by Messrs. Woodhouse and Rawson (Patents Nos. 6,214, 1882; 4,527, 1887; and 350, 1890). It was intended also to be succeeded by a cell with a rotating cathode (in charging) of zinc amalgam supported on a copper wire net (Patent No. 12,824, 1884). In the original process, the lead plates were boiled for several days in a *10* per cent. instead of in a *1* per cent. solution of nitric acid. By this process they were coated with a greyish-yellow deposit of basic lead nitrate about 40 mils (·04in.) in thickness. The plates were then dried in air, and the active material was reduced to metallic lead by making them cathodes in an electrolyte of dilute sulphuric acid *containing some copper sulphate.* Lastly, the plates intended for peroxide elements were formed in dilute sulphuric acid electrolyte containing pyrotartaric acid ($H_2C_5H_6O_4$). At one time I puzzled myself considerably to discover the occult reasons for the above additions to the electrolyte. They appeared to be counter-indicated by obvious considerations of prudence and economy—the one being a metal which is deposited upon lead from any of its solutions, and which, though removable from the anode to the electrolyte by charging, would remain on the spongy-lead plates to illustrate in a striking manner the phenomenon of local action; the other being a reducing agent, equivalent to five atoms of carbon with four molecules of water, to be oxidised at the expense of the charging current. I ultimately arrived at the conclusion that these ingredients were added from what some of our transatlantic cousins term "pure cussedness," or else by way of mortification and penance for past sins.

In regard to the most recent modification of the cell, Mr. Epstein, writing to the *Autocar* in January, 1896, said: "My company are at the present time manufacturing a type intended for traction purposes, which gives, with a total weight of 30lb., 150 ampere-hours, and this at an average potential difference of 2·3 volts." This accumulator, for reasons which have not been explained, failed to give satisfaction in practice.

CXLVIII.

De Meritens (Patent No. 1,173, 1882) originally constructed his plates with laminated lead about 16 mils (·016in.) in thickness. The thin lead sheet was folded backwards and forwards in strips 60 mils broad, so as to form a plate about this thickness. This was "formed" on the Planté system. It was found, however, that by reason of the expansion of the metal the strips came into contact with each other, so as to prevent free access of the electrolyte. This effect could, of course, be obviated by maintaining the strips at a greater distance apart. But a second difficulty then arose: the layers of peroxide, more especially at the edges of the strips, soon obtained a thickness of four mils and over, and when this happened the plate fell to pieces. After this discouragement, laminæ of greater thickness were used, but for various reasons, amongst which was the interest at that time taken in the "pasted" plate systems of Faure and Volckmar, the invention of De Meritens—though of greater merit than some of the more recently devised laminated plates—became neglected, and, in the electrical periodicals of this country at least, was scarcely, if ever, mentioned.

CXLIX.

M. de Kabath (Patent 287, 1883) made use of lead strips 40 mils in thickness and ·4in. wide. Strips 20in. in length were corrugated so as to reduce their length to 14·4in. These were arranged alternately with straight strips 14·4in. long, and were soldered together at the contact end; the sets being enclosed in a box of lead, parchment, or caoutchouc, perforated with holes. It may be of use here to remark—for it cannot be too often repeated—that the use of a conductive envelope, or of any surface of lead external to, or even on a level with, the active material, is, electrically speaking, a very serious mistake, resulting in loss of energy in charging, rapid corrosion of metal, and a lowering of E.M.F. and increase of resistance during discharge. The use of such a material as parchment would also be, obviously, a mistake; but a containing box of perforated vulcanite would be less objectionable, since it affects only the internal resistance of the cell. After a process of formation extending over six months—during which the gradually augmenting capacity of the cell could be practically utilised, on the condition of occa-

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sionally reversing the charge, after running down the cell—as much as 13·2 watt-hours, and 8·2 ampere-hours, per pound of plates was obtained; these figures indicating that the cell was run down until the P.D. fell to 1·6 volt. Referring to the diagram (Fig. 2, p. 134) it will be seen that this capacity compares very favourably indeed even with the results obtained in recent competitive trials of accumulators for traction. But it is to be feared that the prognostications of M. René Tamine* were justified soon after the maximum recorded capacity had been reached, and that the Kabath elements fell to pieces by reason of their electrical perfection. This catastrophe was doubtless in some degree hastened by the addition to the electrolyte of 1 per cent. of nitric acid during the first 200 hours of the formation.

CL.

In the original Dujardin accumulator, only the peroxide plate was constructed of laminated lead; the negative electrode in charging being a very narrow box of perforated lead or lead-antimony alloy, filled with a paste of spongy lead obtained by the reduction of the peroxide of the metal. The lead strips for the peroxide element are 32 mils in thickness and ·4in. in width; by a rolling process, or "spinning," they are obliquely corrugated, or cellules or depressions, forming projections on the opposite side, are produced upon them, to prevent the surfaces coming into contact. The strips are arranged horizontally, their ends on each side being united together by autogenic soldering. They are allowed freely to expand in the process of forming, the top and bottom bars of lead being severed in the middle.

The Dujardin-Planté elements are partly formed, or prepared for the forming process, by immersion, and by being charged as anodes, in a solution composed of one kilo of any alkaline nitrate, two kilos of sulphuric acid and 10 kilos of water. This solution is really one of an alkaline sulphate with free nitric and sulphuric acids. To regenerate the deoxidised nitric acid, air is forced into the bath with advantageous results.

The capacity of the original Dujardin-Planté cell has been stated to be from 6·5 to 6·8 ampere-hours per pound of plates; and mention has been made of a very light form of this battery with a capacity of from eight to nine ampere-hours per pound of plate. It may be wise, however, to take these figures *cum grano salis*. The capacity of the D.P. cell as manufactured in this country is, for a four-hour discharge, about three ampere-hours per pound of *cell*.

The high-discharge type of cell constructed in America by Mr. Rooney is very analogous to the above; the strips, which are alternately straight and corrugated, being formed in a nitrate solution. It bears some resemblance also to the Blot cell; since the strips, "burned" together at one end, and attached by the same end to a horizontal bar of lead, are disposed vertically, and are left free to expand, so that "buckling" is entirely obviated. The peroxide plates are, however, enclosed in a casing of perforated vulcanite.

* Tamine, "Récherches sur les Accumulateurs Electriques," p. 96.

A LARGE PARSONS STEAM TURBO-ALTERNATOR.

It is gratifying to know that at the present time, when we hear of so many orders for electrical plants being sent to America and Germany, that one of our prominent electrical manufacturers has succeeded in wresting an order from the German dynamo builders, in spite of the heavy import duty which will have to be faced. We refer to the fact that the firm of Messrs. C. A. Parsons and Co., of Heaton Works, Newcastle-on-Tyne, have an order on hand for two 1,000-kw. turbo-alternators, which are to be supplied to the municipal electricity works at Elberfeld. These machines are the largest which have yet been made by the firm, and it is evidently expected that their efficiency will also surpass record. The alternators are designed for 4,000 volts, and when running at a speed of 1,500 revolutions per minute will give a frequency of 50 complete periods per second. The general arrangement and design of the turbo dynamo and alternator, and also the arrangement for supporting them and their condenser, are shown in Figs. 1, 2, and 3. It will be seen from this that the machines are supported

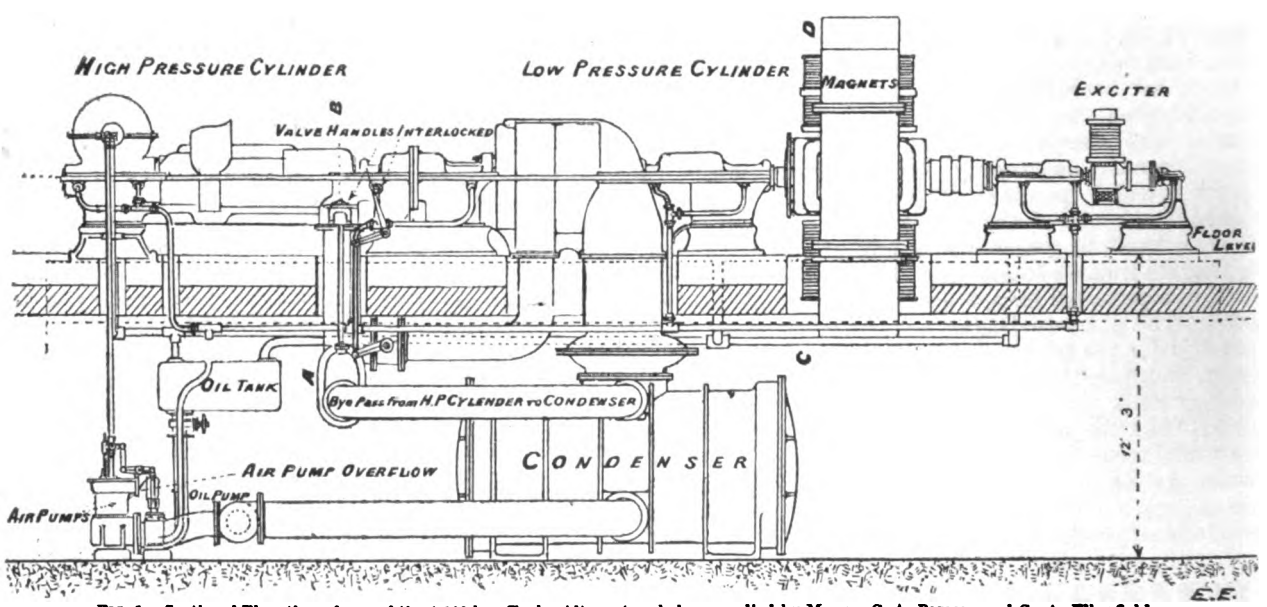

FIG. 1.—Sectional Elevation of one of the 1,000-kw. Turbo-Alternators being supplied by Messrs. C. A. Parsons and Co. to Elberfeld.

on iron girders, which extend longitudinally over an arched well in which the condensers are placed. The steam-turbines are of the horizontal-flow type, which the Hon. C. A. Parsons has developed to such a great state of efficiency in recent years. In the arrangement of the governors for these turbines several modifications are being introduced to ensure a constant speed and small variations, whatever the load may be. This will be done by the combination of the electrical governor used on previous steam-turbines and a Proell governor, which will be capable of hand adjustment. This further addition is needed, because the alternators would be required to work in parallel with each other and with other engine-driven alternators at Elberfeld. The electrical governor itself is to be capable of controlling the voltage to within 1 per cent. when 25 per cent. of the load on the alternator is suddenly switched on or off. The surface condenser which is supplied with each turbine will have 3,600 square feet of cooling surface. The air-pump used in connection with this condenser will be driven by a worm-wheel gear from the turbine shaft, and the oil-pumps will be also driven from the same gearing. As regards the efficiency of this set, Messrs. C. A. Parsons and Co. have guaranteed the following figures: with a steam pressure of 170lb. per square inch with 50deg. of superheat the pounds of steam required per kilowatt-hour is not to exceed 24½lb. at full load; at half load the steam

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consumption under the same conditions is not to be more than 26½lb. It must be remembered that these figures are for an alternate-current plant, and we are also assured by the contractors that much more economical figures are expected to be found on the trial of these machines in Newcastle.

The general design of the alternator can be seen from the illustrations, Figs 1, 2, and 3. It is of the four-pole type, with a drum type of armature. The conductors are buried in the iron core, which gives great mechanical strength to withstand the centrifugal force. The design of the machine is

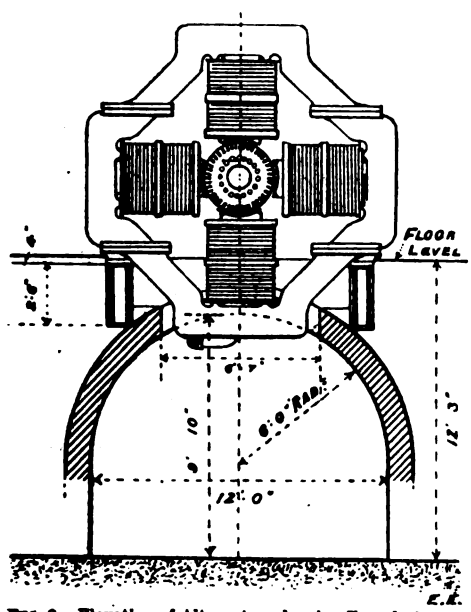

FIG. 2.—Elevation of Alternator, showing Foundations.

naturally simplified by the high speed at which it runs, and the makers have guaranteed that on a non-inductive load the fall in voltage at the terminals between no load and full load shall not exceed 6 per cent. The direct-current exciter for the alternators will be mounted, as shown by Fig. 1, on an extension of the main shaft. The whole weight of the 1,000-kw., including the condenser, air-pump, and pipes, will be about 85 tons. The remarkable fact, however, is the small amount of floor space taken up by these sets, which enables a large amount of plant to be placed in a comparatively small building. This point has been fully

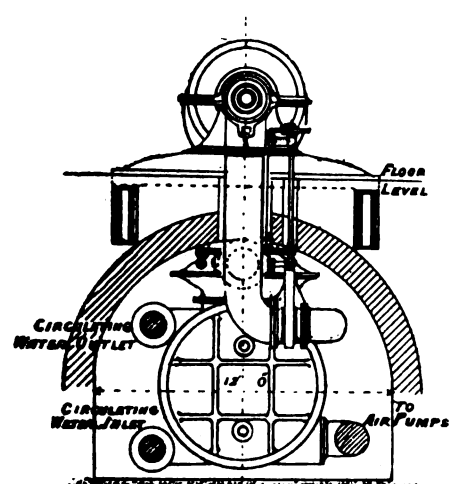

FIG. 3.—Section showing the Condenser Arrangements and Connections.

recognised by the Metropolitan Electric Light Company, in London, who have equipped one or two of their stations with these steam turbo-alternators. The reason why they were adopted, in the first instance, by the Metropolitan Company was the fact that, owing to the perfect balancing of their revolving parts, no vibration is transmitted to the foundations, and hence the machines do not lay the companies open to compensation claims from surrounding property owners. We understand that before these two large steam-alternators are dispatched to Elberfeld they will be submitted to extensive trials in Newcastle, at which the Corporation of Elberfeld will be represented by their consulting engineer, Mr. W. H. Lindley. On account of the large amount of steam required to run these big sets at full load, Messrs. Parsons and Co. have been obliged to lay down a large battery of new boilers.

THE ELECTRIC "TESTED LAMP" COMPANY'S LABORATORIES.

We were privileged on Wednesday last to inspect the laboratories and stores of the Electric "Tested Lamp" Company, Limited, at 15, Victoria-street, S.W. As this company has only recently come into existence, a few lines as to its objects may be of service as an introduction to the description of the equipment of the laboratories and stores. In the present state of the incandescent lamp industry the consumer has absolutely no guarantee beyond the maker's statement as to the quality of the lamps he receives. Although we do not wish to say hard things about the manufacturers of incandescent lamps, it is well known that they do not manufacture and sell for the good of the consumer only, but that the ultimate object of their being in business is to make money. We also know that practically all lampmakers agree to take back defective lamps if returned within a certain time of their being delivered, and that in the majority of cases they are called upon to replace a certain number of defective lamps. These defects, however, are only found out by the consumer in the event of the lamp refusing to give any light at all, owing to a broken filament, or when the lamp burns out after having been connected with the mains for an hour or so. The other defects in the lamp only show themselves after it has been used for some considerable time on the supply mains. The cost of such defects fall on the consumer only. The other point which at present is in a most unsatisfactory state is the want of uniformity in the watts per candle-power taken by the incandescent lamp. It is found, for instance, that in one batch of lamps sent out by a good maker the watts per candle may vary from three to at least five, while the candle-power itself varies over a much wider range, although all the lamps are supposed to be identical. As a result of all these considerations, the consumer, or, for the matter of that, the consulting engineer who advises his clients as to what type of lamp to buy, are almost entirely dependent on the commercial integrity of the firms with whom they deal. In our opinion, too keen competition is the chief cause why lamps which are not what they claim to be are put on the market. The wide variation in price between a 16-c.p. lamp at 1s. 9d. and another at 9d., can largely be explained in this way: in every manufactory, for every 100 lamps completed, a large proportion—often over one-third—will not pass the standard tests, and with good firms these lamps are broken up. The firms which quote such very low prices for lamps cannot afford to test each individual lamp with the thoroughness with which it ought to be tested; neither can they afford to reject such a large proportion of the lamps manufactured. To avoid all these difficulties, the Electric "Tested Lamp" Company has established a laboratory for the testing of incandescent lamps, and are prepared to stock and supply to the general public lamps of any make which shall be free from the above-mentioned defects. For example, this company guarantees that all lamps which have been stamped with their mark (a glow-beetle) shall give the candle-power specified to within 10 per cent., and the watts per candle to within 7 per cent. They also guarantee that the vacuum shall be good; and as a poor vacuum is responsible for the short life of a large number of lamps, this vacuum test is a most important one. The other points guaranteed are that the filament shall be uniform throughout and free from cracks or flaws, and that the lamps shall last at least a definite number of hours, varying with the class of lamp required.

The company on this point recommend that where the charge for electricity exceeds 5d. per unit, no lamp shall be allowed to remain on the circuit more than 500 hours. The managing director, Mr. A. W. Gattie, gave us the

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following particulars of two batches of lamps which he had removed from the Trocadero Restaurant and the Haymarket Theatre respectively. The reports of tests on these lamps we do not give in full, as it would not be fair to the makers of the lamps, seeing that the hours which the lamps had been lighted were not obtainable. Of the first batch of five lamps from the Trocadero, all were supposed to be of 16 c.p., and all were of different makes. The actual candle-powers were as follows :

Lamp.	C.P.	Watts.	Watts per candle-power.
A	14·24	53·5	3·75
A	10 24	54·6	5·33
C	13·44	63	4·68
D	11·52	53·5	4 64
E	13·44	70·3	5·23

The lamp marked D had a good vacuum, and the lamp marked E a very bad vacuum ; whereas in the other three lamps only a fair vacuum was found. The report goes on to show that whereas lamp A in the above condition gave 1 c.p. for 1,000 hours for 1s. 6½d. with electricity at 5d. per unit, lamp B will cost 2s. 2½d. per candle-power on the same basis. This conclusive figure is rather spoilt by the quotation per 1,000 hours, as the change in a lamp with time makes such a figure obviously unobtainable in practice. Still, the conclusion is obvious that the proprietors of the restaurant were using some lamps which it would pay them to throw away.

In the case of the Haymarket Theatre, six 8-c.p. lamps were taken at random from holders at different parts of the house. Two of these lamps were of venerable age, and were greatly respected by the authorities on that account. Unfortunately, their age was their only recommendation, as one lamp only returned 4·56 c.p. for an expenditure of 37 watts, while the other gave 2·71 c.p. for 24 watts. On the above basis of 1 c.p. per 1,000 hours, the cost of lighting the first lamp per candle comes out at 3s. 4½d., and that of the second 3s. 8¼d. The other four lamps gave rather more than their stated candle-powers, and ranged about four watts per candle. Two of them, however, had very bad vacua, so that their lives were not likely to be long. The two old lamps had good vacua, so that had Mr. Gattie not interfered they would have probably continued to take nearly nine watts per candle for many hours. This test shows how much supervision is needed.

Coming now to the routine in the laboratories of the Electric "Tested Lamp" Company, the lamps are, as soon as received from the makers, subjected first to a test for vacuum. The lamps are placed on a travelling belt, which conveys them through an alternating electrostatic field of carefully-determined intensity. The belt brings them into the field in a dark room, where an observer can rapidly pick out those that show by glowing that their vacuum is defective. Really good lamps in this respect are practically invisible. The lamps which pass this test are then tried for continuity of the filament and for flaws in the same. This is done by applying intermittent currents, which cause the weak spots to glow first, and so faulty lamps can be recognised, as cannot be done when these lamps are incandesced. When these two preliminary tests have been completed, the final trials as to candle-power and current consumption are made. The final and best method of carrying out these two tests simultaneously has not yet been settled, but the photometers are in regular work testing lamps, while at the same time the current at standard voltage is being read.

The arrangements now about to be tried for carrying out these two operations quickly consists in a revolving disc, equipped with a number of lampholders, into which lamps to be tested will be placed. This disc will be revolved step by step, and as each lamp comes opposite the photometer the current will be switched on automatically. The operator in the dark room having adjusted his paraffin block photometer correctly, the candle-power will be indicated to the operator outside, who has the ammeter under his care. Should the candle-power be within the prescribed limits, and also the watts per candle, the lamp will then be stamped with the company's "beetle" mark. It is proposed to interlock this stamp with the dials of the recording instruments, so that no inferior lamp can be so stamped. The lamps, when tested, are stored on convenient trays, of which an enormous number have been erected by the company.

The whole of the current required for the work is taken from accumulators. At present there are installed two batteries, each of 80 cells, of the Chloride Syndicate's R.G. type. Each battery has a 60 ampere-hour capacity ; a small battery of 80 cells of the Tudor type and 12 ampere-hour capacity has also been added. The whole equipment has been mostly designed by Mr. A. G. Seaman, who has taken great care in the selection of his standard instruments, and in the devising of methods to check these standards. For this purpose a Crompton potentiometer and several of the Ayrton and Mather reflecting instruments are being used. The company has also equipped a separate room for making life tests on the various makes of lamps for purposes of record. In this way they will hold at their disposal a complete series of curves as to the behaviour of incandescent lamps. We understand that all lamps which do not pass the required test are promptly returned to the makers, and that the company is prepared to supply tested lamps of any desired make. In this way the public can obtain any particular lamp they require, and can also be spared the annoyance of having to check, as far as they are able in a limited way, the lamps they receive. On the other hand, if they are not particular as to the make of lamp, they can in certain cases obtain tested and guaranteed lamps at comparatively low prices. This new undertaking seems to have in it every promise of success.

COMMERCIAL INSTRUMENTS FOR INDICATING AND RECORDING ELECTRICAL QUANTITIES, WITH A NOTE ON THE NEW ARON METER.

Mr. G. S. Shoults read a paper before the Northern Society of Electrical Engineers at the end of December last on the above subject, in which he goes most fully into the various questions connected with obtaining really reliable electrical instruments at a cheap price. Owing to the length of the paper, we have been obliged to condense it very much, but the illustrations which, through the kindness of Mr. Shoults we are enabled to give, will make the features of the paper more easily understood. The author confines himself exclusively to instruments used in the commercial applications of electricity as opposed to those used by pure scientists for absolute measurements. He points out that the practical development of electricity demands that instruments shall be readily obtainable ; that they shall be such as can be read by unskilled persons ; and that they shall be readily transferable. The first of this class of instruments to be produced was designed by Deprez, and afterwards in improved form by Messrs. Ayrton and Perry. The author points out that in these earlier forms it was not at all unusual to find that the instruments could not be used continuously, and that the voltages had only to be kept on for a short time to ensure them being burnt out. He also considers that the early failure of permanent magnets in England was unduly emphasised, and that this acted in keeping English instrument makers somewhat behind in the type of measuring instruments introduced by Weston, an American.

In laying down requirements for a really good class of switchboard instruments, the author expresses surprise that such large dials are favoured by consulting engineers, and Mr. Shoults considers that the large case, with practically nothing in it, should be replaced by a small case containing the mechanism, which could be sunk within the box of the board. To do this, holes of 5in. in diameter are required in the switchboard. The author considers that a 9in. dial is large enough for nearly all purposes, and that with a larger scale accuracy is sacrificed, as, although the intrument may be read from afar off the readings are not so reliable.

He next takes up the question of short-range instruments and the best way to obtain this, dividing his method into two as follows : (1) by so modifying the electrical or magnetic parts that there is no deflection to speak of till

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the voltage or current rises to the lower limit; when this is once attained the needle moves over a large angle for an increase of the voltage to the upper limit; (2) by lengthening the index until, with the normal expansion of the scale, a sufficiently long space is obtained between the working limits; in this case the electrical or magnetic mechanism is normal and the angular deflection small. In both these cases errors such as are found with large dials are to be expected, and the author does not think that a successful example of the first class really exists. Another objection to the first class is the absence of a zero mark, so that if anything alters in the movement there is no indication of it.

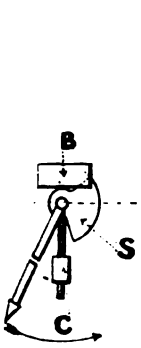

FIG. 1.

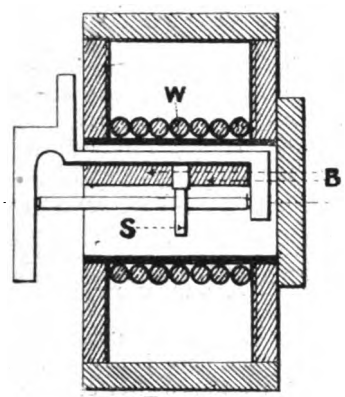

FIG. 2.

The author considers that the Lord Kelvin station voltmeter is a good example of the second class, giving a large scale for a small angular movement. These instruments have an error of $1\frac{1}{4}$ per cent., due to the heat of the current, which, however, is not a serious drawback, as a practically constant current is kept flowing. Mr. Shoults tested one of these instruments, and found that 10 watts were expended in it at the normal reading.

The next point considered is the extent of the errors due to stray magnetic fields. Of the instruments now in the market that are most free from the errors caused by such magnetic fields, the author classes the Cardew and other hot-wire instruments, both ammeters and voltmeters, electrostatic voltmeters, and all instruments of the D'Arsonval type when enclosed in stout iron cases. In experimenting with one of these latter instruments a large magnet caused only a variation of 0·5 per cent. when placed on an iron case. The permanent change was nothing. An electromagnet had a larger effect, but the conditions under which it was applied are not possible in ordinary practice.

In electromagnetic instruments which are not so expensive as the foregoing, the effect of stray magnetic fields may be avoided in two ways—one by screening, and the second by increasing the strength of the working field of the instrument. The placing of such an instrument inside an iron case is effective as a shield, but it is likely to induce in time larger errors than it eliminates. After referring to the instruments of this type by Messrs. Nalder Bros. and Thompson, and to Lord Kelvin's iron cages, in which latter instruments the method of increasing the working field is referred to, the author proceeds to describe the McWhirter standard instruments. The plan adopted by Mr. McWhirter is, as shown in the diagrams (Figs. 1 and 2), to replace the brass cheeks of the main coil of any ordinary electromagnetic instrument with cheeks of iron about $\frac{1}{4}$in. thick, and then to slip over the whole bobbin a tube of iron of like thickness; in this way an iron-clad coil is obtained, having its magnetic circuit almost complete when the movement of the instrument is placed in the hollow core. The iron-clad bobbin shields the movement from all cross fields in the same way that an outside iron case would, but the advantages possessed by it are that it is symmetrical in shape, and since it forms in itself the magnetic circuit of the instrument it is not liable to polarise. It is also obvious that for a given expenditure of energy in the winding a stronger field can be obtained than with a plain bobbin. Experiments are quoted to show that this shield reduces the error caused by certain stray fields from 30 per cent. down to as low as $\frac{3}{4}$ per cent. The author also claims that the meter-watt iron-clad bobbin can be used on alternating circuits as well as on direct currents.

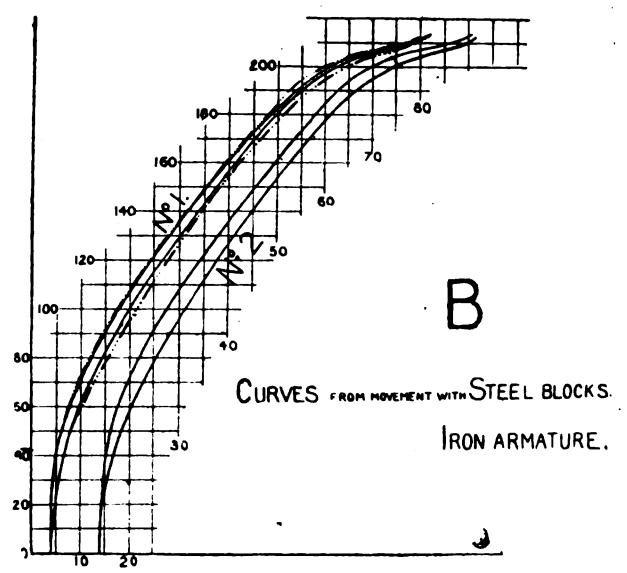

FIG. 4.

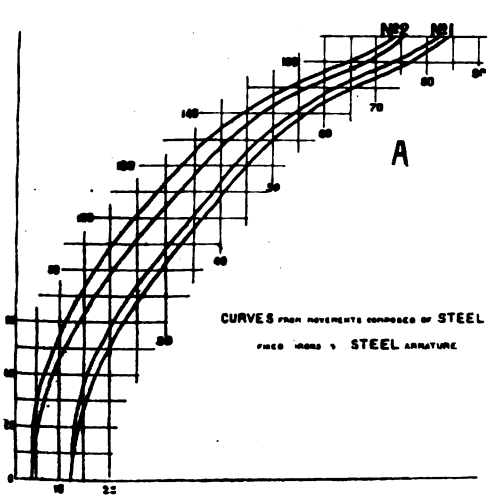

FIG. 3.

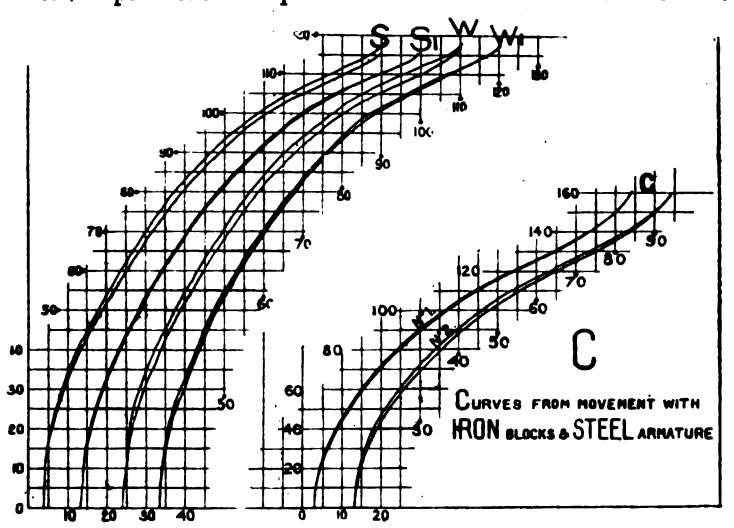

FIG. 5.

The next subject in the paper is that of residual magnetic effects in electrical machine instruments. Mr. Shoults combats the old idea that it was necessary to reduce the iron to a minimum in order to prevent this effect being present. In the curve shown in Fig. 3 the one marked S was taken with a brass bobbin, and the curves marked S^1 with an iron-clad bobbin. From these curves it will be seen that the quality of iron used need not affect the result. The curves were obtained by taking readings as the current fell gradually from a maximum to zero. It was then reversed, and gradually increased to a maximum again,

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In the other curves marked S[1] the current was broken at each step in the circle. The experiments show that the two methods gave practically the same result. The author further experimented with the Stanley movement, in which hardened pure steel was used in the place of soft iron with the idea of obtaining an exaggerated hysteresis curve. The results of these experiments are shown in the three pairs of curves marked A, B, C (Figs. 3, 4, and 5). In the curves marked A both the blocks and the sector were of hardened steel, the curves marked B had an iron sector and steel blocks, and the curves marked C were obtained with iron blocks and a steel sector. Mr. Shoults concludes that the last curves prove conclusively that the sector may be made of almost any sort of iron or steel, the hysteresis curves showing no larger deviations from those obtained by all-iron movement, as shown in the curves S S and 1.

Concerning the accuracy of commercial instruments, the author raises the point of how far accuracy should be sacrificed to convenience and price. He points out that one well-known maker guarantees at a special price an accuracy of one-tenth per cent., which is absurd with respect to some of the instruments sent out, as their scales do not permit reaching to this degree of accuracy. The guarantee should, in the author's opinion, be so worded as to cover the whole of the scale. After detailing the accuracy that may be expected from hot-wire instruments—D'Arsonval and other kinds—the author explains that accuracy and price are very closely connected, and that the demand for cheap instruments has much to do with the poor accuracy obtained.

In regard to foreign competition in measuring instruments, attention is called to the fact that the American types are well made and accurate; but, on the whole, the author considers that English instruments are more substantial and more satisfactory than those of foreign competitors. Mr. Shoults next proceeds to review the actual force used in various instruments, which he expresses as the torque per watt at a given radius. The following is the table he compiles:

Type of instrument.	Watts used in active part.	Torque per watt in grammes at 1cm. radius.	Degrees deflection.
Kelvin balance	70·9	25·19	—
Kelvin gauge	6·4	·295	45
Dolivo voltmeter	·8	·187	75
Stanley voltmeter	1·4	·139	72
Stanley-McWhirter	1·4	·195	72
Nalder voltmeter	·6	·415	70
Evershed voltmeter	1·17	·184	78
Weston pattern	·0012	472 0	84

At the end of his paper the author reviews briefly the large subject of measurement of alternating current and the measurement of power, but in these divisions, as in that devoted to resistance indicators, technical details are not so widely interspersed as in the first part of the paper, which concludes with a good account of the new Aron electricity meter, in which Mr. Shoults refers to the full description which appeared in our columns on July 9, 1897. In this carefully compiled paper the accuracy attainable with the Aron meter is given in detail, and special reference is made to the accuracy of this in recording the energy given to an inductive alternating current.

INSTITUTION OF ELECTRICAL ENGINEERS.

Rules for the Regulation of the Wiring of Premises for Connection to Public Supply Mains.

BY J. PIGG, ASSOCIATE.

(Continued from page 139.)

Besides the differences already noted, considerable differences exist in specifying the insulation resistance between mains in those instances where it is recognised. In this respect the two insurance companies whose rules have been referred to specify the insulation resistances required between mains in the same way—*i.e.*, it must not be less than that specified to earth. The actual values for any installation will, of course, differ to the same extent as the difference in their specifications of insulation to earth.

The rule of the Institution of Electrical Engineers does not provide for a test of the insulation resistance between mains, and many other authorities ignore such tests, so far as can be ascertained from their rules.

Some authorities specify that the insulation resistance between mains shall not in any case be less than 75,000 ohms, a value, in many instances, considerably lower than that exacted to earth. In one case examined the insulation between mains is to be not less than one-third of that specified to earth. In another case, however, the insulation between mains is required to be double that specified to earth.

Another point of some importance, brought out by an examination of the specifications, is the variation in the limit of insulation, as fixed by various authorities, at which the right is reserved to discontinue supply to an installation already connected to the mains, in consequence of a decrease of the insulation resistance from its original value.

As already stated, the Board of Trade limit for connection is $\frac{A}{10{,}000}$, and many authorities quote this as the limiting value of the leakage current allowable. In other cases, however, specific figures are given for the minimum insulation resistance after connection, and these range from 10,000 to 500 ohms.

Whilst considerable divergences in practice have already been found to exist in the specifications for insulation resistance, a closer examination reveals further differences.

The necessity for specifying insulation resistances is obvious, and arises from the importance of confining the value of the leakage *current* within safe limits. The author has no experience which would justify the assertion that "electricity can readily change to fire," but that fires may be the direct result of leakage is undeniable.

The strength of the leakage current from any installation depends, not only upon the value of the insulation resistance, but also upon the pressure acting across that resistance. Hence it would seem desirable that the insulation resistances specified should bear some relation to the pressure employed as well as to the size of the installation. Given a maximum leakage current, it is obvious that the insulation resistance which is just sufficient to confine the leakage from a 100-volt circuit within the limit imposed, will not be sufficient to do so for 200-volt or 250-volt circuits. Under such a condition, the insulation resistances of otherwise exactly similar installations would require to be proportional to the pressures employed.

The other factor determining the strength of the leakage current, the value of the insulation resistance, depends, in some proportion, upon the size of the installation. Other things being equal, the installation containing the largest number of lamps will have the lowest insulation resistance. It by no means follows, however, that the proportion existing between the insulation resistances of different installations will be so regular as would seem to be implied by the proportions given in some of the rules which have been considered—such as, for example,

$$R = \frac{p\,E}{A}, \quad R = \frac{R_1}{A}, \quad R = \frac{R_1}{N}$$

The insulation resistance obtained on any installation will depend greatly upon its design as a whole, the grouping of the means of utilising the power required, the number and character of auxiliary fittings, the design of the fittings employed and the care with which they are fixed and connected, and the character of the workmanship in other directions. The equations given above all assume that the means of utilisation of power increase in a regular order, and that leakage will increase in the same degree. In respect of the rate at which the insulation resistance will vary with the size of the installation, the equation

$$R = \frac{R_1}{n}$$

is nearer to the exact conditions obtaining.

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Consider the equation expressing the Board of Trade regulations already referred to

$$R = \frac{p\,E}{A},$$

where E = testing pressure, A = maximum current used, and R = the insulation resistance to earth or between mains, according to the points between which the testing pressure is established.

If E also equals the working pressure, we obtain the insulation resistance as to the ratio of the product of the working pressure by a constant to the maximum current used on the installation. Or, since $\frac{E}{A}$ equals the minimum conductor resistance, the minimum insulation resistance must be equal to the product of the minimum conductor resistance and the constant, or

$$R = r\,p.$$

It may also be noted that the results obtained are true resistances, and that no exception can be taken to the character of the equations obtained under the regulation.

If we further consider the equation $R = \frac{p\,E}{A}$, we find that the insulation resistances exacted by the regulation for installations taking the same maximum currents, but at different pressures, are directly proportional to the pressures; but for installations taking the same powers at different pressures, the insulation resistances are in proportion to the squares of the pressures.

This equation, as already noticed, assumes that the insulation resistances will vary inversely as the maximum currents employed. This, of course, is not quite correct for all cases. Given two installations with lamps of different candle-power, but of the same efficiency, and in other respects exactly alike, there is no reason to anticipate any difference in the insulation resistances to be obtained. The Board of Trade regulation, however, would require a higher insulation resistance for the installation containing the lamps of lower candle-power. In exactly the same way, it will be noted that in two installations, otherwise exactly alike, that in which lamps of the highest efficiency are used will require the highest insulation resistance to comply with the regulation.

The grouping of a number of lamps on one fitting will also tend to increase the insulation resistance obtainable, as compared with that obtainable with single lamps, owing to the number of points for leakage being diminished.

If the equations expressing the Board of Trade regulations are further examined we find that they furnish two methods of specifying insulation resistance in addition to that obtained indirectly by specifying the maximum leakage.

From $R = \frac{p\,E}{A}$ we may obtain: the minimum insulation resistance to earth, or between mains, must be such that, if tested with a pressure equal to the product of the constant and the working pressure, the resulting current shall not exceed that specified as the maximum current required for the installation.

From $R = r\,p$ we may obtain: the minimum insulation resistance must not be less than the product of the constant and the minimum effective conductor resistance when all appliances are in use.

Consider next the case of a specification the wording of which gives the insulation resistance of an installation as

$$R = \frac{R_1}{A}.$$

If E_1 = testing pressure, and C = testing current, we have

$$\frac{E_1}{C} = \frac{R_1}{A} \text{ and } E_1\,A = C\,R_1.$$

If we consider the first equation, we find that since the denominators of both members of the equation are of the same nature, a pressure must be the equivalent of a resistance; and from the second equation we are led to the conclusion that a power is the equivalent of a pressure.

Further, we see that unless the testing pressure is equal to the working pressure, neither member of the second equation has an actual existence.

If we consider the equation $R = \frac{R_1}{A}$ in the equivalent form $R = \frac{r\,R_1}{E}$, where r represents the minimum conductor resistance, and E the working pressure, we see that the insulation resistances required for installations using different pressures, are inversely proportional to the pressures employed.

In two installations taking the same maximum currents, but employing different pressures, the insulation resistances exacted under any one set of rules will be—

$$\frac{R_2}{R} = \frac{r_2\,E}{r\,E_2}, \text{ and since } \frac{r_2}{r} = \frac{E_2}{E},\ R_2 = R.$$

If the two installations take the same maximum powers at different pressures—

$$\frac{R_2}{R} = \frac{r_2\,E}{r\,E_2}, \text{ but since } \frac{r_2}{r} = \left(\frac{E_2}{E}\right)^2,\ \frac{R_2}{R} = \frac{E_2}{E}.$$

If the maximum currents required in the two installations are such as to make $r_2 = r$, then $\frac{R_2}{R} = \frac{E}{E_2}$.

Under the Board of Trade regulation the insulation resistances required in the three cases considered would be as under:

With the same maximum currents $\frac{R_2}{R} = \frac{E_2}{E}$.

With the same maximum powers $\frac{R_2}{R} = \left(\frac{E_2}{E}\right)^2$.

With currents in the same proportion as the pressures $\frac{R_2}{R} = 1$.

The strengths of the leakage currents in the three cases considered under this rule, and under the Board of Trade regulation, are set out below.

Under $R = \frac{R_1}{A}$	Under $R = \frac{p\,E}{A}$
Leakage Currents.	*Leakage Currents.*
$\frac{C_2}{C} = \frac{E_2}{E}$	Same maximum currents $\frac{C_2}{C} = 1$
$\frac{C_2}{C} = 1$	Same maximum powers $\frac{C_2}{C} = \frac{E}{E_2}$
$\frac{C_2}{C} = \left(\frac{E_2}{E}\right)^2$	Currents in proportion to pressures $\frac{C_2}{C} = \frac{E_2}{E}$

A very similar method of specifying insulation resistances is that adopted in some cases, in which the wording of the rule is such as indicates that the authors recognise that a *resistance* is not legitimately obtained by dividing another resistance by a current. Hence we find specifications which read as under:

"The insulation resistance . . . should not be less than the number of ohms which shall be indicated by the number resulting from the division of 40,000,000 by the number expressing the maximum current in amperes . . . ," which, if somewhat involved, has the advantage of being precise. In the actual results obtained this method differs in no way from that just considered. The only difference lies in the language employed to express the results desired. Obviously it matters little whether we call R_1 and A numbers only, or resistance and current respectively, so long as it is intended that the result of certain operations in which they are involved shall indicate the magnitude of a certain physical quantity. At the same time there is something to be said for precision of language, and against flagrant disrespect of dimensional units and their applicability to the identification of physical quantities.

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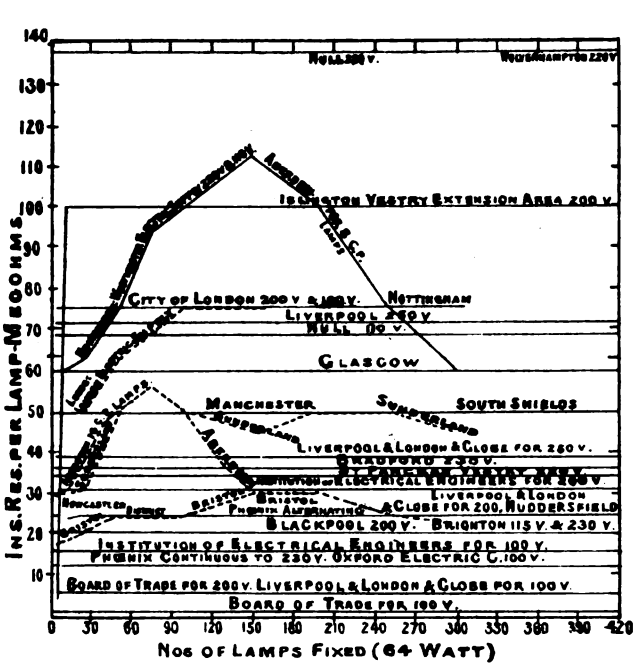
Some reference has already been made to the method of specifying adopted by the Phœnix Fire Office, and followed more or less closely by others. As already remarked, the specification named is based upon a practically constant resistance per lamp, although specific figures are given for installations containing given numbers. Hence the specification named is capable of being expressed in the general form $R = \frac{R_1}{N}$, which, of course, is the general form for specifications where the insulation resistance required is defined as the ratio of a constant resistance to the number of lamps fixed. The fact that R_1 is not constant for all specifications and, in some cases, not constant throughout the same specification has already been referred to, and no further comment is needed here.

Such a method of specifying the requirements to be met takes account of only one of the factors involved in the determination of the strengths of leakage currents—viz., the size of the installation—and that not in an exact way, as has already been referred to. The specifications ignore altogether the effect of the pressure employed, although in some instances where this form of specification is in use different pressures are in use or allowed.

One of the specifications which is drawn in a similar manner to that of the Phœnix Fire Office, specifies the figures for numbers of 33-watt lamps or their equivalent. The specification is not drawn on a regular basis throughout its whole range. Had it been so, the general form would have resolved itself into $R = \frac{R_1}{E\,A}$, which differs from any other form considered. As the value of R_1 varies at one point to a figure very nearly double that at either end of the range, the specification appears to be somewhat arbitrary.

Of the form of specification $R = \frac{R_1}{n}$, where n is the number of *points*, it is unnecessary to refer further to it than has been already done, except to point out that it also ignores the effect of variation in the pressure employed, and that, for the average installation, the insulation resistance exacted will be greater than where the form $R = \frac{R_1}{N}$ is in use, the value of R_1 being assumed to be equal in the two cases.


Ins. Res. per Lamp-Megohms
Nos of Lamps Fixed (64 Watt)
Hull 200 v.
Southampton 220 v.
Brighton Vestry Extension Area 200 v.
City of London 200 v & 100 v.
Nottingham
Liverpool 200 v
Hull 100 v.
Glasgow
Manchester
South Shields
Liverpool & London & Globe for 250 v.
Birkenhead 230 v.
Institution of Electrical Engineers for 200 v.
Liverpool & London & Globe for 200, Huddersfield
Bristol
Blackpool 200 v.
Brighton 115 v. & 230 v.
Institution of Electrical Engineers for 100 v.
Phœnix Continuous to 230 v. Oxford Electric C. 100 v.
Board of Trade for 200 v. Liverpool & London & Globe for 100 v.
Board of Trade for 100 v.

Probably the greatest differences in the various specifications are those that exist in the magnitudes of the insulation resistances exacted. In order to show these differences fully it is necessary to reduce them to a common basis. In the accompanying diagram the insulation resistances per lamp required under various specification are shown for 64-watt lamps in every case; and where the insulation resistance required depends in any way upon the working pressure, the pressure for which the value of the resistance per lamp is suitable is marked. As will be seen, the values of the insulation resistance required per lamp vary, with the higher pressures, between 138 megohms to 6¼ megohms, which is the Board of Trade unit for 200-volt supply. In the case of representative bodies, the diagram shows the insulation resistances required for the same maximum powers at different pressures. Thus, under the Board of Trade regulation, and the rule of the Liverpool and London and Globe Insurance Company, the insulation resistances are proportional to the squares of the pressures employed. Under the rule of the Institution of Electrical Engineers, and similar specifications, they are proportional to the pressures only. Under the Phœnix Fire Office rule they do not vary in any way with the pressure used. The diagram also shows in a very conspicuous manner the irregular character of the basis of some of the specifications examined.

If we further examine the various specifications, we find that those in which the insulation resistance of the complete installation is inversely proportional to the maximum current employed cover all classes of apparatus that may be used, whilst other forms of specifications have necessarily, or should, to be complete, to specify directly for other appliances than incandescent lamps.

Some diversity is also exhibited in the requirements for such special cases. In some specifications the insulation resistance required for motors and arc lamps is to be equal respectively to that required for the number of incandescent lamps taking the same *energy*. In other cases the insulation resistance is to be equal to that exacted for a certain number of incandescent lamps, irrespective of the power taken by the special apparatus specified for, or of the power required by the incandescent lamps which form the basis of the requirements for the special apparatus. In other cases, again, the insulation resistance is to be "to the engineer's approval," and in still other cases the requirements are not specified or referred to in any way.

In one case it will be noted that, although the insulation resistance required for motors follows from the insulation test for the complete installation, a minimum insulation resistance of one megohm is specified. In this case, on the basis of the insulation resistance required for the complete installation, the minimum is reached for a motor taking a little more than 3 e.h.p. Under the Board of Trade regulation, the insulation resistance would require to be only 230,000 ohms for such a motor. In another case in which the insulation resistance required for such a motor follows from the insulation resistance exacted for the complete installation, and would be, under the rule, two megohms, a minimum of 50,000 ohms is fixed. Under other rules of similar construction the insulation resistance required varies between 1 and 2¾ megohms approximately.

In other cases where the insulation resistance is specified in terms of a number of incandescent lamps irrespective of the power required, the minimum for any size of motor is two megohms.

In another case where the insulation resistance of an installation is specified irrespective of the power taken by those lamps, so far as the specification shows, the insulation resistance required for motors is specified as to be equivalent to that required for the number of lamps taking the same *energy*.

In the case of the use of arc lamps the conditions differ somewhat owing to the differences between the pressure required for one lamp of ordinary construction and the usual pressures of supply. Where the insulation follows from the prescribed insulation test, the result is not the insulation per lamp, but that per circuit of such lamps. Hence the insulation resistance per lamp will vary with the pressure and the current. Thus, under the Institution of Electrical Engineers' rule, the resistance exacted for a circuit of arc lamps taking 10 amperes would be one megohm, and under other specifications of a similar character four megohms. If these lamps are arranged two in series on 100-volt circuits, the insulation resistance per lamp would be two and eight megohms respectively. If arranged four in series on 200-volt circuits, the insulation resistance per

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lamp would be four and sixteen megohms respectively. Under the Board of Trade regulation the insulation resistances for 100-volt and 200-volt circuits would be 100,000 and 200,000 ohms respectively, and the insulation resistances, per lamp, 200,000 and 800,000 ohms respectively. Under other specifications of various construction, the insulation resistances per arc lamp, irrespective of the power required, varies between two and five megohms. In another case, where the insulation resistance of arc lamps is directly specified, the figures given are those which are expected *per circuit*, irrespective of the number of lamps on such circuit, and therefore independent of the pressure employed.

Another point in which some diversity of practice is apparent is the mounting of motors. In the great majority of cases motors are to be efficiently insulated from earth, together with all their accessories. This is varied somewhat in certain specifications by requiring the frames of motors to be earthed for pressures above a certain specified limit. In one case the limit is 250 volts. In another case it is 460 volts. In another case, however, the framework of motors is to be connected to earth by a copper conductor of a sectional area equal to that of the leads up to a maximum of 10 square millimetres.

Another point which may have attention called to it is the inference which might be drawn by anyone sufficiently depraved from the wording of a number of the specifications with reference to the testing pressure to be employed. In many cases we find that "*current* will not be supplied *if, when testing with a pressure of — volts*, the insulating resistance is below . . ." The italics are the writer's, of course.

Leaving on one side the fact that what is supplied is "power," and what is charged for is "work," the remainder might cause an enquiry as to whether resistance was dependent upon the pressure used in measuring it. Although it may be desirable *before measuring* to break down an incipient fault by the use of a higher pressure, the use of that pressure *for the purpose of the measurement* has no effect on the value obtained.

At the same time it may be worthy of consideration whether the use of a pressure higher than that used in working, of such values as are ordinarily available, is of much use in breaking down an incipient fault under the ordinary conditions of wiring. It is not desired to advocate a return to the method of testing which has been described as being done with "a forty-guinea bridge, a leaky cell, and a detector which stuck on the slightest provocation," but it would seem to be a particularly bad case upon which the usual testing pressures would have the desired effect, the more especially as the testing battery or generator seldom has much power. The real object of testing insulation resistance is the ascertainment of the leakage to be expected under working conditions, although this seems to be sometimes partly lost sight of, and it would seem, seeing that no greater pressure is to be applied in working, that the working pressure would be most suitable for testing. There are, of course, cases where higher testing pressures may be of advantage, but these are in the case of installations which have become defective.

(To be continued.)

At last night's meeting of the Institution of Electrical Engineers the following were the candidates balloted for.

Member.—F. H. Jackson, 16, Edwardes-square, Kensington.

Associate Members.—E. E. Craig, 37, New King-street, Belfast; E. Geipel, Electricity Works, Chatham; W. F. Jones, 55, Monton-road, Eccles, near Manchester; A. W. Marshall, 180, Loughborough-road, Brixton, S.W.; D. G. Shephard, 4, Queen Victoria-street, E.C.; F. L. Todd, 64, Victoria-street, S.W.; C. E. Wilson, care of the Telegraph Manufacturing Company, Helsby, near Warrington.

Associates.—F. R. Batty, 1, Commercial-street, Bradford; E. S. Dissanaike, the Technical College, Colombo; J. P. Gregory, jun., 48, Sydney-street, S.W.; W. E. Milns, Chapeltown, near Sheffield; J. H. M. Wakefield, Engineering Department, Post Office, Leeds.

Students.—C. N. Moberly, care of Rev. C. L. Vashon-Baker, Stanford Parsonage, Loughborough; P. G. Moore, The Limes, Mount-street, Derby.

THE WILLIAMSON AND JOSEPH HIGH-VOLTAGE LAMPHOLDER.

The above firm have sent us one of their new patent lampholders, which shows how impossible it is to say when ultimate improvement has been reached in any matter. Lampholders seemed such a well worn subject that we should not have expected such a radical alteration as Messrs. Williamson and Joseph have made. In their new holder, illustrated in Figs. 1 and 2, the porcelain body is made in two parts, which are clamped together by the

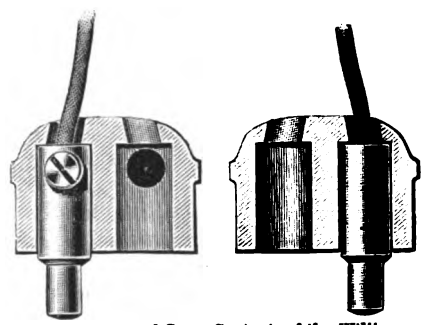

FIG 1.—Porcelain Segments and Brass Contacts of the Williamson and Joseph High-Voltage Lampholder.

brasswork of the holder. The result of this sectional construction is that all the live metal used in the body of the holder can be completely encased. The two pieces of porcelain thus fit round the brass contacts, which also form the terminals, much in the way that the two shells of a walnut encase the kernel. The screws clamping the flexible or other conducting wire in these brass contact pieces fit into recesses in the porcelain, and prevent the contacts from revolving and working loose. This can be readily seen by Fig. 1, while Fig. 2 shows the two segments in the brasswork ready to be clamped.

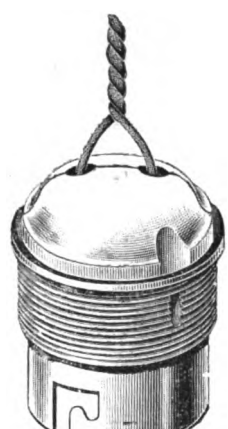

FIG 2.—View showing the Segments in place.

While this holder gives great facilities for rapid wiring, the dangers from the usual faults of hurrying are greatly minimised. Thus loose ends of flexible wire can be readily seen when the individual wires are attached to the separate contacts. Again, the danger from the screws which clamp the wire becoming shorted on to the brasswork is entirely avoided. We are told by the makers that the porcelain they use has been most carefully selected to secure non-hygroscopic qualities. On the whole we are very pleased with this new type of lampholder, and it appears to us to be so designed as to facilitate its accurate and cheap production in quantities.

CORRESPONDENCE.

ELECTRICITY AS AN EXACT SCIENCE.

SIR,—Assuming that it was from a position of stupid isolation that I ventured to ask Mr. Fahie for an explanation of his letter in your issue of 20th ult., I would now tender my apologies for having been "unnecessarily severe." I trust that Mr. Fahie will add to his former kindness by accepting this apology.—Yours, etc.,

HOWARD LITTLE

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PARLIAMENT, MUNICIPALITIES, AND TRAMWAYS.

During the current session Parliament will have to consider Bills of the nature as proposed by Manchester in reference to Manchester Corporation tramways. It will be just as well that the aim and scope of the Manchester Bill should be fully known and widely discussed, inasmuch as, if passed, it is a measure of a far-reaching kind. Practically, the matter comes to this. The Manchester Corporation, as the greatest and wealthiest central authority, makes up its mind to control its tramway system, and finding its own system connected to the systems in areas pertaining to surrounding authorities, agrees with or terrorises these authorities into agreement, so that it becomes the promoter of a combine—to be run at its risk, and possibly to its advantage. There are various points raised for consideration. The most important of these, perhaps, are: (1) Is the working of a tramway system within the sphere of municipal action? (2) What conditions ought to prevail in order to justify a municipal authority pledging its own rates to carry on operations outside its own area? For many years past we have persistently contended that the working of tramways lies outside the true sphere of municipal action, hence, so far as we are concerned, the conditions stated above do not command favour. Let us see how far our description of the measure is warranted. In the *London Gazette* of Nov. 22 last, on pp. 7,123-4-5, will be found the usual pre-description of the proposed measure. Among other things we are informed the Act is—

"To confirm and carry into effect any agreement or agreements entered into between the Corporation and the Urban District Councils of Failsworth, Droylsden, Audenshaw, Gorton, Denton, Levenshulme, Heaton Norris, Moss-Side, Withington, and Stretford, severally and respectively," etc. . . .

"Also the following local authorities—namely, the Mayor, Aldermen, and Burgesses of the boroughs of Salford, Oldham, Stockport, Ashton-under-Lyne, Stalybridge, and Eccles, and the Urban District Councils of Swinton and Pendlebury." Authority is to be taken for the "payment, collection, division, and apportionment of rents, tolls, rates, and charges arising from such tramways and traffic." Further, authority is taken to "empower the Corporation to work the city tramways and outside tramways," etc.; also "to construct, maintain, and use dynamos and other electrical apparatus, "etc.

Enough has been said to show the wide-spreading character of this Bill. It may be perfectly true that the proper organisation of the working of these tramways is best carried out by a central authority. It may also be perfectly true—though the assumption sounds almost incredible—that a corporation department is the best way to obtain it, as well as the best central authority. From a purely selfish point of view, electrical engineers ought no doubt to welcome this interposition of Manchester, in that it would bring a great accession of electrical work to the industry. But the whole question is of far wider import than is connected with this one Bill. Here seventeen or eighteen adjoining authorities are concerned. Why not a couple of hundred? Why not fill

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South Lancashire with tramways? Why not extend to London or to Bristol and on to Plymouth? Surely the most elementary knowledge of tramway work must show that the system at present mapped out under this Bill is incomplete. There are extensions needed, and in all probability more will be needed. Will the Corporation of Manchester exploit these extensions, or will they leave the field open till private enterprise has shown that extensions will pay, then promote another Bill for compulsory purchase? Tramway working is trading pure and simple, and every principle underlying municipal action is against municipal trading. In the discussion on Mr. Davies's paper at the Society of Arts, the Attorney-General, Sir R. Webster, said: "Not only was the power of a corporation to earn money as traders quite a modern development, but in the beginning of the reign it was contrary to law." He went on to state "that was not a mere accident owing to the want of development of modern enterprise, but was due to a sound system of political economy, that it was almost impossible to put the burden of a trading undertaking on the right shoulders, and so to regulate the charge that you did not put a burden on those who derived no benefit." The laws of political economy have long since had no terrors for municipal authorities; they are daily broken with seeming impunity, but nature in the long run will undoubtedly assert itself and demand a recognition of these laws. Meanwhile, as corporations can take few, if any, risks, and only step in as traders where success is assured, are the members of the community who are members of the municipal areas going to stand aside when, after risking the initial and experimentary losses to prove a thing practical, their returns for these expenses are taken from them and turned into the coffers of the trading authorities. We have ere this discussed the matter from another standpoint. It is a retrograde movement, and will, instead of leading to improved street surfaces and assisting to get rid of the troubles of present-day traffic, rather tend to perpetuate bad road surfaces and congested traffic. Our text is and will be, The best possible road surfaces, subways, with traffic carried out by means of motor-worked vehicles, obtaining the greatest flexibility with the greatest economy.

REVIEWS.

Die Ankerwicklungen und Ankerkonstruktionen der Gleichstrom-Dynamomaschinen. Third edition. By PROF. E. ARNOLD. Julius Springer (Berlin), and R. Oldenbourg (München). Price 12 marks.

Excellent as were the earlier editions of this little book, the latest one shows abundant signs of further extension and improvement. We cannot do better than briefly survey the extent and nature of the changes introduced. In the first place, we find that the first chapter—which deals with the generation of a continuous current, and the development of the multipolar from the bipolar winding, including general rules relative to the connections—has been entirely rewritten, being, in its present form, well calculated to give the reader a clear insight into the origin of the different forms and modifications of windings. What are known as series-parallel windings are also dealt with in the first portion of the book in a very thorough manner, inclusion being given to a modification introduced by the author which has found extensive application on the Continent for multipolar machines. Not the least noteworthy addition is, perhaps, a chapter dealing with the execution of closed armature windings, with special reference to sparking at the commutator, and armature reaction, wherein we find the windings originated by such well-known men in the electrical world as Messrs. J. Swinburne, C. E. Brown, and W. Sayers fully described and discussed. In the same chapter the phenomena pertaining to the short-circuiting of the coils are mathematically treated, whereby many interesting deductions are arrived at.

Passing on to the second part of the book, which deals fairly exhaustively with the constructional details relating to continuous-current machines, we find that many new types of construction have been added, and since the principal dimensions, particulars as to the winding, and the bore of the field magnets for each armature are given, the electrical and magnetic particulars concerning the armature may be, of course, verified. The text, it may be added, is illustrated with upwards of 400 diagrams and curves, besides which there are 12 sets of working diagrams drawn to scale, and a useful table giving the dimensions and full particulars relative to 24 different types of construction. These diagrams, etc., greatly enhance the value of the treatise, which cannot fail to be of great service in the hands of the student, not to mention the practical man, to whom it likewise appeals.

FORTHCOMING EVENTS.

FRIDAY, FEB. 10.

Royal Institution.—At 9 p.m., "The Motion of a Perfect Liquid," by Prof. H. S. Hele-Shaw, LL.D., M.I.C.E.

Institution of Junior Engineers.—At Westminster Palace Hotel, at 7.30 p.m., joint discussion with the Architectural Association on "Factory Design," by Mr. J. H. Pearson.

Institution of Mechanical Engineers.—At 7.30 p.m., "Evaporative Condensers," by Mr. H. G. V. Oldham.

Physical Society.—At 5 p.m, annual general meeting and a paper by Mr. Benjamin Davies on "An Ampere-meter and a Voltmeter with a Long Scale."

Institution of Civil Engineers.—At 8 p.m., students' meeting, paper to be read by William Middleton, Stud.I.C.E., on "The Electrical Driving of Engineering Workshops."

SATURDAY, FEB. 11.

Institution of Electrical Engineers.—At 2.30 p.m., visit of students to the Shoreditch Central Station, Coronet-street, Shoreditch.

Royal Institution.—At 3 p.m., Lord Rayleigh, M.A., D.C.L., F.R.S., on "The Mechanical Properties of Bodies" (first lecture of a course of six).

TUESDAY, FEB. 14.

Institution of Civil Engineers.—At 8 p.m., "The Lake Superior Iron Ore Mines and their Influence upon the Production of Iron and Steel," by Mr. Jeremiah Head, M.I.C.E., and Mr. Archibald P. Head, A.M.I.C.E.

Liverpool Self Propelled Traffic Association.—At Royal Institution, Liverpool, at 7.30 p.m., "The Application of Steam to Self-Propelled Road Vehicles," by Mr. W. Norris, A.M.I.C.E., M.I.Mech.E.

WEDNESDAY, FEB. 15.

Society of Arts.—At 8 p.m., "The Balloon as an Instrument of Scientific Research," by the Rev. John M. Bacon, F.R.A.S.

THURSDAY, FEB. 16.

Institution of Civil Engineers.—At 2.30 p.m., students' visit to the works of the new Vauxhall Bridge.

VERITY AND STEELE'S NEW PATENT HIGH-TENSION SWITCH AND FUSE.

We have this week inspected at the offices of Messrs. Verity's, Limited, King-street, Covent Garden, their new types of high-tension switches and fuses which they are just putting on the market. These instruments have been designed by Mr. Louis J. Steele, the chief electrician to the firm, and are being manufactured in quantity so that orders can be fulfilled promptly. The switch is illustrated in Figs. 1 and 2. Fig. 1 shows the front view of the switch when open, and Fig. 2 the back view of the same switch when closed. All the metal work seen in Fig. 1 projecting above the marble base-plate is absolutely safe to handle

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when the switch is off. When the switch is on, the only parts accessible from the front which are at a high potential used in the circuit are the contact bars, which can be seen behind the ebonite plate at the end of the lever. These contact bars are insulated thoroughly from the lever to which they are attached, and the ebonite plate forms an efficient protection to everyone but the intentional suicide. The high-tension parts of the switch, which are mounted on the back of the marble, are enclosed in a cast-iron case, as can be seen in Fig. 1. The leads go into

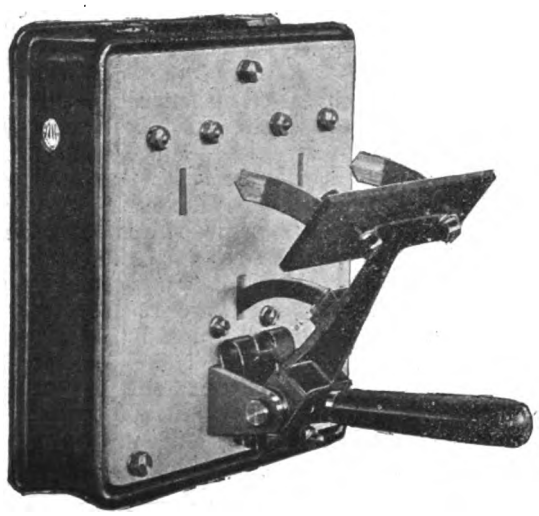

FIG 1.—The Verity-Steele High-Tension Switch when Open.

this to the terminals through bushed holes in this cast-iron case. Other two holes allow of a screwdriver being inserted to connect up the switch. The view at the back of the marble plate, shown by Fig. 2, illustrates an additional safeguard against accidental contact. The insulating sheet represented by the dark rectangle, which extends right across the surface, is moved up by means of a connecting rod attached to the main switch lever by a circular strut. This shutter entirely closes the hole through the marble when the switch is off, so that it is quite impossible to get a shock. It seems to us that to

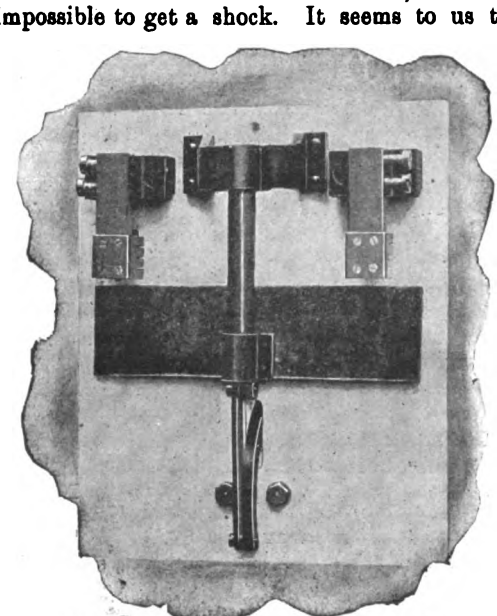

FIG. 2.—Back View of the Switch when Closed.

make this safeguard absolute, the holes left for the screwdriver must also be plugged. Apart from the safety of the switch, its mechanical construction is good, and the electrical contacts are ample in every way for the current they are designed to carry. An ingenious locking gear is provided on the main axle of the lever, which locks the switch in the "on" position against all vibration, or even against mechanical force applied to the switch lever. The plate which locks this lever is released by the main handle before the force is applied to break contact. The switch lever has a quick break, owing to a spring being introduced between it and the actuating handle. These switches are made both single and double pole, in which latter case an insulating link is used between two switches and worked by a common handle. The high-tension fuses of Mr. Steele's design being manufactured by this firm are illustrated in Figs. 3 and 4. Fig. 3 shows the fuse complete, and Fig. 4 shows the same after the fuse has been blown. The main principle underlying this fuse is that of quenching an arc by means of oil. A fuse wire goes through two contacts on the porcelain bridge-piece, seen on the front of the illustrations, through a glass U-tube, which is filled with a thin rosin oil. The weight of this tube and the oil is supported by a fuse wire. When the fuse

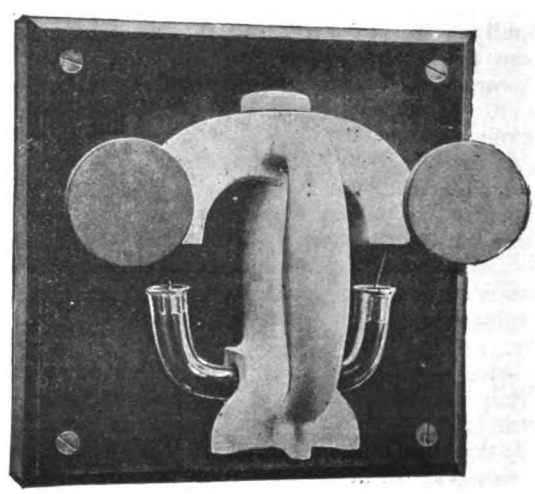

FIG. 3.—The Verity-Steele High-Tension Fuse.

goes the U-tube falls down to a range of about 1in., which draws the fused end down right under the oil. That this action is successful in quenching an arc is well known by the success of the Ferranti oil fuse, in which the same method of quenching is used. The two high-tension connections of this fuse are secured to the base by means of screws provided with large ebonite heads as shown in the illustrations. When these are slackened, the whole of the porcelain can be removed easily and the fuse replaced without difficulty or danger. By twisting a fuse wire round itself at one end and leaving it single at the other, the break always occurs at the one side and just above the oil. In this way the arc is always obtained at the one point and the wire is always drawn under the oil.

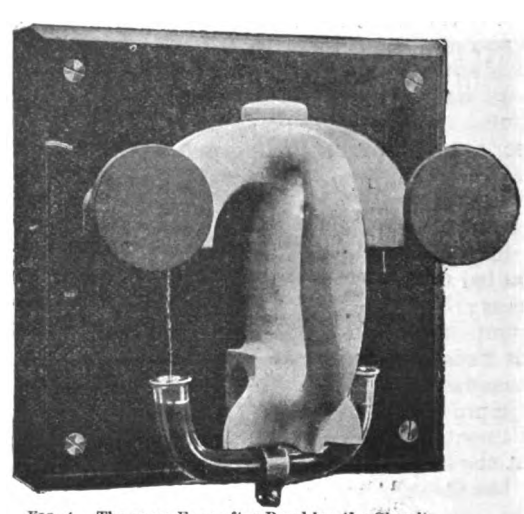

FIG. 4.—The same Fuse after Breaking the Circuit.

The advantage specially claimed for this fuse, beyond its safety, is that the terminals are in air, and hence can be kept clean easily.

NERNST'S ELECTRIC LIGHT.*

BY JAMES SWINBURNE.

Before describing Nernst's invention, it may be profitable to spend a few minutes reviewing the position of electric lighting. The whole industry is at present controlled by the incandescent lamp. We are so accustomed to this, and

* Paper read before the Society of Arts, Feb. 8, 1889.

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it is taken for granted in such an unconscious way, that we do not realise how much everything depends on the maker of the carbon incandescent lamp.

In very early days—that is to say, in the early eighties—there were a few Edison lamps at 100 volts, with an efficiency too horrible to mention, but the Swan lamp came along made for 50 volts. I say made for 50 volts advisedly; I mean that the makers tried to make 50-volt lamps, and produced lamps taking from 40 to 60 volts. If the lamps were not bright enough you ran the engine faster, or put a smaller pulley on the dynamo. (The belt then generally slipped; but that is not to the point) For about four years, which is a long period in the development of such a rapidly-growing industry as electrical engineering, the makers of incandescent lamps, or, in fact, the makers of the Swan lamp, decreed that the E.M.F. used should be from 40 to 60 volts. There was no appeal. There was no development of central-station supply at that time, but still, even then in large buildings, there was the longing for higher pressures on account of the cost of the mains.

About 1885 the Swan 100-volt lamp came into use. It was a clumsy affair with little loops of platinum at the sides. At first the lamps were pretty bad, but they gradually improved, and 100 volts, or in some cases 110 volts, became the recognised pressure for electrical supply.

As town lighting from central stations came into being, the limit of 100 volts became a serious trouble, and the evil was partly mitigated by the use of three or even five wire systems. I must point out that the incandescent lamp exercises its tyranny in two ways. It not only insists on a low pressure, such as, say, 100, and thus demands large leads to feed it, but it is so sensitive to variations of pressure that the system of distribution has to be arranged to give a practically uniform pressure at the terminal of the lamp. The necessity for uniform pressure probably gives more trouble and costs more than the mere low pressure, and it would be cheaper to supply at 100 volts with a good margin of permissible variation of pressure than supply at 200 with a very small percentage of variation.

Quite lately the incandescent lamp makers have produced things called 200-volt lamps, and some make them for 250 volts. So there is a general tendency on the part of supply companies to jump to a 200-volt supply. The innocent consumer is therefore pressed by the company to chang over to 200 volts. The company likes the change very much, and the lamp maker also enjoys it, as he makes more lamps and charges more for them.

Considering the enormous importance of the incandescent lamp, its improvement has received extraordinarily little attention. It limits us as regards pressure, it used to hamper us by its cost, it limits us as to variation of pressure, and it limits us very seriously by its inefficiency. Yet, in spite of these, the carbon incandescent lamp has made practically no advance in 15 years. Of course mere detail improvement in manufacture has taken place, and this has led to better quality and greater uniformity, hence cheapness; but there has been no radical improvement. The jump to 200 volts from 100, or from 50 to 100, did not depend on any sort of radical improvement in the incandescent lamp; it was merely the result of detail improvements making it possible to produce long thin filaments. Other things being equal, it is easy to see that the long thin filaments must be weaker. If the carbon has the same specific resistance, the relation between pressure and length is $E = L^{\frac{3}{2}}$, and $E = D^{-\frac{3}{2}}$. If the filaments are flashed, the proportions will be still more extreme. The question of high-pressure incandescent lamps is thus, how far can we make the filaments longer and thinner and flimsier without exasperating our consumers? Unfortunately the consumer is rapidly getting saddened as it is. The 100-volt 8-c.p. lamp does not please him much, and the 200-volt 8-c.p. lamp has in no way delighted him; if the lamp is made with two 100-volt filaments in series, it combines the disadvantages of both without the advantages of the small candle-power of either. But it adds some further disadvantages peculiar to the higher pressure which I have not so far touched upon—and that is, that the higher the pressure the more troubles there are through the silent discharge, or whatever it is called. I need only refer to the well-known experiment in which third terminal is sealed into the lamp A galvanometer then shows a current going across country inside the lamp. This is, no doubt, intimately connected with the life, or rather with the death of the lamp

I have dealt with the question of high-pressure incandescent lamps at some length because the subject is really of vital importance, and is too much neglected. Our technical colleges, and our technical Press, and our technical societies pay the greatest attention to questions of a per cent. or two in the efficiences of dynamos and transformers, and give a good deal of attention to engines and boilers. That is because there is plenty of room for calculations in connection with these subjects, but the incandescent lamp, which at present holds the whole career of the lighting industry in the little curl of flimsy red-hot carbon that can hardly support its own weight, receives no attention at all. How much does the average electrical engineer know about incandescent lamps? The only subject that is treated in the same way is the cable. About half the money in town-lighting goes in the cable—a mere fraction in the dynamos and transformers themselves—so the average electrical engineer knows nothing about cables.

So far I have only discussed the incandescent lamp; the arc lamp has also to be considered. I will not say much about the arc lamp just now, but will add a little more when the Nernst lamp is compared with it. The ordinary arc is limited in pressure to about 50 volts, including the series resistances necessary for regulating. The enclosed arc is a new development, which is more satisfactory as regards pressure and as regards consumption of carbon.

The lamp I describe to night is the invention of Prof. Walther Nernst, of the University of Göttingen. Though he is a young man, Prof. Nernst's name is already known to all modern chemists as a leading authority and original thinker in the field of physical chemistry. It is unusual for a man who has climbed to the top of one tree to jump to the top of another.

Nernst's, like most great inventions, is exceedingly simple as soon as it is understood. The efficiency of an incandescent body, as far as radiation goes, depends simply on the temperature. The efficiency of an incandescent lamp, for instance, depends on the temperature of the filament only, providing there is no loss by convection. The carbon will not stand a sufficiently high temperature, especially as, in addition to its low specific resistance, the filament has to be long and slender, and thus weak. Nernst, therefore, chose a material that would stand higher temperatures than carbon, and his material has the incidental advantage that its specific resistance is so high that strong rods can be used for high pressures instead of thin filaments. The most refractory materials so far used in lighting are zirconia, which has been used to replace lime in the limelight, and the oxides or so-called rare earths, in the Welsbach mantles. I am aware, of course, that many people suppose that the Welsbach mantle is not very hot, treating it as if it were at a temperature, for instance, below the melting point of platinum. The light emitted is supposed to be due to some special power of selective emission due to the oxides employed. I have had a good deal to do with incandescent gas mantles, and I find no reason to suppose there is any magic effect of this sort going on. The part of the flame where the mantles hang fuses platinum wire easily, and very few materials can stand the temperature without fusing or volatilising. Lime and many other oxides volatilise slowly from the mantles. I do not mean that the mantles are above the boiling point of lime; I have some idea of its melting point, as I have made a few pounds of melted lime and ran it out on the floor to look at it. The Welsbach mantles, which are now chiefly thoria, are at a temperature near their softening point, and in the making are raised to a temperature at which they begin to soften.

Nernst takes highly refractory oxides as his material. It does not seem promising, because such oxides are notoriously good insulators. But such insulators are electrolytes when hot. Nernst, therefore, heats the rods to make them conduct, and then heats them electrically, preserving a temperature which is within the limits that the material can bear

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without softening. This means that he can take the most refractory bodies supplied by the whole range of chemical research, and can heat them to a temperature short of their softening point, and can thus get an efficiency unknown to workers on the incandescent lamp. Such efficiency also means whiteness of light, so long as the efficiency is not too high. Thus the crater of the arc, being at a temperature of boiling carbon, gives a light that is unpleasantly blue.

The material is worked up into little white rods. Each rod is mounted on two platinum wires, a little paste made of refractory oxides being applied to the joints. The little rod with its two wires is then mounted on a holder which fits ordinary electric light fittings. As the rods fall in resistance as the temperature increases, after the manner of electrolytes, an increase of current produces a decrease of resistance. This tends to give some instability in running in parallel on supply circuits. This instability is corrected, as in an arc lamp, which has analogous properties, due to a different cause, by a series resistance. The Nernst rod has therefore a resistance in series. This is made up of exceedingly fine wire, and for ordinary circuits amounts to 10 or 12 per cent. of the whole resistance of the lamp. The consumption, including the resistance, is 1·5 watts per candle for large lamps, and 1·6 for small lights or low pressures. In small or low-pressure lamps the loss of heat at the ends is larger in proportion.

Such a lamp as I have described will not light up of itself, for the rod is an insulator when cold. The simplest way to start it is to warm it up with a match, or better with a small spirit lamp. Such a lamp as this is not only very cheap as regards first cost, but very economical in running. The life of rods, running at an efficiency of two-thirds of a candle per watt, including the resistance, is already more than 500 hours in good specimens. If the Nernst lamp advances as much in the first few years of its existence as the carbon lamp did between 1880 and 1882, it will soon be made so well that the rods last a lifetime. When the rod is worn out, a new rod with its wire mounts is all that is replaced. The whole lamp is not thrown away at all.

The method of lighting I have described, though it may be used in many cases, such as large public rooms, is really a savage mode of ignition, fit only for dealing with uncivilised commodities, such as gas and tobacco.

The small lamps and the lamps of medium size are in practice started by a heating resistance. This is arranged close to the rod, and in shunt to it. As soon as the rod is hot enough to conduct, its current works a tiny cut-out in the resistance circuit. In large lamps the heating system is a little more elaborate, as the resistance arrangement is arranged as a sort of hood which covers the rod. As soon as the rod conducts, not only is the resistance circuit broken, but the electromagnet lifts the little hood clear off the rod. In all these forms, the rod and its mounting are replaceable without interfering with the rest of the lamp.

We now have to consider the part the Nernst lamp is probably going to play in the near future.

Compared with the small incandescent lamps, as you deal with a material of much higher specific resistance, it is easy to give both small lights and high pressures. The question of lighting is exceedingly important, though it appears trifling at first sight. People are so accustomed to lamps being turned on from the door without any further trouble that they will generally object to having to light them with matches or spirit lamps, but there are many cases in which it will be quite satisfactory to have one lamp with an automatic lighter to show you the way into the room, the rest being lighted with matches or a spirit lamp as needed. There will be, however, a considerable opening for the cheap, small-power, high-efficiency lamp, and the disadvantage as to lighting is small in such cases as cafés, restaurants, churches, hotels, railway stations, and, in short, in most public rooms is small.

Coming now to the next size—that is to say, lamps of 20 c.p. to 200 c.p., and even small lamps in which it is worth while to have automatic ignition—the first cost of such lamps will be higher than the first cost of incandescents, but as the rod itself has alone to be replaced, that is a matter of very slight importance. This size of Nernst lamp has, further, every chance of completely ousting the carbon incandescent on the score of cheapness, as to renewals, higher efficiency, better coloured light, and, perhaps, more especially high pressures. Once the Nernst lamp becomes so general that systems of distribution are laid out to suit it, instead of to suit the carbon lamp, the carbon lamp is practically "out of the running." It must be remembered that the Nernst can compete with the carbon filament at any pressure that suits the filament, but the Nernst lamp can easily go right out of the depth of the filament and have the higher pressures to itself. It must be remembered that at present the cost of cables in a system of distribution is an exceedingly large item.

Turning now to the large lamps, they compete with the arc lamp in efficiency. Of course, the efficiency of the arc lamp is not a very definite quantity. The candle-power is generally determined by multiplying the current by 2 and adding zeros at discretion. All I can say is, that however many zeros the good nature of the maker may supply, a Nernst lamp taking the same power gives a better light. When carefullly arranged on the photometer, the arc may be better in given directions, but a lot of light given in directions that you do not want is not the same as the same light distributed with a uniform spherical emission. The arc lamps shown here will give the audience a good idea of the relative values. The Nernst gives a pleasanter and, of course, a perfectly steady light. Coming to costs, the Nernst will be very much cheaper in first cost, but enormously cheaper in maintenance. It also goes quite away from the arc as to pressures. There is no trouble, for instance, in making large lamps to work in parallel at 500 volts and by using double rods at 1,000 volts. This puts an entirely new development of electric lighting in the hands of the engineer.

There is one point I have said little about yet. The incandescent lamp which is still with us gives trouble not only because of the low pressure it needs, but also because it demands that the pressure shall be kept uniform. It seems quite possible that the Nernst lamp may be made to stand a much greater variation of pressure than the filament. If this proves true, it means an enormous difference in the designing of distribution mains. I do not like to say much about this yet as the invention is too young, and too little time has been available to make much certain progress in that direction. Results are promising, but it is best not to be sanguine.

It is difficult to discuss an invention like this without being carried away with enthusiasm. I feel, however, that I have but feebly shown forth the probable future of what seems to me the greatest invention in electric lighting that we have seen for many years. Still, I am sure I have not been too sanguine.

Discussion.

Mr. Alexander Siemens, who presided, said that after the manifestation of approval that had been expressed by the audience he need not express many words in praise of Mr. Swinburne's disquisition. Indeed, it was somewhat difficult to say anything spontaneously in regard to a new invention; but certainly Mr. Swinburne had fascinated them all very much in putting all the good points of the Nernst lamp forward, with the additional possibility extended to them that in future they might be able with matches and spirit lamps to return to the good old habits of their forefathers. His only object in rising, however, was to ask if anyone desired to make observations or ask Mr. Swinburne any question.

Prof. Ayrton observed that they must certainly congratulate Dr. Nernst in the most hearty way for having achieved such a wonderful result by the application of so simple a means—namely, that of rendering an insulator a conductor by heating it. The idea, however, was not new. Having referred to a paper which was read on this subject before the Royal Society 23 years ago, the speaker went on to remark that the production of such a lamp as they had seen that evening was of considerable commercial importance, and they had witnessed an entirely new departure in electric incandescent lamp lighting.

Mr. Hiram S. Maxim had always understood, with regard to the Welsbach light, that it did not depend upon the temperature. He thought we should find in nature quite a number of instances in which light was emitted without heat, and he instanced the glow-worm and the fire-flies of America, by the aid of which light a person could easily read and also find out the time by his watch. Any material that did not pass its substance into the surrounding air would give a light just in proportion to the temperature. In other words, a piece of platinum or other metal would give the same light provided none of

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the substance was wasted. Should, however, the least particle pass into the air we got colour. However, he was not much of a chemist—he was a gunmaker. He very well remembered that when he took to gunmaking people advised him to stick to electricity. Since that time the whole world had had to come to England for its machine guns but only the other day he saw it stated in a newspaper that Mr. Maxim had better stick to his guns and not dabble in electricity.

After a few observations from **Mr. Erskine**, who referred to the ever-increasing desire of the public for better lighting facilities,

Mr. W. M. Mordey congratulated the society on having had the privilege of listening to such a paper as Mr. Swinburne's. What had been shown to them was a departure which, in his opinion, would rank in importance with the invention of the Swan lamp—now more years ago than he cared to say. He did not think that since then there had been an invention so pregnant with results as the lamp which had been described to them that night. They ought to thank Dr. Nernst on having made this discovery and to take care that he was not robbed of the credit due to him by people who would on the morrow say that they themselves had done this very thing several years ago in their own laboratories. He believed there had not been much improvement in the carbon-filament lamp for many years, and it was a most extraordinary thing that when the failure of this filament to improve was demonstrated to us someone should come along and give us the Nernst lamp.

Dr. Fleming said that, of course, in considering the value of any invention it became a very important matter to consider not merely the energy and consumption or life of the device, but also any possible deterioration. Everyone using the limelight was aware of the fact that after a few minutes the light was speedily diminished, although the temperature was unchanged, and the question suggesting itself was this—was there a deteriorating quality in the oxides to any marked extent? as this was an important commercial factor.

Major Flood Page remarked that Dr. Nernst's invention might be a new departure—and everybody had been expecting a departure—but it was one which he believed could be worked in with the existing systems, so that they would all gain. Great advances had been made in electrical science, and they would all welcome the new lamp, which he verily believed would be of benefit to all He congratulated the Society of Arts on the opportunity they had had of listening to Mr. Swinburne, and he also expressed his thanks to Dr. Nernst.

Mr. A. Colefax, referring to an observation from Dr. Fleming, said he had some few months ago visited Germany and seen Dr. Nernst. The filaments did not, so far as he was able to discover, deteriorate in use, though he believed that in every form of incandescent light hitherto introduced there had been this deterioration.

Mr. A. A. Campbell Swinton, Mr. Morse, Mr. Lorrain, and **Mr. A. H. Dykes** having each added a few observations,

Mr. Swinburne replied, after which

The **Chairman** said he must really utter a word of warning. Prof. Fleming had alluded to the commercial side of the question, but he would remind them that only really good things could be good things, because they were worth the money paid for them. Mr. Swinburne had in dealing with his paper evaded the question of cost, and until that matter was satisfactorily settled they could not value the new lamp fairly. Neither could they form any judgment as to the possibility of introducing it on a large scale. That was a point which could only be tested practically. Mr. Swinburne had told them that the arrangements connected with the preliminary heating were rather expensive. He said it was easy to replace one of the rods, and, as far as he (the chairman) could see, that was so. But in that connection he would just remind them of another invention in electricity—that of accumulators. When these were first introduced everybody said they would do wonders—relieve central stations, and so on. Well, they had done a good deal, but not all that was expected. He therefore thought it his duty to throw a little cold water on all the enthusiasm, and remind them that the whole test of the pudding was in the eating. If as a householder he paid 1s. 1d. for these lamps and he could get incandescent lamps for 1s., he should buy the latter.

The usual votes of thanks closed the proceedings.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. Questions may be sent at any time. Answers must be written on one side of the paper only.

Questions.

140. What is the action of a choking coil in an alternate-current circuit? If one arc lamp taking 10 amperes is being used on a 100-volt circuit, what power will be taken from the mains if a choking coil is used in series with the lamp?—C. H.

141. In a public supply at 230 volts, are consumers paying proportionately less for their light when the voltage falls to, say, 200 through want of power at the station, the meters used registering in Board of Trade units?—W. McC.

Answers.

Question No. 134.—What are the advantages and disadvantages of dust destructors in connection with central stations?

Best Answer to No. 134 (*awarded* 10*s.*).—The advantages of dust destructors in connection with central stations have been rather over-rated during the past few years. The impression that the ashbin refuse of the average district is sufficient to provide that district with all the electricity it requires is not correct. In my opinion the following way is the best in considering this subject: (1) from the dust disposal point of view; and (2) from an electric lighting point of view. It is almost impossible to show a financial advantage by the use of dust destructors if the refuse has been previously disposed of by tipping it on a site for which the local authority has not had to pay rent. The advantages of dust destructors from a refuse disposal point of view are as follows: (1) the insanitary conditions arising from heaps of fermenting refuse on a site adjacent to a town is avoided; (2) the collection of refuse into quantities for carrying away, which may almost cause outbreaks of infectious disease, is avoided; (3) the refuses destroyed in the destructor the same day as it is collected instead of being left in heaps to decompose; (4) with a well-designed refuse destructor properly worked there is no chance of obnoxious fumes being allowed to escape into the atmosphere.

This last consideration really decides that some good can be got from refuse destructors for electric lighting purposes, for to ensure that no unburnt and obnoxious fumes shall be emitted the temperature of the flues must be very high. It is then that, having raised this very high temperature, a certain amount of heat is available for generating power, and there is no reason why the gases should be delivered into the chimney at very high temperatures. Assuming, then, that the refuse destructor is to be used for destroying the refuse, and that the cost is borne by the sanitary authorities, a certain amount of free steam is available for electric lighting.

From an electric lighting point of view the advantages then become especially apparent with an alternate-current system of distribution, or for one in which accumulators are used for storage purposes, or in which there is a day load on the station derived from motors, as at Shoreditch. The heat got from refuse destructors may then be easily capable of anything but the heaviest loads when the whole lighting of the district is going on. At such times, coal can be used to help the boilers which are in the destructor flues. As regards the quantity of steam which can be obtained from 1lb. of refuse, figures as high as 1lb. of steam per pound of refuse have been obtained in fairly regular practice. Even then refuse should not be compared to coal, as the cost of burning it is considerably greater.—E. T.

Question No. 135.—Should arc lamps for street-lighting be arranged zigzag alternately on each side of the street? Quote some of the methods of arranging them that are actually used in practice, and compare their relative merits, giving details as to distance and the current used in the lamps.

Best Answer to No. 135 (*awarded* 10*s.*).—The question of the arrangement of arc lamps in the streets is best considered from three points of view: (1) lighting efficiency; (2) erection and maintenance; (3) appearance.

From the first point of view the best position for the lamps is undoubtedly in the centre of the road, the absorption of light being a minimum, but this position is rarely suitable in the majority of English towns, owing to the narrowness of the streets and the density of the traffic. In broad thoroughfares, however, and especially where tramways are likely to be laid or electrically equipped, this position offers the best solution, as the posts can be used to

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support the trolley wires. With regard to the question of placing them alternately on opposite sides or all on the same side of the street, the first position is preferable, as it gives a better distribution of light and a better lighting effect, though cable and labour is economised by having all the lamps on the side on which the feeding cable is laid. An example of the central position may be found in the lighting of Euston-road, where the lamps are placed about 70 yards apart in the centre of the roadway. At Dover the lamps are suspended over the centre of the road from ornamental iron brackets, which are attached to a house on either side of the street. The lamps are placed 80 yards apart and 21ft. from the ground. At Aberdeen a similar arrangement is adopted in some of the streets, using a simple span wire instead of a bracket. At Cheltenham an avenue is very effectively lighted by arc lamps suspended from span wires over the centre of the roadway. Bristol uses 10-ampere arcs 66 yards apart. Chelmsford has 20 12-ampere arcs arranged, in general, alternately on either side of the street at about 80 yards apart. Blackpool uses 10-ampere arcs 50 yards apart. At Brighton, all the principal streets are lighted by arcs arranged alternately on opposite sides of the road. The promenade is lighted by 12-ampere double-carbon lamps, arranged alternately on the sea and on the road side of same. The distances vary from 45 to 55 yards. A number of seven-ampere arcs are used in the less important streets. No hard-and-fast rule can be adhered to in assigning the position for arc lamps, and the physical features of each locality must be studied, preference being given to sites opposite street openings and in the centre of open spaces.

All things considered, the best arrangement would seem to be alternately on opposite sides, and certainly this gives a street a better appearance when viewed from one end than either the centre or the one-side arrangement. If the lamps be overhung some 6ft. from the kerb, as is done at Brighton and other places, the lighting efficiency is not much diminished, while the lamps are in a more convenient position for inspection and cleaning than if placed in the centre of the road.—E. M.

Answer to No. 135 (*awarded* 5*s.*).—No general rule can be given for the arrangement of arc lamps, for each street has to be considered on its own merits, and the solution applicable for a narrow street in a poor neighbourhood would be quite unsuitable for a main thoroughfare in an important town. Where there are refuges in the centre of the street, or where suspension by span wires is allowed, the most advantageous solution is to place the lamps on the axial line of the street. In other cases the zigzag method is often the best. This is the method adopted in Milan, Havre, Cologne, and Vienna, as well as in many important streets in London, Paris, and Berlin. In all the streets in New York, with the exception of the Fifth-avenue, it is the method employed. M. Blondel has pointed out that if we could use lamps which took half the current of those ordinarily employed, and use twice the number of them, a much better distribution of light would be obtained at the same cost. For example, in Fig. 1,

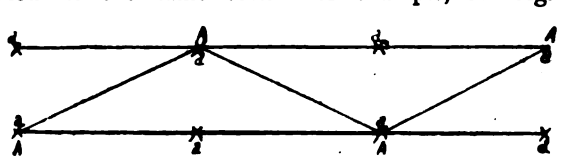

FIG. 1.

if we replaced the large lamps, A, A, A, by small lamps, *a*, *a*, *a* . . . we would secure a better distribution of the light. This statement, however, needs to be modified, as it would not be suitable for very narrow streets. A very effective way is used in the Fifth-avenue of New York, which is an extremely well-lighted street. In addition to rows of arc lamps down each side of the street exactly opposite to one another there is a row down the centre, each lamp of this row being at the centre of the rectangle formed by four neighbouring side lamps. This is called a "quincunx" arrangement. A slightly modified form of this arrangement is used in the Rue Royale in Paris, which is also an excellently lighted street. (See Fig. 2, which is taken from *Le Génie Civil.*) For wide streets and important thoroughfares with refuges down the centre, this quincunx arrangement is the best. For narrower streets without refuges, lamps suspended by span wires down the axial line would be the most economical. Where span wires are not allowed, we must use either small lamps placed opposite one another or larger lamps in zigzag.

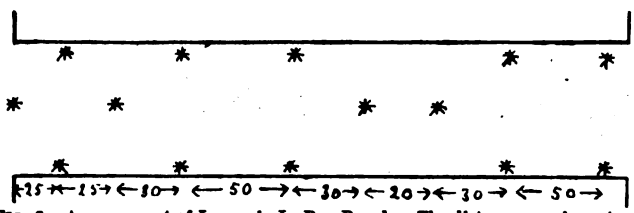

FIG. 2.—Arrangement of Lamps in La Rue Royale. The distances are in metres

The following details as to distance and current used in the lamps, etc., are taken from M. Blondel's paper in *Le Génie Civil*, which has been translated into English by Mr John Hesketh :

Cities.	Kind of current.	Globe.	Current in amperes.	Mean distance from post to post in feet.	Mean height of lamps in feet.
London	Continuous	Small opal globe in clear glass lantern.	10	115	17 6
Paris (Grand Boulevards)	,,	Opaline.	10	130 to 200	20
Milan	,,	,,	4·5, 6, 10, 15, & 20	130 to 200	30
New York:					
Avenues ...	,,	Clear glass.	10	260	21
Cross streets	,,	,,	10	300	21
Havre	Alternating	Opaline.	12 to 15	230 to 270	14,18·3 and 25
Portsmouth.	Rectified	,,	12	270	25

J. C. R.

LEGAL INTELLIGENCE.

THE ELGIN TELEPHONE TEST CASE.
Judgment.

In the Elgin Sheriff Court recently this case, already referred to in our columns, was further debated before the Sheriff, who issued the following interlocutor and note :

"ELGIN, Jan. 26, 1899.—The Sheriff Substitute having advised the cause, finds that the pursuers are the National Telephone Company, Limited, with registered offices at Oxford-court, Cannon-street, London, and that the defender is a baker and confectioner carrying on business at South-street, Elgin ; finds that on Feb. 23, 1894, the witness, Alexander Ramsay Lamb, then district manager for the West Highland district for the pursuers, was in Elgin canvassing for subscribers to the Telephone Company, which was then about to establish telephone communication there ; finds that in consequence of representations made to the defender by the said Alexander Ramsay Lamb, the defender, who had also at that time a business in Nairn, would, in respect of the advantage which he stated in the presence of the said Alexander Ramsay Lamb in his opinion accrue to him from telephonic communication being established between the two points, agreed to become a subscriber ; and that in confidence thereof he assented to the agreement which was written out in his presence at the time by the witness Lamb, being signed on his behalf by the witness James Mutch, the defender being incapacitated from signing himself in consequence of having lost an arm ; finds that the agreement in question is in the following terms : 'Agreement for exchange line. The National Telephone Company, chief office, Oxford-court, Cannon-street, London, E.C. ; district office, 9, Union-street, Inverness, Feb. 23, 1894. The undersigned (hereinafter called the lessee) agrees with the National Telephone Company, Limited (hereinafter called the company), subject to the conditions endorsed hereon, to pay the company the rent or sum of £8. 10s. per annum in advance for a term of five years, and thereafter in like manner the company's tariff rate of a yearly contract (unless the lessee enters into another agreement for a further term) for the use of a telephone wire and one instrument from 18, South-street, Elgin, to the Elgin telephone exchange and inter-communication with subscribers of said exchange. This agreement may be determined at the end of the said term or any subsequent year by either party giving to the other not less than six calendar months' previous notice in writing, expiring on the date previous to the rent being due on any such year. Signature, *pro* Alex. Austin ; business or occupation, baker and confectioner ; address, Elgin. The above rate is restricted to £6. 10s. sterling until such time as the Elgin exchange is put in communication with the company's

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inter-town system in Scotland'; finds in law that the said agreement is not a probative document, that the same was not read over either in whole or in part to the defender, and that the conditions printed on the back were not brought under his notice; finds that the condition contained thereon has not been purified in respect that the inter-town system has not been established by the company; finds that in 1896 the Government by agreement with the company established the inter-town system of telephonic communication in Scotland; finds in law that no privity of contracts exists between the Government and the defender; finds further in law that the pursuers have no title to sue for the extra charge of £2 sterling for the inter-town system: therefore decerns against the defender for the sum of £6 sterling as concluded for; *quoad ultra* assoilzies him from the conclusions of the action; finds the defender entitled to his expenses; allows an account thereof to be lodged, and when lodged remits the same to the auditor of court to tax and to report; and decerns

"(Signed) CHARLES RAMPINI."

"NOTE.—In this case, which was remitted from the Small Debt Court on the statement that it was a test case, and that legal questions of importance were involved in it, the pursuers sue for £8. 10s., being 'rent for telephone for year from July 10 1898, payable in advance in terms of agreement granted by defender dated Feb. 23, 1894.' The pursuers further base their action on the agreement. In that agreement is the curious condition that the rent is to be restricted to £6. 10s. per annum until such time as the Elgin exchange is put in communication with the company's inter-town system in Scotland. The company plead that this condition merely fixes a point of time The defender pleads that is an agreement to give him the benefit of the company's trunk line when established at £8. 10s. a year. It certainly is a very indefinitely expressed condition, and must therefore be interpreted *contra proferentem*. The agreement is not a probative document. Verbal evidence is therefore admissible, and that evidence—the evidence of the witness Lamb on the one side and of three reliable business men of Elgin, whose testimony has stood the test of cross-examination, on the other—is clearly and without doubt to the effect that the defender was induced by Lamb to believe, and actually did believe, that he was to have the benefits of the trunk connection when established for the £2 more than the sum which he then agreed to pay for the local connection. This was certainly Lamb's representations to them. Whether it was a misrepresentation or not on his part, and whether he did or did not go beyond his authority, are matters for which they cannot be held responsible. The proof goes further. The condition adjected has never been purified by the pursuers. The trunk system has never yet been established by them, but by the Government, between whom and the defender there is no privity of contract. "(Intld.) C. R."

ACTION AGAINST ELECTRICAL ENGINEERS.

In the Westminster County Court on Wednesday, his Honour Judge Lumley Smith, Q.C., had before him the case of Reed *v.* Belshaw and Dunn and Watson, in which the plaintiff, a civil engineer, residing at 35, Lincoln's-inn-fields, sued the defendants, Messrs. Belshaw and Co., a firm of electrical engineers, and Messrs. Dunn and Watson, a firm of architects, to recover damages for trespass, and for appropriating his electric leads.

The **Plaintiff's** case was that for some time past he had been the tenant of the second floor of the premises in question, and during the first part of his tenancy he used electric light. Some time ago, however, he had the current cut off, and shortly afterwards he found a man in his room pulling down the casing. He made enquiries into the matter, and found that Messrs. Dunn and Watson, who occupied the floor below, were having electric light fitted to their premises, and that for that purpose Messrs. Belshaw, a firm of electrical engineers, were making use of his (plaintiff's) leads and fittings. After some correspondence with the two defendant firms he was unable to come to terms, and consequently he now brought this action to recover damages for trespass, and also for the use of his wires.

The defence was that the plaintiff's leads were made use of under the mistaken notion that they were the property of the superior landlord.

His **Honour** said it was an action which never ought to have been brought, but still, there had doubtless been a technical offence, and for that he should award the plaintiff 10s. The plaintiff, however, would have to pay the defendant's costs, as the sum in court was more than sufficient.

WHITE v. HEADLAND'S PATENT ELECTRIC STORAGE BATTERY COMPANY, LIMITED.

The appeal from the decision of the Divisional Court (Mr. Justice Lawrance and Mr. Justice Channell) with regard to costs in this case was allowed by the Court of Appeal on Wednesday last.

COMPANIES' MEETINGS AND REPORTS.

ANGLO-AMERICAN TELEGRAPH COMPANY, LIMITED.

The ordinary general meeting of this Company was held on Friday last at Winchester House. Mr. Francis A. Bevan presided. The report (published in our last issue) was adopted and the dividend approved.

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY, LIMITED.

The annual general meeting of this Company was held on Tuesday at the offices, Golden-square, Mr. E. J. A. Balfour presiding. An amendment that the new shares should be issued at par and not at a premium having been ruled out of order, the report was adopted.

At an extraordinary general meeting held subsequently sanction was given to the introduction of a Bill into Parliament for acquiring lands and erecting generating stations.

WATERLOO AND CITY RAILWAY COMPANY.

The tenth half-yearly general meeting of this Company was held at Waterloo Station yesterday afternoon, Mr. W. S. Portal in the chair.

The **Chairman** said that at the last meeting he had to express his regret that the line had not been opened. This time he offered them his sincere congratulations on the results which had been obtained since the opening last August. The first paragraph of the report would show them that the line was opened on Aug. 8 last. The second showed them the position in which they stood with regard to the subways, etc, being proceeded with by the Central London Railway. Their capital account at Dec. 31 last showed a total outlay of nearly £550,000. The further estimated expenditure of £52,000 was amply provided for by the capital powers of the Company, which at present amounted to £600,000. The gross receipts from the line amounted to £10,887, and from this the London and South-Western Railway Company had retained £4,119 in respect of working expenses, leaving £6,768. 10s. 8d. payable by them in order to provide, under the agreement of March, 1894, for a dividend at the rate of 3 per cent. per annum from Aug. 8 to Dec. 31, 1898, on the Company's ordinary and borrowed capital. To this sum had been added bankers' and general interest and a portion of the profit on the sale of Consols representing the parliamentary deposit, which enabled the directors to recommend the payment of a dividend of 3 per cent. per annum for the full half-year. This dividend would be payable on the 18th inst. The Baker-street and Waterloo Railway Company were seeking powers for a deviation of their railway at the southern end which might affect the Waterloo and City Railway, and care would be taken to see that the rights and interests of the Company would be duly protected.

The report was seconded by **Lieut.-Colonel the Hon. H. W. Campbell.**

A **Shareholder** said that, in face of the difficulties which had had to be encountered, the line was very satisfactory. The introduction of a time-table had been a great improvement. If there had been any grumbling it was because of the bad approaches at the ends, and he suggested also that a moving platform as used in Paris might be introduced successfully.

SOUTH STAFFORDSHIRE TRAMWAYS COMPANY.

An extraordinary meeting of shareholders in this Company was held at Cannon-street Hotel, E.C., on Wednesday afternoon to consider the provisions of a Bill now before Parliament for conferring further powers on the Company with respect to the leasing and working of tramways and for other purposes.

Mr. Schuster presided, and explained that the Bill was the result of an agreement entered into in June, 1897, between their Company and the Electric Construction Company. The agreement was parted with to the British Electric Traction Company, who were really promoting the Bill, although using their Company's name.

Mr. Munts the solicitor, explained the main points in the Bill. Under Clause 5 the Company would be authorised to grant a lease to the British Electric Traction Company. Under the lease there could be a minimum rent of 1½d. per mile, the cars running not less than a certain mileage per annum. Other obligations were imposed on the lessee in connection with the working of the line and payment of debenture interest. Clause 21 would restrain the local authorities of the district from exercising their powers of purchase for a period of 35 years from the passing of the Act. This would give them a considerably longer life, as their lease ran out in about 3½ years, and the corporation could then compulsorily purchase the tramways. The local authorities would probably have something to say on the point, and were holding meetings with a view to opposing the Bill. They said that the Tramways Act could not be varied by a private Bill of that nature. The borrowing powers of the Company would also be raised by the Bill from £50,000 to £100,000.

In reply to a question by a shareholder (Mr. Hilliard), the **Chairman** said the arrangement would give the Company a new lease of life.

The **Chairman** then put the question to the meeting for the approval of the Bill, when it was carried with three dissentients, Messrs. Millbarn, Stanhope, and Villiers. The meeting then terminated.

GREAT NORTHERN AND CITY RAILWAY COMPANY.

The half-yearly general meeting of the Great Northern and City Railway Company was held on Tuesday at the Westminster Palace Hotel, Sir Charles Scotter in the chair.

The following progress report was submitted by Mr. Douglas Fox: "At the Regent's Canal the contractors are in possession of

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all the necessary houses (except one) for the temporary purposes of their yard, and for the permanent generating station. The working shaft at this point has now been sunk to its full depth—viz, 53ft. from the surface—and the heading to give access thence to the railway tunnels is being started. The foundations for the electric light engine and air compressor are in place, and some of the machinery has been delivered on the ground. Progress is being made with the head-gear for the shaft. The construction of the special shields for driving the tunnels is well in hand, and they will be quite ready by the time the heading reaches the centre line of the railway. The work is being pushed forward day and night, the number of men at present employed being 78. All necessary notices to treat for the land at Drayton Park, as well as those for the Essex-road site, have now been prepared and are in the hands of the solicitors for service. We are still awaiting the approval, as per agreement, by the Great Northern Company of the plans of the stations."

With reference to the Great Northern Railway Company's Bill for the construction of an electric underground line from Wood Green to King's Cross and thence to the Strand, it was said that the directors did not look on this as a competitor, as the great flow of traffic was to and from the City; but they would have to safeguard their interests at Finsbury Park.

The report for the half-year stated that the whole of the A and B share capital, amounting, A to £780,000, and B to £267,330, had been applied for and allotted in July last. The receipts on capital account to Dec. 31 amounted to £244,738, and the expenditure to £158,306, the latter sum including £2,262 interest on capital.

The report and accounts for the last half-year were adopted. Sir Henry Burdett and Sir Francis Knollys were re-elected directors. Messrs. W. B. Peat and Co. were reappointed auditors, and the Hon. Cecil M. Knatchbull-Hugessen was elected an auditor of the Company.

BLACKPOOL AND FLEETWOOD TRAMWAY COMPANY.

The directors, in their statement of accounts for the half-year ended Dec. 31, 1898, congratulate the shareholders on the successful working of the undertaking, especially having regard to the insufficiency of the rolling-stock. The number of passengers carried from July 14, 1898, to Dec. 31, 1898, was 734,293, and the gross receipts amounted to £14,476. 2s. 10d., and the net profit to £8,584. 4s. 3d. After providing for interest on the debentures, £8,006. 9s. 3d. remained, and the directors recommend a dividend for the half-year at the rate of £8 per cent. per annum, free of income tax, which leaves a sum of £3,206. 9s. 3d. to be carried forward. The directors propose to devote the proceeds of their new issue of £30,000 to the increase of the rolling-stock of the Company, to the purchase of further generating plant, additional land, and the erection of works, and to other purposes of the Company attributable to capital expenditure. The directors who retire by rotation are Messrs. Robert Breese Barningham and Robert Slater Boddington, both of whom are eligible, and are recommended for re election. Mr. Alexander Bruce having resigned his seat on the board, the directors will propose a resolution reducing the number of directors to six. A resolution will also be proposed fixing the directors' remuneration. The retiring auditor by rotation is Mr. Wm. Aldred, who is eligible and offers himself for re-election.

SCARBOROUGH ELECTRIC SUPPLY COMPANY, LIMITED.

The directors of the Scarborough Electric Supply Company, Limited, in their annual report state that during the past year 53 additional consumers and the equivalent of 2,277 8-c.p. lamps have been added to the Company's system, making a total of 383 consumers and 22,344 lamps connected. During the past year electric energy to the amount of 220,009 Board of Trade units had been supplied to consumers at a revenue, including meter rents, of £5,442. 9s. 8½d., as against 214,044 units and £5,179. 13s. 9d. revenue for 1897. The profit on the year's working was £2 331. 16s., as against £2,044. 13s. 0½d. for 1897. Adding to this the balance of £128. 12s. 5½d. brought forward, and the sum of £278 premium on new shares issued, there was, after certain deductions, a sum of £2,332. 14s. 6½d. available for distribution. The directors recommend a dividend of 5½ per cent., leaving £368. 10s. 6½d. to be carried forward.

CAMBRIDGE ELECTRIC SUPPLY COMPANY, LIMITED.

Directors: D. Munsey, Esq. (chairman), Meadowcroft, Cambridge; Hon. C. A Parsons, F.R.S., M.A., M.I.C.E., M.I.E.E. (managing director). Wylam-on-Tyne; Sir B. C. Browne, D.C.L., Westacres, Benwell, Newcastle-on-Tyne; P. W. Latham, Esq., M.D., Trumpington-street, Cambridge; John B. Simpson, Esq., M.I.C.E., Bradley Hall, Wylam-on-Tyne. Manager and engineer: John H. Barker, A.M.I.C.E., M.I.E.E.

Report of the directors (with abstract of accounts) to be presented to the ordinary general meeting of the Company to be held at the Company's offices, Thompson's-lane, Cambridge, on Friday, Feb. 17, 1899, at 12 noon:

Your directors have pleasure in reporting that the prospects of the Company continue to be satisfactory. During the year 1898 there has been added to the Company's mains the equivalent of 3,885 8-c.p. lamps, making the total 25,080. The number of units supplied has been 260,307, an increase of 38,800, or 17 per cent.; 36 new consumers have been added, making the total 365. There has been a general increase all round in the Company's extension of mains; the capital expenditure for the past year has been £3,035. 13s. 7d.; 16,706 yards of pipe and cable have been laid down, and the duplicate system of distribution referred to in last year's report is on the point of completion. The Company after paying all charges, placing £250 to the reduction of preliminary expenses, £300 to depreciation account, and £84. 1s. 7d. to the credit of suspense account, has a balance of £3,037. 9s. 11d., which, added to £292. 16s. 10d. brought forward from last year, makes £3,330. 6s. 9d. An interim dividend of £1,068. 9s. 3d. and interest on temporary overdraft £71. 0s. 3d., have already been paid, leaving a net balance of £2,190. 17s. 3d., out of which the directors recommend the payment of a dividend of 4½ per cent., making, with 2½ per cent. already paid, 7 per cent. for the year. This will absorb £2,067. 5s. 6d., leaving a balance to carry forward of £123. 11s. 9d. Mr. Simpson retires by rotation; he is eligible and offers himself for re-election. The auditor, Mr. Arthur Rutter, also offers himself for re-election.

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1898.

Dr.	£	s.	d.
To Generation of Electricity.			
Coal, including dues, carriage, unloading, storing, etc.	1,188	13	2
Oil, waste, water, and engine-room stores	173	5	3
Proportion of salaries of engineers and officers, as certified by the engineer	133	0	0
Wages at generating stations	725	1	9
Repairs and maintenance	317	6	7
To Distribution of Electricity.			
Proportion of salaries of officers, as certified by the engineer	13	0	0
Wages to linesmen, fitters, labourers	42	2	4
To Rents, Rates, and Taxes.			
Rents, rates, and taxes	407	11	8
To Management Expenses.			
Directors' remuneration for year 1898	147	0	0
Directors' remuneration for year 1897 in arrear	147	0	0
Salaries of managing engineers, secretary, accountants, clerk, messengers, as certified by manager	256	18	10
Stationery, printing, etc.	100	17	4
Auditor of Company	10	10	0
Auditor appointed under the provisions of the order	15	0	10
Law Charges.			
Law expenses	10	6	2
Depreciation, etc.			
To depreciation in respect of leasehold works, buildings, plant, machinery, etc.	300	0	0
Reduction of preliminary expenses	250	0	0
To amount written off suspense account	84	1	7
Special Charges.			
To insurances, etc.	23	2	6
Total expenditure	4,344	18	0
Balance carried to net revenue	3,037	9	11
	£7,382	7	11

Cr.	£	s.	d.
Sale of current	6,768	18	8
Public lighting	23	0	4
Rental of meters	318	7	6
Transfer fees	4	12	6
Cash discounts, etc.	117	8	11
Hire of alternator	150	0	0
	£7,382	7	11

GENERAL BALANCE-SHEET.

Cr. Liabilities.	£	s.	d.
Capital account—amount received	48,666	0	0
Sundry creditors	768	18	8
Net revenue account, £3,259. 6s. 6d.; less interim dividend, paid Aug. 2, 1898, £1,068. 9s. 3d.	2,190	17	3
Depreciation fund account	1,000	0	0
Bankers	1 759	15	2
Workmen's deferred pay	63	0	0
	£54,448	11	1

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	46,874	12	10
Stores on hand at Dec. 31, 1898: coal, £84. 4s. 11d; oils, waste, etc., £22. 2s. 2d.; general (lamps, etc.), £265. 5s. 9d.; stores on capital account, £3,038. 12s. 4d.	3,410	5	2
Preliminary expenses, £1,752. 14s. 8d.; less amount written off, £1,252. 14s. 8d.	500	0	0
Sundry debtors for current supplied to Dec. 31, 1898	3,660	8	11
Cash in hand	3	4	2
	£54,448	11	1

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in Board of Trade units		435,383
Quantity sold	Public lamps 1,638; Private consumers by meter 24,669	260,307
Quantity used on works, offices, and workmen's houses		6,494
Total quantity accounted for		266,801
Quantity not accounted for		168,582
Number of public lamps		1
Total maximum supply demanded, kilowatts		751

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CENTRAL LONDON RAILWAY COMPANY.

A meeting of the shareholders of this Company will be held on the 15th inst. at 3 p.m. for the purpose of receiving the report of accounts for the half-year ending Dec. 31, 1898, the election of two directors and an auditor for the ensuing year. An extraordinary general meeting takes place afterwards for the purpose of considering a Bill to extend the time for the completion of the Central London Railway and for other purposes. The report for the half-year ended Dec. 31 states that the expenditure for the half-year has amounted to £371,567, the total to date being £2,445,076 The engineers report that the main-line and station tunnels are completed, with the exception of 100 yards which remain to be constructed at the Bank Station. At this point the lift shafts are sunk, and the roof of the public subway is now being put in. The low-level subway connecting the line with the City and South London Railway Company is complete. The power station and depôt at Shepherd's Bush and the large buildings necessary for the rolling-stock and electrical machinery are approaching completion. A large portion of the generating plant has been delivered. At several of the station sites building operations are in progress, and the erection of the electric lifts is in hand.

BRISTOL TRAMWAYS AND CARRIAGE COMPANY.

The report of the directors of this Company for the half-year ending Dec. 31 last, to be presented to the shareholders at the ordinary general meeting, to be held at the Grand Hotel, Broad-street, Bristol, on Wednesday, Feb. 15, 1899, states that the gross receipts for the half-year amount to £78,258 14s. 8d., and the working and general expenses and renewals are £55,806. 0s. 1d., leaving a net balance of £22,452. 14s. 7d., which it is proposed to appropriate as follows: interest on 4 per cent. mortgage debenture stock, etc., £2,492. 13s. 6d.; dividend at the rate of 7 per cent. per annum (free of income tax) for the half-year ending Dec. 31, £14,218. 15s.; balance carried to reserve and renewal funds—viz., leased premises redemption, £250; contingencies, £3 000; electrical renewals, £1,000; permanent-way renewals, £1,491 6s. 1d.—a total of £22,452. 14s. 7d. The receipts from the tramways department show an increase of £8,143, and those of the carriage department an increase of £781. The total number of passengers (excluding postal riders) carried during the six months on the company's cars and omnibuses was 12,644,476. Fair progress has been made with the work of constructing the authorised tramway extensions and the adaptation of existing lines and depôts for electrical operation. The site of the central power station at Counterslip has been cleared to the required extent, and the company's contractor is now engaged upon the foundations and new harbour wharf. An eligible site of five acres of land at Brislington has also been acquired for the erection of an extensive depôt and car-building works, the provision of which will enable the Company to deal economically with the enlarged undertaking under the new conditions of mechanical working. The St. George and Hanham Light Railway Order was confirmed by the Board of Trade on Nov. 28 last, but certain formalities to satisfy further requirements of that department still delay the actual construction of the line. With reference to the additional capital proposed to be created at the forthcoming meeting, it is the directors' intention to issue the 25,000 new shares as 4 per cent. preference shares, with rights to cumulative dividends and to rank upon the assets of the Company, for the amount of the share only, in priority to the ordinary share capital. These shares will be issued at an early date and allotted at par to the holders of ordinary shares in the proportion of one new preference share for every two ordinary shares held. Mr. Joseph Wethered (director) and Mr. Solomon Hare (auditor) retire at the ensuing meeting, and offer themselves for re-election.

WESTMINSTER ELECTRIC SUPPLY CORPORATION, LIMITED.

Directors: The Right Hon. Lord Suffield, K.C.B. (chairman); the Right Hon. Lord Ampthill; Edmund Boulnois, Esq., M.P.; W. Hayes Fisher, Esq, M.P.; Sir Douglas Galton, K.C.B., F.R.S; J. Browne Martin, Esq.; R. W. Wallace, Esq., Q.C. Engineer-in-chief: Prof. Alex. B. W. Kennedy, LL.D., F.R.S., M.I.C.E. General manager: Captain Edmund I. Bax. Secretary: Frank Iago, Esq.

Report of the directors (with abstract of accounts) to be presented to the shareholders at the ordinary general meeting of the Company to be held at the offices of the Corporation, Eccleston-place, S.W., on Wednesday, Feb. 15, at 11 a.m.:

The supply of current which, on Dec. 31, 1897, was provided for the equivalent of 290,561 lamps of 8 c.p., had increased by Dec. 31, 1898, to the equivalent of 339,986, and at the present time there are on circuit the equivalent of 343,617, and applications have been received for a further 8,134 lamps of 8 c.p. The length of roadway in which mains have been laid now exceeds 48 miles, making about 197 miles of ways, in which upwards of 168 miles of copper (strip and cable) have been drawn. The directors have taken special steps to encourage the use throughout the system of supply of 200-volt lamps. The effect of this change, when completed, will be to increase very greatly the capacity of the existing mains and to reduce further capital expenditure under this head. The extensions of the central stations at Davies-street and Eccleston-place, referred to at the last general meeting, have been completed, and the plant is at work. The plant and machinery have been working satisfactorily throughout the year, and have been fully maintained from revenue. Owing to the continued increase in the applications for current the central station at Davies-street is now practically equipped for its maximum supply, while the space available at the other stations will shortly be utilised. As it has been found impossible to obtain a further suitable site for extension or the provision of a new station within the Corporation's authorised area, the directors have united with the Board of the St. James's and Pall Mall Company in promoting a Bill for a joint central station outside the companies' areas for the purpose of supplying current in bulk to the existing stations of this Corporation and of the St. James's Company. The capital invested in this undertaking, as shown in the balance-sheet, is at present unremunerative. The late prolonged strike in the South Wales coalfields, and unforeseen difficulties in the completion of Millbank-street station, have caused very considerable additional expense during the year. The directors consider that they may congratulate the shareholders on the fact that, notwithstanding these difficulties and the extra rebate allowed to consumers (which came into force on Jan. 1, 1898), the total cost per unit remains about the same, and there is no decrease in the amount available for dividend. An interim dividend at the rate of 10 per cent. per annum for the half-year ending June 30, 1898, has been distributed. After allowing for depreciation, sinking fund, etc., the net balance available for dividend is £28,033. 6s. 4d.; the Board therefore recommend the payment of a dividend at the rate of 14 per cent. per annum, less income tax, for the past half-year, making 12 per cent. for the year ending Dec. 31 last, carrying forward a balance of £1,000. 9s. 8d. The directors have to record with extreme regret the death during the past year of their colleague, Mr. James Heslop Powell, and, in accordance with the articles of association, they have elected the Right Hon. Lord Ampthill to fill the vacancy. In accordance with the articles of association, two of the directors, W. Hayes Fisher, Esq, M.P., and Sir Douglas Galton, K.C.B., retire, but, being eligible, offer themselves for re-election.

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1898.

Dr.				£ s. d.
To Generation of Electricity.				
Coal, carriage, unloading, etc.	£14,642	10	7	
Oil, waste, water, and engine-room stores	1,844	10	2	
Proportion of salaries of engineers and officers	2,035	3	11	
Wages, etc., at generating stations	5,454	14	9	
Repairs and maintenance; buildings, £1,232. 11s. 4d.; plant, £3 338. 17s. 3d.; instruments, £14. 14s. 4d.	4,586	2	11	
				28,563 2 4
To Distribution of Electricity.				
Repairs and maintenance of mains: materials, etc., £78. 2s. 3d.; proportion of salaries of officers, £128. 6s. 8d.; wages, etc., £850. 15s. 5d.	1,057	4	4	
Repairs and maintenance of meters: materials, etc., £457. 4s. 10d.; wages, etc, £740. 1s.	1,197	5	10	
				2,254 10 2
To Rents, Rates, and Taxes.				
Rents	1,076	9	8	
Rates and taxes	4,498	9	9	
				5,574 19 5
To Management Expenses.				
Directors' fees	3,000	0	0	
Salaries of manager, engineer-in-chief, secretary, clerks, etc.	6,566	13	2	
Stationery and printing	396	2	5	
General charges and office expenses	597	9	9	
Wages of meter readers, inspectors, etc.	891	4	10	
Depreciation on office furniture	46	0	0	
				11 497 10 2
General law charges and parliamentary expenses...				630 1 1
To Depreciation, etc.				
Sinking fund	1,500	0	0	
Depreciation account	15,350	0	0	
				16,850 0 0
To Special Charges.				
Insurance	643	14	0	
Board of Trade audit	85	0	0	
Cost of supplying steam	1,522	6	4	
				2,251 0 4
Total expenditure				67,621 3 6
Balance to net revenue account				50,078 14 7
				£117,699 18 1

Cr.	£ s. d.
Sale of current by meter	111,633 11 3
Sale of current by contract	6 8 0
	111,639 19 3
Less bad and doubtful debts	638 11 1
	111,001 8 2
Rental of meters, etc., on consumers' premises	4,759 2 11
Transfer fees	98 15 0
Supply of steam	1,840 12 0
	£117,699 18 1

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Dr. GENERAL BALANCE-SHEET, DEC. 31, 1898.	£	s.	d.
Capital account	598,800	0	0
Amount received on founders' shares cancelled	500	0	0
Temporary loan from bankers	10,000	0	0
Sundry creditors	6,290	0	3
Deposits by consumers	88	10	0
Debenture interest accrued, £3,500; less income tax, £116. 13s. 4d.	3 383	6	8
Depreciation account	55,912	11	1
Sinking fund	9,393	12	0
Reserve fund	9,401	8	8
Net revenue account, £47,342. 9s. 8d.; less interim dividend to June 30, 1898, at the rate of 10 per cent. per annum, £19,975; and less income tax, £665. 16s. 8d., £19,309. 3s. 4d.	28,033	6	4
	£721,802	15	0

Cr.	£	s.	d.
Capital account	626,365	11	2
Stores in hand: coal, £633. 10s. 1d.; stores, £226. 5s. 11d.; general, £210. 12s. 9d.	1,070	8	9
Sundry debtors for current supplied to Dec. 31, 1898	40,913	14	1
Other debtors	1,879	9	2
Cash at bankers	9,460	10	9
Cash in hand	56	1	10
Deposits with vestries, etc.	465	19	0
Central Electric Supply Company, Limited, outlay on freehold site, etc.	23,306	3	6
Advances under house wiring agreements	148	6	10
Investments at cost	12,686	9	11
Cost of redemption of 5 per cent. and 4½ per cent. and issue of new 3½ per cent. mortgage debentures, £6,980. 2s. 11d.; less amount written off, £1,530. 2s. 11d.	5,450	0	0
	£721,802	15	0

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Board of Trade units generated		5,847,585
Quantity utilised—		
Sold to consumers	5,065,195	5,129,411
Used on works for lighting, etc.	64,216	
Quantity expended in distribution—		
In batteries	32,970	642,979
In feeders	610,009	
Total quantity accounted for		5,772,390
Quantity unaccounted for		75,195
Number of lamps on circuit		339,986

NATIONAL TELEPHONE COMPANY, LIMITED.

The report of the directors of the National Telephone Company, Limited, for the half-year ended Dec. 31 last states that the income for the half year amounts to £573,707, as compared with £507,602 for the corresponding period of 1897, being an increase of £66,104. The working expenses for the half-year amount to £312,462 (£283,085). The net profit is £206,889 (£178,457). The Board will recommend the payment of a dividend at the rate of 6 per cent. per annum, less income tax, on the first and second preference shares; 5 per cent. per annum, less income tax, on the third preference shares; and 6 per cent. per annum, free of income tax, on the ordinary shares; £50,000 will go to the reserve fund, leaving £8,287 to be carried forward. At the meeting the question of provision for the future will be brought forward, and, in accordance with the notice, also a resolution authorising the directors to borrow sums up to three-fourths of the issued capital of the Company for the time being. Resolutions will also be proposed approving of the Bills to be introduced into Parliament by the Company.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Harwich.—The Corporation are prepared to enter into negotiations for the transfer of their electric lighting provisional order. Tenders by May 16.

London, W.—Tenders are invited by the Hammersmith Vestry for the supply of electrical stores for 12 months ending March 25, 1900. Tenders by 15th inst.

Belfast.—Tenders are required by the Belfast and Northern Counties Railway Company for the supply of telegraph ironwork, batteries, signal fittings, etc. Tenders by Feb. 13.

Gloucester.—The Electricity Supply Committee are prepared to receive tenders for the supply and erection of various plant at the municipal electricity works. Tenders by Feb. 28.

Edinburgh.—The Magistrates and Council invite tenders for an overhead travelling crane and storage batteries for their electric lighting station in Macdonald-road. Tenders by Feb. 20.

West Hartlepool.—The Corporation invite tenders for feeders, mains, arc light leads, with road work, particulars of which appear in our advertising columns. Tenders by Feb. 13.

Edinburgh.—The Magistrates and Council invite tenders for works in connection with their electric lighting station in Macdonald-road, particulars of which appear elsewhere. Tenders by Feb. 27.

Nelson.—The Gas Committee of the Corporation invite tenders for the supply and erection of various plant, particulars of which appear in our advertising columns. Tenders by Feb. 14.

Glasgow.—The Trustees of the Clyde Navigation invite tenders from manufacturers for two sets of engines and direct-coupled dynamos, particulars of which appear elsewhere. Tenders by 17th inst.

San Severa (Italy).—Tenders are invited for the electric lighting of the town. Particulars are to be obtained from, and tenders addressed to, the Corporation (Syndaco) of San Severa, Province of Foggia, Italy, by Feb. 25.

London, N.—The Shoreditch Vestry are prepared to receive proposals and to contract with any person or persons for various articles and works, for particulars of which refer to our advertising columns. Tenders by 28th inst. at 6.30 p.m.

Kingston-on-Thames.—The Guardians of the Union invite tenders for the provision of telephonic communication between the various buildings upon the workhouse premises, Kingston-on-Thames. For particulars see our advertising columns. Tenders by Feb. 14.

Manchester.—The Tramways Committee of the Manchester Corporation invite tenders for supply of sample electric tramcars. Specifications and forms of tender may be obtained on application to Mr. J. M. McElroy, secretary, Tramways Department, Town Hall, Manchester. Tenders by 20th inst.

Belfast.—Tenders are invited for the supply and erection of the following, for the Electric Committee: (Section C, 7) water-tube boilers, two 12½-kw. steam dynamos, switchboard. Specification and conditions of contract may be obtained on application to Mr. Victor A. H. McCowen, city electrical engineer, on payment of £1. 1s. per copy, which sum will be refunded on the return of the specification with a bona fide tender. Tenders by 10 a.m. on 23rd inst.

London, N.—Tenders are invited for materials and for wiring and fitting the Shoreditch workhouse, infirmary, casual wards, dispensary, nurses' home, porter's lodge, offices, etc., at Kingsland-road and Hoxton, for the Guardians of St. Leonard, Shoreditch. Specifications can be seen and all information obtained at the office of Mr. C. H. Doughty, Town Hall, Old-street, Shoreditch, until 13th inst., upon payment of £5, to be returned to persons bona fide tendering. Tenders by 15th inst. at 4 p.m.

Shanghai.—The Shanghai Municipal Council invite tenders for a concession for constructing and working about 23 miles of electric tramways on the trolley system in the streets of Shanghai. The special attention of tenderers is drawn to the fact that the tender (if any) recommended by the Council will require ratification by the ratepayers. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 being deposited with Messrs. Pook and Co., which sum will be retained by the Council, and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China (telegraphic address Dynamo, Shanghai; "ABC," fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Tramway Concession," must be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, and received by 12 noon on March 15.

Shanghai.—The following resolution in reference to the telephone system in Shanghai was passed at the last annual meeting of the ratepayers of the Foreign Settlements at Shanghai, north of the Yang-king-pang: "Resolution VIII.—That the Council be and is hereby authorised to enter into negotiations with the China and Japan Telephone Company or any other company, and in its discretion grant a franchise with a view to the community being supplied with an adequate and efficient telephone service at a fixed maximum charge." In accordance with the above resolution the Shanghai Municipal Council invite tenders for a concession for a period of 30 years for the exclusive right of establishing and working a telephone system in Shanghai. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 sterling being deposited with them, which sum will be retained and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China. Telegraphic address, Dynamo, Shanghai (ABC, fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Telephone Concession," to be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, by 12 noon on March 31.

RESULTS OF TENDERS.

Sunderland.—The Corporation have accepted the tender of W. T. Henley's Telegraph Works for cables.

Derby.—The Town Council have accepted the tender of S. Z. Ferranti, Limited (£7,000), for a new steam alternator at the electric lighting station.

Hereford.—The Town Council have accepted the tender of the India Rubber, Gutta Percha, and Telegraph Works Company, Silvertown, to carry out the installation for electric lighting of the centre of the city, at a cost of £11,231.

Brighton.—The Town Council have accepted the tenders of Messrs. Willans and Robinson, Limited, to supply and erect two combined engines and dynamos and condensing plant at the electricity generating station for the sum of £15,191, and to maintain such machinery for a period of 12 months from the erection.

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Cardiff. — The committee have received for extensions necessary at the electric lighting station tenders as follows: Jones Bros., £4,924; J. Allan, £4,880. 12s. 9d.; W. Thomas, £4,700. 14s. 10d.; Symonds, £4,640; Maggs, £4,442; Rees and Thomas, £4,363. 2s.; Turner, £4,288. 9s. 2d.; Lattey, £4,287; Chubb and Co,, £4,084. 1s. 1d. The last-named tender has been accepted.

St. Pancras.—The Vestry have received the following tenders for the supply of arc-lamp columns:

	Design No. 1.	Design No. 2.
McDowell, Steven, and Co.	£9 9 0	*£9 2 6
W. McFarlane and Co.	9 14 0	10 0 0
Falkirk Iron Company	10 0 0	—

* Accepted.

Sheffield.—The Tramways Committee of the Corporation have recommended the following tenders for acceptance: Cole, Marchant, and Morley, Bradford, for two engines for the extensions at Kelham power station, £6,796; J. Brown and Co., for supply of four boilers (similar to those previously supplied) for the extensions at the Kelham power station, £6,250; British Thomson-Houston Company, Limited, for two tramway generators of 500 kw. capacity, £5,280. 12s. 6d.; that an extended contract be entered into with J. Eshelby for the construction and erection of extensions to the power station at Kelham Island, on same schedule of prices as contained in his present contract, the city surveyor estimating the cost at from £9,000 to £10,000.

Middlesbrough—The Town Council have accepted the following tenders for the plant and mains required for the municipal electricity works: Section A, boiler-house plant: three Lancashire boilers, three sets mechanical stokers, steam feed pump, electric feed pump, injector, electric motor and switchgear, weighing machine, barrows, etc., Holdsworth and Sons, Croft Boiler Works, Bradford, £3,058. 5s. Section B, engine-house plant: one 300-kw. slow-speed steam dynamo, one 100-kw. high-speed steam dynamo, 200 square feet of floor plates, motor-transformer, tools and instruments, oil-filtering apparatus, painting, and spare parts, Davy Bros., Limited, Sheffield (with R. P. Jackson and Co.'s dynamos), £6,900. Section D, overhead travelling 15-ton crane, handrailing, ladder, and 100ft. of steel rail, Southgate Engineering Company, Limited, New Southgate, £325. Section E, switchboard and instruments, Nalder Bros. and Thompson, London, £1,200. Section F, accumulators, stands, and instruments, Hart Secondary Battery Syndicate, Limited, Stratford, E., £1,880. 16s. Section G, underground work: trenching, brick surface boxes, troughing, cables, joint boxes, etc., British Insulated Wire Company, Limited, Prescot, £8,711. 1s. 1d. Section H, meters: 100 direct current meters, Chamberlain and Hookham, Limited, Birmingham, £500.

BUSINESS NOTES.

Italy.—The electric railway from Milan to Monza was formally opened on Tuesday.

Luton.—The Town Council have asked Mr. Ashton to oppose the National Telephone Company's Bill.

Fleetwood.—A trial survey is boing made for the construction of an electric tramway from Fleetwood to Morecambe.

Leagton.—The Council have decided to petition Parliament in opposition to the National Telephone Company (No. 2) Bill.

Pembroke (Ireland).—The Town Council have directed the clerk to petition in his own name against the new Telephones Bills.

Coventry.—The City Council have decided to oppose the Bill promoted by the Leicestershire and Warwickshire Electric Supply Company.

Barnsley.—We learn that a Manchester firm has been engaged to advise the Electric Light Committee as to the lighting of the workhouse.

Bangor.—The Local Government Board have sanctioned the loan of £14,150 for electric lighting purposes, including the purchase of land.

Newburgh.—The Town Council have agreed to oppose the petition of the National Telephone Company to have their poles placed without cost.

Glasgow.—The Corporation have adopted the sub-committee's report on the conversion of the tramways. The latter we have referred to in a previous issue.

Glossop.—The Town Council intend to support the Manchester Corporation in their opposition to the Bill of the Lancashire Electrical Power Supply Company.

Oldham.—The Town Council have unanimously agreed that a petition be promoted in Parliament against the Bill of the Lancashire Electric Power Company.

Handcock and Dykes.—This firm have opened a branch office at 3, St. Nicholas-buildings, Newcastle-on Tyne, to deal with their business in the North of England.

Walker.—The District Council is against the Walker and Wallsend Union Gas Company's Electric Lighting Bill on account of the monopoly the same would convey.

Dundee.—At the monthly meeting of the Harbour Board a remit was made to the harbour engineer to report on the question of lighting the harbour by electricity.

New York (U.S.A.).—The Manhattan Elevated Railroad Company has decided to use electricity as its motive power, and to issue 18,000,000dol. more stock for the purpose.

Whitby.—Mr. W. H. Preece has been retained to advise the Urban District Council on the installation and maintenance of the electric light in the Whitby urban district.

Hampstead.—The salary of Mr. G. H. Cottam, chief electrical engineer, has been increased by £50 per annum, and other increases to members of the Vestry's staff have been granted.

Canterbury.—The engines at the electric light station were started on Wednesday. The customers already connected will have the use of the current free until the 22nd inst.

Richmond (Surrey).—The Town Council have decided not to consent to the application by the National Telephone Company to lay tubes underground for carrying telephone cables.

Newcastle-under-Lyme.—The Town Council have sealed a petition against the National Telephone Company's Bill. The British Traction Company intend to extend their line.

Blackpool.—A proposal that Mr. Quin be permitted to take engagements as a consulting engineer outside the Corporation is before the General Purposes Committee of the Corporation.

Salford.—Messrs. Lacey, Clirehugh, and Sillar have been appointed consulting engineers to the Town Council in connection with a proposed expenditure of £250,000 on electricity works.

Leeds.—The Lighting Committee at a meeting on Tuesday decided to recommend the Council to obtain an additional boiler, at a cost of between £2,000 and £3,000, for the electric lighting works.

Kingswood.—The Urban District Council have adopted amended plans for the Hanham light railway, at the same time asking the company to do with less double lines on account of the narrowness of the roads.

Stirling.—The Police Commission on Tuesday agreed to ask the sanction of the Secretary of State for Scotland to borrowing £30,000 for the electric lighting scheme. The contracts amount to £24,500.

Petersfield.—A committee has been formed of local gentlemen to enquire into the advisability of promoting the construction of a light railway from Petersfield to West Meon, and probably to Winchester.

Wrexham.—The Council have resolved that Mr. W. H. Trentham be engaged to report on the subject of electricity for public street lighting, refuse destructor, and motive power for tramway work.

Bath.—A meeting of the Joint Committee of the Corporation will be held shortly for the purpose of considering the question of electric traction. Three routes are proposed by the British Electric Traction Company, Limited.

Heacham.—At the last meeting of the Parish Council the chairman proposed that a small company should be formed to bring the electric light into the village provided the support of the leading inhabitants could be obtained.

Southend.—Mr. J. B. Mitchell, the electrical engineer to the Corporation, estimates that the electrical outfit for the proposed new line of trams from Shoeburyness to Leigh will cost £34,696. This brings the total cost up to £75,000.

Derby.—The Town Council have appointed the Tramways Committee as follows: the Mayor, Aldermen Woodiwiss, Doherty, and Duesbury, Councillors, Butterworth, Dean, Gandy, Horne, Johnson, A. Attewell Stone, and Wilkins.

County of London and Brush Provincial Electric Lighting Company, Limited—With reference to the first issue of £200,000 4½ per cent. debenture stock, we are informed that applications have been received for £1,721,900 of stock.

Wood Green-to-the-Strand.—The Bill previously referred to by us will be submitted for approval to a special meeting which will follow the half-yearly meeting of the Great Northern Railway Company at King's Cross on Tuesday next.

Stock Exchange.—The committee have placed the issue of the Costa Rica Electric Light and Traction Company, Limited, of £130,000 5 per cent. first debentures. Nos. 1 to 1,000 of £100 and 1,001 to 1,600 of £50 each, on the official list.

Sutton Coldfield.—At the quarterly meeting of the Town Council, the General Purposes Committee reported that the Corporation's provisional order for electric lighting had been found in order, and the proofs marked "complete."

Highland Water-Power Bill.—The Perth Town Council have agreed to oppose the proposed Highland Water-Power Bill, on account of the damage to salmon fishing. The inhabitants of Fort William have passed a resolution to support the scheme.

Windsor Castle.—It is reported that the connection of Windsor Castle with the Windsor and Eton Electric Installation Company's service by which the principal apartments of the Royal residence will in future be lighted, will be completed by the 11th inst.

Telegraph Construction and Maintenance Company, Limited. Subject to audit of the accounts, the directors propose paying a dividend of 10 per cent. (£1. 4s. per share), in addition to the 5 per cent. already paid, making 15 per cent. for the year 1898.

Bacup.—At the monthly meeting of the Town Council the minutes of the Lighting Committee recommending that a joint committee of the General Works and Lighting Committees be formed to deal with the entire question of electric lighting was adopted.

Eccleshill.—A satisfactory trial has been made of the extension of the Bolton tramway to Eccleshill by the chairman of the Tramways Committee (Alderman Cowgill) and the electrical engineer (Mr. Gibbinge), accompanied by the contractor's representatives and other officials.

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Walmer.—At the last meeting of the District Council the Chairman said they had consulted with Deal about the electric light, but no report had been presented. He believed, however, that information was being printed which would be in their hands before the next meeting.

Darlington.—The Town Council have consented to the introduction into the borough of an electric system of tramways. The cost is estimated at over £120,000. The distance of the whole of the new tramways will be between nine and ten miles, and nearly all of it double track.

Gateshead.—The Gateshead and District Tramways Company have approved of the Gateshead and District Tramways Bill, now before Parliament. The Corporation are negotiating with the tramways company to get the proposed new tramway to Sheriff-hill extended to Wrekenton.

W. T. Henley's Telegraph Works Company, Limited.—Subject to audit, the directors recommend a dividend on the ordinary shares at the rate of 12 per cent. per annum (including the interim dividend of 4 per cent. already paid) and a bonus of 2 per cent. per annum, less income tax, payable March 1.

Brush Electrical Engineering Company, Limited.—The directors have declared an interim dividend at the rate of 6 per cent. per annum on the preference shares for the half-year ended Dec. 31, 1898, payable on March 1. 1899. The transfer books will be closed from 14th inst. to March 1, 1899, inclusive.

Tunstall.—The District Council have sealed an agreement with the Potteries Electric Traction Company, Limited, by which the company undertake to complete the whole of the tramways in the town on or before April 3, or to pay a penalty of £50 for every day after April 3 during which the tramways remain uncompleted.

St. Marylebone.—At a meeting of the Vestry yesterday a report was received from the Works Committee recommending, as regards the question of extending the incandescent scheme of public lighting in Marylebone-road, that the Vestry take no action in the matter pending the result of the Marylebone Electric Light Bill.

Pembroke.—The Finance Committee of the County Council have under consideration a communication from the agent of the National Telephone Company regarding the establishment of a telephonic system in Pembrokeshire, and exchanges in Haverfordwest, Milford Haven, Neyland, Pembroke Dock, Pembroke, and Tenby.

Swansea.—At the half-yearly meeting of the Mumbles Railway and Pier Company held at Swansea last Saturday, it was stated that the company were in treaty with the British Electric Traction Company, and arrangements were proceeding satisfactorily regarding the working of the Swansea and Mumbles Railway by electricity.

Pontefract.—The Guardians having discussed a report from the Building Committee recommending the lighting of the workhouse and premises with the electric light, by which it was thought the Board would save at least £100, it has been decided to postpone action for a month, and in the meantime obtain the advice of a consulting engineer.

Birmingham.—With regard to the application of Messrs. Dick, Kerr, and Co. for the consent of the Corporation to the construction of several lines of tramway within the city, the concession to be for a term of 21 years, upon certain terms, it has been found that the narrowness of the streets precludes the execution of such a scheme at present.

Liverpool.—The Local Government Board have sanctioned a further loan of £44 000 for electric lighting purposes. The Tramways Committee have ordered the preparation of plan, etc., for six new cars with outside seats, and for the conversion of 12 horse cars into trailers. The work is to be carried out at the Lambeth-road works.

Ipswich.—The report of the Tramways Committee adopted on Wednesday recommended that the Corporation should withhold assent to the Ipswich Company's Order, 1899, with the view of acquiring the undertaking themselves next year, and that it be referred to the committee to negotiate for the purchase of the tramway undertaking by agreement.

Eastern Telegraph Company, Limited.—At an extraordinary general meeting of the shareholders of this Company, held at Winchester House, Old Broad-street, on the 8th inst., a special resolution was confirmed to the effect "that Article 29 of the Company's articles of association be altered by striking out the amount £10 and inserting in lieu thereof £1."

Increase in Prices.—The Electrical Power Storage Company, Limited, have, from 7th inst., increased all prices in their catalogue by 10 per cent. We are informed that this step has been necessitated by the considerable advances in the prices of raw materials, especially lead, during the past few months, and that this increase also applies to all outstanding estimates.

Sheffield.—A sub-committee of the Tramways Committee had recommended that the cars be divided by a partition, and half of the cars be reserved for smokers. The committee, however, did not accept that suggestion, and decided that except in workmen's cars no seats should be reserved for smokers inside cars. This part has now been referred back to the committee so as to provide further facilities for smokers.

Dublin and Lucan Steam Tramway Company.—The report for the half-year ended Dec. 31 last states that, notwithstanding the transition period from steam to electric haulage through which the Company is still passing, the net income of the past half-year will be sufficient not only to pay the debenture interest and preference dividend, but, in addition, to discharge one half-year of the latter, which had been previously in arrears.

Prestwich.—At the meeting of the District Council on the 8th inst., the Chairman reported that a deputation had waited upon the Manchester Corporation with a view to joining in the opposition to the Middleton Light Railway Bill. The Corporation intimated that on a future occasion they would be willing to enter into negotiations as to supplying the Prestwich district with electricity for lighting and other purposes.

Foxcroft and Duncan.—We are informed that this firm have appointed the "Optimus" Works Company, of Birmingham, sole agents for the Midlands for their arc lamps, measuring instruments, etc., and Messrs. Morris, Warden, and Co., of Glasgow, sole agents for Scotland and Ulster for their measuring instruments, also Messrs. James, Mills, and Co., of Salford, agents for their instruments for the North of England.

Newcastle.—A meeting of leading tradesmen is announced for to-day to protest against the adoption of the overhead system of working the proposed electric trams in the city. The Tramway Committee will report to the Corporation at its meeting on Wednesday next that the committee undertake not to proceed with the system of overhead trolleys in the heart of the city until they have received the opinion of an expert, and report to the Council.

Paisley.—The following resolution was agreed to at a meeting of the Town Council recently: "That a committee be appointed to enquire as to the advisability and best method of acquiring and extending the tramways in Paisley, and to report to a future meeting of Council." At the same meeting the Council gave their consent to a Bill promoted by the Glasgow Corporation for forming tramways so far as these tramways were situated in the burgh of Paisley.

St. Martin-in-the-Fields.—The Vestry have decided to oppose the National Telephone Company's Bills and also to request the Corporation of the City of London and the London County Council to oppose the passing into law of the same. Another resolution carried at the same time expressed the opinion of the Vestry that the telephone service ought to be under the control and management of some public authority, such as the Corporation or the County Council.

Chelmsford.—The Chelmsford Electric Lighting Company, Limited, are sending a letter to each member of the Chelmsford Corporation confirming the offer of their undertaking to the town, which Mr. Reeves, their secretary, made on their behalf at the last meeting of the Town Council. The directors are prepared, if the Corporation entertain the proposal, to convey the whole property, including the mains and other work in the streets, to the Corporation at cost price (£38,000).

Crosby.—The surveyor has been instructed to report upon the question as to the cost and practicability of electrically lighting the Serpentine, Blundellsands road, Burbobank-road, Nicholas-road, and Warren-road. A letter from the Waterloo District Council has been received by the Urban District Council stating that the delay with the overhead railway complained of was owing to the rise in the price of the setts. The Telephone Company's Bill is receiving the attention of the Council.

Bournemouth.—At a meeting of the Town Council last week the Electric Lighting Committee reported upon a correspondence from Messrs. Martin and Leslie on objections lodged by the Bournemouth and District Electric Supply Company, Limited, and the Bournemouth and Poole Electricity Supply Company, Limited. The town clerk was instructed to prepare answers and to ask Messrs. Lacey, Clirehugh, and Sillar to report on the condition and efficiency of the company's works. This was agreed to.

Aberdeen Music Hall Company.—At the general meeting of this Company, Mr. Alex. Webster, the chairman, said, with regard to the proposed scheme of redecoration of the music hall and the introduction of the electric light, that it still remained for the directors to go into the matter in detail in consultation with experts, and they proposed to leave it an entirely open question whether they should light the music hall entirely with electric light or whether the lighting by gas could not be advantageously retained to a certain extent.

Swansea.—The Local Government Board have sanctioned the proposed loan of £60,000 for electric lighting purposes. A sub-committee has been authorised to deal with the tramways company's parliamentary application for powers for the extension of their system. At a meeting of the Tramways Electric Lighting Committee of the Corporation, estimates of the cost of the electric lighting scheme and plans submitted by the tramway company for placing in the streets feeder and other cables and relaying the tramway were discussed. The latter were accepted.

Nelson.—A sub-committee of the General Purposes Committee of the Town Council have resolved that notice be given for an extension of line of light railways from Nelson centre to the boundary of the borough at Newbridge, and that the sub-committee visit Halifax and Leeds to inspect the narrow-gauge railways there. It has also been resolved that the Light Railways Sub-Committee have full authority to oppose the application of Messrs. Greenwood and Batley, Limited, of Leeds, with respect to proposed light railway (Nelson, Colne, and Trawden).

Stoke Newington.—At a special meeting of the Vestry on Tuesday last correspondence was considered from the Vestry of St. Mary, Battersea, asking the Vestry to oppose the powers sought to be acquired by the County of London and Brush Provincial Electric Lighting Company's Bill to connect the company's areas of supply, and to break up and otherwise interfere with

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streets in the intervening districts, and also inviting the Vestry to appoint three delegates to attend a conference to be held at the Municipal Buildings, Lavender-hill, S.W., on the 16th inst., at 7.30 p.m.

Brighton.—The report of the Lighting Committee adopted at the quarterly meeting of the Town Council stated that it was resolved to erect several public street lamps, and to lay feeding mains in Kemp Town, Edward-street, Bond-street, and Victoria-road at an estimated cost of £7,189. 9s. It was also resolved that steps should be taken to appoint an assistant manager, but that the consideration of the details of the appointment should be deferred for one month. Exception was taken to this part of the report, and considerable discussion ensued. Finally 14 voted for and 28 against the exception.

Lincoln. — The Town Council have decided to request Mr. C. H. Seely, M.P., to oppose the General Power Distributing Bill in the House of Commons. The Finance Committee is about to raise the balance (£2,089. 10s. 5d.) of the £20,650 authorised to be borrowed for electricity purposes. In accordance with a report by Mr. Vesey Brown, the Council have decided to empower the Electricity Works Committee to obtain tenders for engines, dynamos, motors, boilers, and fuel economiser for the proposed additions and extensions, and also to lay the electric cable in the streets referred to in the report.

City of London Electric Lighting Company, Limited.—We are informed that, subject to the final audit of the accounts, the directors have decided to recommend to the shareholders the payment of the following dividends: on the preference shares a final dividend of 6s. per share for the six months ended Dec. 31, 1898, making, with the dividend already paid, a total distribution of 12s. per share, or at the full rate of 6 per cent. per annum; on the ordinary shares a final dividend of 3½ per cent. on the capital paid up, making, with the dividend of 2½ per cent. paid on account last July, a total dividend of 6 per cent. for the year ended Dec. 31, 1898.

Appointments Vacant.—The Electric Lighting Committee of the Hull Corporation are prepared to take an electrical improver into their electric light works for a period of two years, at a premium of £30. The Leyton Urban District Council are prepared to receive applications for the appointment of electrical engineer; the commencing salary will be £250 per annum, rising by annual increments of £25 to a maximum of £400 per annum. The Southport Corporation invite applications for the position of an electrician-in-charge at their electricity works; wages 40s. per week. For particulars of these and other vacancies refer to our advertising columns.

Worthing.—A special meeting of the Town Council is to be called to consider the report of the Electric Lighting Committee recommending that their engineers be instructed to complete the preliminary plans and furnish the necessary information to enable the Council to apply to the Local Government Board to sanction a loan of £35,000 for electric lighting works. The committee added that, having considered the borough surveyor's report on the question of the provision of a refuse destructor in connection with the electricity works, and the probable financial effect attending the construction and use of a destructor, it had been decided to eliminate this from the electric lighting scheme.

Edison and Swan United Electric Light Company, Limited. We have received from this Company illustrations and particulars of their "Chameleon" lamp envelope. The idea of this envelope is to do away with the need of a coloured-glass lamp, which often gives rise to annoyance on account of the length of time taken by electrical firms in executing orders. With this lamp envelope, which can be obtained in any colour, and in four different styles, clear-glass lamps can be used. A complete set, with interchangeable coloured glass at the bottom, is also catalogued. This is a very useful arrangement when various coloured effects are required from the same lamp, as, for instance, in connection with table lighting.

Acton.—At a meeting of ratepayers held at the Working-Men's Club, Acton Green, last week, a resolution was carried to the effect that the ratepayers were strongly opposed to the proposal before the Urban District Council to give a monopoly of the supply of the electric light in Acton to a private company for any term of years at a fixed price, and urging upon the Council to withdraw the same. The Council proposes to take the current from the Metropolitan Electric Supply Company in bulk at a cost of 3d. per unit, besides finding the cost of all mains and distribution wires. It is claimed that this outlay would make the price of the current prohibitive, besides taking away from the ratepayers any profits which might arise.

Rochdale.—A deputation is to wait upon the Local Government Board in order to press for a decision with reference to the application of the Town Council for sanction to borrow £30,000 for purposes of electric lighting. The following Bills will be opposed on behalf of the Corporation: General Power Distributing Company, Lancashire Electric Power Company, South Lancashire and Cheshire Electricity Company, Leicestershire and Warwickshire Electric Supply Company, and Midland Electric Power Distribution and Lighting Provisional Order. A petition against the Bills promoted in Parliament by the Lancashire Electric Power Company and the South Lancashire and Cheshire Electricity Company, has been sealed.

Belfast.—From the minutes which were passed at the last meeting of the Corporation, it appeared that the town clerk reported that the provisions of the Belfast Water Bill affected the Corporation in several respects regarding the streets, gas and electrical mains, wires, and pipes, and he was instructed to have amendments drafted and furnished to the solicitors for the Bill. He also reported that the National Telephone Company's Bills, as lodged in Parliament, would give the company power over the streets for the erection or laying down of their wires, but the agents for the Bills have intimated that Belfast will be exempted from the powers of the Bills. On this being done it will not be necessary to take action in the matter.

Eccles.—The town clerk has submitted a report on the subject of the parliamentary Bills, 1899, of the Manchester and Salford Corporations, the Lancashire Electric Power Company, and the Lancashire and Cheshire Electric Company. The Corporation will petition against the Manchester and Salford Corporation Bills respectively, with a view to obtaining a *locus standi* in the matter. The Mayor has been appointed a member of the sub-committee appointed to deal with the promotion of the Eccles Tramways Provisional Order, 1899; and the Electricity Committee have been authorised to take such action as they may deem desirable in regard to the above-mentioned Bills of the Lancashire Electric Power Company and the South Lancashire and Cheshire Electricity Company.

Blackburn.—At the monthly meeting of the Town Council, Mr. Crossley, vice chairman of the committee, said, in reply to questions as to the cause of the delay in the completion of the electric tramway system, that it was entirely owing to the contractors, who were subject to penalties for the very serious delay which had undoubtedly occurred. The committee were powerless owing to the non-delivery of motors. A most satisfactory trial trip had taken place with the one completed car. The recommendation of the Tramways Committee that advertising be not permitted on the new electric cars was agreed to. The Parliamentary Committee propose to petition against the Lancashire Electric Power Company's Bill in order to safeguard the Corporation's own electric undertakings.

Old Swindon.—The Urban District Council have adopted a report of the Incorporation Committee recommending that the Old Swindon Council be asked to co-operate with the New Swindon Council in a joint electric lighting installation, and that power be sought by the scheme of incorporation to extend the area of the New Swindon provisional order to include the area of the whole of the proposed borough; also that it be a recommendation to the two Councils that they should empower the Incorporation Committee to go further into the question of joint electric light installation, and to bring up a recommendation to a joint meeting of the two Councils. A letter which had been received from the North Wilts Electrical Company has been received, read, and referred to the Incorporation Committee.

Aldershot.—At the meeting of the Urban District Council on Wednesday last a resolution was carried affirming: "That this Council consider it undesirable to transfer the powers held by them under the electric lighting provisional order to any company, but do hereby resolve to lay down, within the limited period, an installation of the electric light, which shall be under the direct management of this Council." The amount required will be about £11,000. Another resolution which was on the agenda was not proceeded with. It read as follows: "That directly the transfer of the parish clerk's land to this Council is effected the Electric Lighting Committee shall prepare the necessary plans and obtain tenders for laying down an installation of the electric light, as recommended in the surveyor's report."

Macclesfield.—The Town Council at a meeting last week adopted a resolution to the effect that the attention of Mr. W. Bromley-Davenport, M.P. for the Macclesfield division, Cheshire, be called to the following Bills with report from the Council, that he will oppose the same on second reading—viz., the General Power Distributing Company, Lancashire Electric Power Company, South Lancashire and Cheshire Electricity Company, Leicestershire and Warwickshire Electric Supply Company, and Midland Electric Power Distribution and Lighting Provisional Order, and that the corporate seal be affixed to a petition in opposition to and praying to be heard against the Bill promoted in Parliament by the Lancashire Electric Power Company. It was also decided to oppose the Bills promoted by the National Telephone Company.

Electrical Company's Measuring Instruments.—We have received from the Electrical Company, 122 and 124 Charing Cross-road their new list of measuring instruments for various purposes. This list is most complete, and we are glad to see introduced illustrations of the various dials of voltmeters and ammeters which can be obtained from stock, with other instruments that are wanted without delay. It will be found a great advantage to select scales from an illustrated list in this way. Also dealt with are electricity meters of the new alternate-current type which has recently been introduced by the company. At the end of the list will be found details of wattmeters for three-phase currents, and also phase-meters for single and multi-phase currents, which we hope will soon be found on the market in England owing to the increase in the systems requiring the same.

Smoke Nuisance.—The City of London Electric Lighting Company, Winchester-street, City, were summoned by Inspector Grist, of St. Saviour's Board of Works, for allowing black smoke to issue from a chimney on their premises, Meredith's Wharf, Bankside. Mr. Topham, solicitor, appeared in support of the summons issued, and Mr. Pasmore, who defended, complained that the Board of Works had been too hasty in launching the batch of summonses They commenced the proceedings five days after the last conviction, before the company could have had time to get a better quality of coal. It was submitted that the company were doing everything

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possible to prevent a nuisance. They did not burn Welsh coal because they found it was ineffectual. They tried it once, and were summoned for allowing black smoke to issue. Eventually Mr. Slade consented to visit the premises, and the further hearing was adjourned for that purpose.

Torquay.—Mr. P. Storey, electrical engineer, reported on Tuesday to the Town Council that there are at present 111 private consumers of electric light, 16 more than in December. The revenue for the quarter ended Dec. 25 was £767. Mr. H. A. Garrett, borough engineer, presented a report on the collection and disposal of house refuse, and the working of the new refuse destructor. The cost of collecting refuse in December last amounted to £85. 17s., as compared with £118. 11s., the cost in the previous December. This reduction of £32. 13s. a month was due to the refuse destructor, which reduced the number of workmen necessary. Mr. Garrett stated that tests with the destructor justified him in recommending the extension of the electrical plant by the provision of a battery of accumulators of sufficient power to provide light for lighting the three public roads around the destructor, in addition to lighting the works. The whole cost would not exceed £400.

Leeds Chamber of Commerce. — The monthly meeting of the council of the Leeds Incorporated Chamber of Commerce was held on the 7th inst. Mr. Ewing Matheson, retiring president, who presided, said, with regard to the Bill which is coming before Parliament in regard to the distribution of electrical energy, that, though the district concerned was not within 50 miles of Leeds, the authorities of the city had signified their intention of opposing the scheme. If the Bill was to be opposed in the name of Leeds, the Chamber ought to be prepared to express their views on the question. It was referred to the Parliamentary Committee to deal with this matter as well as with a communication from the Associated Chamber calling attention to measures which were being promoted by a large number of local authorities dealing with the generation and distribution of electricity, and strongly objecting to trade competition by local authorities in electrical appliances.

Cardiff.—The estimates for the Corporation electricity works, covering the half-year ending September, 1899, which were accepted at a meeting of the Lighting Committee of the Council last week, contains the following items, for which we are indebted to the *South Western Daily News*: The total estimated expenditure for the half year amounted to £2,313. 4s. The heaviest item was that of wages at the generating station, the figure being £690. Coal charges were estimated to reach £350. The estimated revenue for the six months was put down at £3,007. 10s. For the corresponding six months of last year the estimated expenditure was £2,250, and the actual expenditure £2,141. 3s. 2d, in the latter being an item of £26. 9s., covering the committee's expenses to London and damage to cab. Plans have been prepared showing that improvements had been made in the lighting of various streets. The Corporation held a special meeting last week, when a motion to allow the tramways company to double certain portions of their lines was carried.

Guildford.—The Albury Parish Council have informed the Rural District Council that the resolution opposing the extension order of the Guildford Electricity Supply Company had been confirmed at a meeting of the Council, who were of opinion that the whole of Albury should either be included or excluded from the order. The company was willing to include the whole of Albury if the District Council would permit this course. The Rural District Council have now passed a resolution consenting to the proposed application of the Guildford Electricity Supply Company, Limited, to the Board of Trade for the extension of the company's area to so much of the area of the Guildford rural district as lies within a radius of 3½ miles from the town hall, Guildford, excepting such part of the parish of Send and Ripley as lies within such radius, the company undertaking to abandon their application for extension of their area to the remainder of the area of the District Council, with the addition that the remaining portion of Albury be included.

Eastbourne.—At the quarterly meeting of the Town Council on Monday the Electric Lighting Committee's proceedings were adopted. The committee recommended a modified offer to be made to the company for the purchase of their undertaking, this being a slight increase of £1,549. They had proposed to give practically £20 a share, and this had been taken up as implying an offer clear of all liabilities on capital account, and it had been pointed out that having regard to these liabilities the offer did not quite reach that amount. The committee, therefore, proposed to make up the deficiency, and treating the present share capital as £25,105, that at £20 for every £10 would be £50,210. They would have to add £29,925, £3,401 to repay amount over expended on capital account, £2,000 compensation to officers, £4,152 for new machinery on order, making a total of £89,688, which, less depreciation and reserve funds, £6,275, left a net total of £83,413. The Council will petition against the Bills to be presented to Parliament by the National Telephone Company.

Scottish Conservative Club.—At the twenty-second annual meeting of the Scottish Conservative Club held at Edinburgh last week, Mr. James Haldane in the chair, the report of the committee, which was adopted, stated that a sum of £944. 12s. 2d. had been charged under extraordinary expenditure on account of electric light fittings, rewiring, and extension, including consulting electrical engineer's fee. The committee had come to the conclusion that it would be more advantageous and more economical for the club to generate its own electricity. The committee proposed to provide, in duplicate, at an estimated cost of about £1,750, a plant of such capacity as would suffice, in the first instance, to efficiently light all parts of the clubhouse, and, with some inconsiderable additions, powerful enough to supply also the energy needful to work a lift should it be decided to have one. The plant would be sufficient to drive such other mechanical appliances as might at any time be adopted for improving the general ventilation of the club or for other purposes.

London County Council.—At the usual weekly meeting of the Council held at the County Hall, Spring-gardens, on Tuesday, it was agreed to lend the Hampstead Vestry £2,560 for electric lighting purposes; the St. Pancras Vestry £30,000 for electric lighting works; and the Shoreditch Vestry £14,375 for various works. Replying to questions on the report of the Highways Committee, Mr. Benn stated that, with regard to electrical traction, they were advised that under one of the tramway company's Acts they had power to once proceed to institute electrical traction on the south side of the river without obtaining further parliamentary power. Notices of intention to lay mains from the following applicants were approved of: Blackheath and Greenwich District Electric Light Company, Charing Cross and Strand Electricity Supply Corporation, under the St. Martin's order; County of London and Brush Provincial Electric Lighting Company, under the Wandsworth order, 1892; and House to House Electric Light Supply Company. A notice was received from Messrs. Kincaid, Waller, and Manville, on behalf of the Vestry of St. Mary, Newington, of intention to lay mains along South-place and St. Agnes-place; the Vestry being the undertaker under the order, the Council had no power of approval or disapproval of the works.

Llanelly.—A meeting of the Property and Estate Committee of the Borough Council was held at the town hall last week, when the Clerk stated that in 1891 a provisional order for electric lighting of the town was obtained from the Board of Trade. A year later the Council decided to obtain estimates and tenders for the fixing of the plant and several tenders were received, and the surveyor estimated the cost at about £10,000. The Council also decided to seek the assistance of an electrical engineer with a view of getting some information as to which scheme was the most workable. That proposal was eventually abandoned. Later on, Mr. J. C. Howell wrote to the Council applying for permission to take over the powers they had received under the order. The Clerk at the time stated that about £200 expense had already been incurred in obtaining the order, and it was decided to offer Mr. Howell the order for that amount. This he had agreed to accept, but the agreement was never executed. Recently the Board of Trade had enquired whether the Council intended to carry out the provisions contained in the order, and if not, it would be cancelled. The Surveyor stated that he had convinced a large number of residents to take the electric light, and received promises to the extent of about £600. A letter was read from an electrical expert stating that he would be pleased to furnish a report upon the probable cost of electricity, etc, at a cost of £35. The clerk was authorised to make enquiries as to the capabilities of this consulting engineer, and the surveyor is to furnish a report as to the probable cost of maintenance at a further meeting of the committee.

Fulham.—At the Vestry meeting last Wednesday the consulting engineer submitted a report stating that he suggested that invitations to tender should be sent at once to Messrs. Siemens Bros. and Co., Limited; S. Z. de Ferranti, Limited; Brush Electrical Engineering Company, Limited; Johnson and Phillips; Mather and Platt, Limited; British Insulated Wire Company, Limited; Crompton and Co., Limited; John Fowler and Co., Limited. He says the benefits arising from the adoption of this course are that matters are expedited, and that advantages arise from having one good firm responsible for the whole work. The cost of a few parts of work may be somewhat increased; but there being as many as eight firms included in the above list, the salutary effect of competition will not be absent. The Lighting, Electric Lighting, and Dust Destructor Committee recommended that the report of the consulting engineer be approved and adopted. The consulting engineer submitted the following report on the Horsfall Furnace Syndicate's contract: "As instructed by you, I wrote to the contractors for your destructor and boiler plant on the 20th inst. instructing them to 'at once' commence the works comprised in their contract with the Vestry. I received an acknowledgement of the instructions on the 22nd inst., and I have no doubt but that they will without delay start on the construction of the chimney shaft, and the rest of the works covered by their contract." Delegates were appointed to attend the conference of London vestries and district boards to be held on Thursday, Feb. 16, 1899, for the purpose of considering the desirability of taking combined action to oppose the Bill of the County of London and Brush Provincial Electric Light Company.

Kensington.—Negotiations have been opened up with the solicitors acting for the promoters of the Brompton and Piccadilly-Circus Railway (Extension) Bill, with the result that they have consented to insert a clause therein by which all the provisions of the section which appears in the same company's Act of 1897 for the protection of the Vestry's interests will be operative in regard to the further works under the present Bill. Notices and plans from the under-mentioned electric lighting companies relative to extensions of their mains have been agreed to under the usual conditions: Kensington and Knightsbridge Electric Lighting Company, Notting Hill Electric Lighting Company, and the House-to-House Electric Light Supply Company. The report of the Special Electric Lighting Committee states that, in accordance with the resolutions passed by the Vestry on Nov. 23 last, a memorial embodying the application of the Vestry for an electric

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lighting provisional order was duly prepared and presented to the Board of Trade, and that objections have been lodged thereto by the Vestries of Chelsea and Hammersmith, by the Chelsea Electricity Supply Company, and by the Kensington and Knightsbridge and Notting Hill Electric Lighting Companies. In view of the failure to come to an agreement upon the more comprehensive scheme previously proposed, it devolved upon the committee to consider upon what terms the Vestry might be recommended to approve the portion of the Kensington and Notting Hill Electric Lighting Bill relating to the acquisition of the said site of land, and they deemed it desirable to appoint a sub-committee to interview the directors of the two companies upon the subject. At the interview between the directors of the companies and the sub-committee, the following terms, which were submitted as being a basis of negotiation, were fully discussed and accepted by the representatives of the companies: (1) that the area of land to be taken under the Bill be reduced in extent to 3¼ acres or thereabouts; (2) that the price to be paid for the land be a sum to be agreed upon as between the Vestry and the companies, or, in the event of non-agreement, to be determined by jury or arbitration at the option of the Vestry; (3) that the companies do contribute towards the cost of the formation of the road and sewer up to the north-east corner of the Central London Railway property the sum of £500, and do pay the sum of £50 per annum towards the maintenance of the said road and sewer; (4) that the Vestry and companies shall bear in equal proportion the cost of forming and maintaining any railway siding constructed for their joint use; (5) that in the event of powers being obtained for the acquisition of the Wood lane side, the Kensington and Knightsbridge Electric Lighting Company do undertake not to proceed with their application under the Bill for powers to take the Stanford-road site referred to in the second schedule; (6) that likewise the Notting Hill Electric Light Company do undertake to amend the provisions of Clause 11 of the Bill, so that the company shall only be entitled to generate electricity at the site proposed to be acquired in Lancaster-road, with the approval of the Vestry as the local authority; (7) that the companies shall contract to supply all electricity required for public purposes, whether for street-lighting or for the parochial and municipal buildings and depôts, the maintenance of which is borne by the rates, at 2½d. per unit, subject to revision in 1903; (8) that, in consideration of the Vestry abandoning their application for a provisional order and supporting by petition the Bill of the companies so far as the same relates to the Wood-lane site, the companies do agree to pay all legal costs and charges incurred by the Vestry up to the present time in connection with the promotion of the said order, provided that the maximum payment by the companies under this head shall not exceed the sum of £250; (9) that the legal and parliamentary charges incurred by the Vestry in connection with the companies' Bill during its passage through both Houses of Parliament shall be defrayed by the companies. With regard to the charges of the companies for supply of electricity to private consumers, the committee have received an assurance from both the companies that, as soon as the joint station on the Wood-lane depôt is constructed and properly equipped, the charge to private consumers will be reduced. In the case of the Notting Hill Company a definite undertaking has been given that their price for the 200-volt pressure shall be reduced to 5d. per unit. The committee have been furnished with the following prices: Notting Hill Electric Lighting Company—the price at 100 volts is 8d. per unit, and at 200 volts 6d. per unit, subject to rebates, the charge for power and heating is 4½d. per unit; Kensington and Knightsbridge Electric Lighting Company—the price at 100 volts is 6d. per unit, and at 200 volts 5d. per unit, subject to rebate, day loads or power at 200 volts 4d. per unit, special power loads at 200 volts 3d. and 3½d. per unit. The committee have come to the conclusion that it would be wise on the part of the Vestry to come to an agreement with the companies on these terms, and they recommend that an agreement be entered into accordingly, and that upon the execution of this agreement the Vestry notify the Board of Trade of their intention to abandon their application for a provisional order as regards the areas of these companies, and to take all such other steps as may be necessary to secure the withdrawal of the said application; also that upon the House-to-House Electric Lighting Company agreeing to the terms arranged with the other two companies as regards the price of electricity for public purposes, and upon their giving a satisfactory assurance that the price to private consumers shall be reduced at an early date, the application for the provisional order as regards their area be also abandoned.

PROVISIONAL PATENTS, 1899.

JANUARY 30.

2044. A method of varying the electromotive force of—and consequently the current in—a circuit carrying an alternating current of electricity. Joseph Hutton, 37, Huntriss-row, Scarborough.

2068. An improvement in conveying electric current to portable fittings for lighting or to motors and other electrical purposes. Frederick Clare Melhado, 39, Bedford-row, London.

2074. An improved electric arc lamp. Charles Eschwei, 31, Southampton-buildings, Chancery-lane, London.

2104. Improvements in electrically-illuminated signs or advertisements. John Hunter, 6, Lord-street, Liverpool.

JANUARY 31.

2118. Improvements in or connected with the manufacture of electrical cable or conductor conduits. Arthur Musker, 15, Water-street, Liverpool.

2129. Improvements in or relating to means for preventing the creeping of acids or other deleterious matter in electrical apparatus. Job Thomas Niblett and Malcolm Sutherland, 61, Chandos-street, Strand, London.

2130. Improvements in safety devices for electromagnetic circuits. Bertram Thomas, Cornbrook Telegraph Works, Manchester.

2131. An improved means or apparatus for reducing or extinguishing the electric arc formed on breaking electrical circuits. Richelieu Acock, 31, Sholebroke-view, New Leeds, Yorks.

2144. Improvements in and relating to primary batteries. Thomas Heffernan, 7, Quality-court, Chancery-lane, London.

2165. An improved cover of electrical cells. Lothar Fiedler and Emil Jäckel, 102, Burdett-row, Bow, London.

2166. An elastic support for electrodes. Lothar Fiedler and Emil Jäckel, 102, Burdett-row, Bow, London.

2170. Electric heating apparatus. Alexander Ritchie Leask, 91, Minories, London.

2171. Improvements in electric heaters. Alexander Ritchie Leask, 91, Minories, London.

2174. An improvement in commutator brushes for electrical machines. Siemens Bros. and Co., Limited, and Alexander Siemens, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

2175. Appliance for automatically regulating the frictional pressure on the rails of the driving wheels of electrically-propelled vehicles. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

2176. Safety appliances in connection with overhead or exposed conductors of electrical railways and tramways. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.)

2177. Method of supplying electrical energy to motor vehicles from two overhead conductors. Siemens Bros. and Co, Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.)

2218. Improvements in electrical cut-outs. Martin Schmidt, 40, Chancery-lane, London. (Complete specification.)

FEBRUARY 1.

2246. Improvements in electrical gas-lighting appliances. James Frederick Bennett and Walter Appleyard, Don Confectionery Works, Sheffield.

2268. A new or improved cord grip for electric lampholders, fittings, and the like. Frederick Brown, 22, Glasshouse-street, Regent-street, London.

2273. Improvements in electro-therapeutics. Charles Aubrey Day, 321, High Holborn, London. (Henry Gibson O'Neill and John Rooney, United States.)

2280. Improvements in electric arc lamps. Emil Frischauer and Anton Othmar Simmonier, 4, South-street, Finsbury, London.

2288. Improvements in or relating to accumulator plates. Paul Ferdinand Ribbe, 322, High Holborn, London. (Complete specification.)

2299. Improvements in the manufacture of electric accumulators or secondary batteries. John Garfield Hathaway, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

2303. Improvements in and relating to electrical conductors. William Alfred Phillips, 323, High Holborn, London.

2304. A new or improved method and means for fireproofing insulated wires and cables. William Alfred Phillips, 323, High Holborn, London.

2305. Improvements in means for covering wires and cables William Alfred Phillips, 323, High Holborn, London.

FEBRUARY 2.

2341. Improved apparatus for branding by electricity. William Phillips Mendham, 1 and 2, Quay-head, Bristol.

2350. A new or improved method of connecting electric telephonic apparatus as a system. Francis George Bell and Max Byng, 73, St. Stephen's-road, Upton Park, London.

2358. Improved arrangement for exciting the magnets of dynamo-electric machines. Max Deri, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

2362. Improvements in apparatus for regulating vehicles propelled by electric motors. Henry Francis Joel, jun., 55, Northbrook-road, Ilford, Essex.

2369. Improvements in the manufacture of electrodes and division plates for secondary batteries. William Moore McDougall, 45, Southampton-buildings, Chancery-lane, London.

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2377. Improvements in electric igniting devices. Hedley Baring Rees, 322, High Holborn, London.

2386. Improvements in apparatus for use in connection with wireless telegraphy. Max Julius Nehemias and Heinrich Friedrich Arend Schröder, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

2396. Improvements in and relating to the fixing of insulators for carrying electric line wires. Hugo Fleischhacker, 1, Broad-street-buildings, Liverpool-street, London. (Complete specification.)

FEBRUARY 3.

2422. An automatic guard or safety appliance for use on electric cable or other tramcars, motorcars, and the like. James Lennie, 115, St. Vincent-street, Glasgow.

2425. Improvements in and connected with the trolleys of electric railways. Arnold Hartley and James Rhodes, Penny Bank-chambers, Halifax.

2428. Improvements in electric switches. Henry Charles Gover and Jan Meines Huisman, 62, St. Vincent-street, Glasgow.

2454. A new or improved method of and means for electrically connecting railway carriages, vans, and locomotive for communication or signalling purposes. Daniel Cunningham, 22, Glasshouse-street, Regent-street, London.

2459. "Hague's telephenograph attachment." James May Hague (professional name Clarence Hague), 7, Lupus-street, St. George's-square, London.

2482. Improvements in means or apparatus for recording and repeating and retransmitting Morse characters for use with telegraphic instruments. Charles Stevens, Charles Clement Vyle, and William Milner, 23, Southampton-buildings, Chancery lane, London.

2507. Improvements in and in connection with primary battery electric generators. Haydn Thies Harrison, 46 Lincoln's-inn-fields, London.

FEBRUARY 4.

2525. Improvements in or connected with electric batteries. John Laskey Dobell, 57, Chancery-lane, London.

2527. Improvements in electric safety fuses for high-voltage circuits. Oliver Moon and John A. Loughlin, Luna Electric Works, Harpurhey, Manchester.

SPECIFICATIONS PUBLISHED.

1897.

29505. Magnetic telegraphy and telephony. Lodge.

1898.

1002. Electricity-measuring instruments. Voysey and Wilson.

1011. Holders or sockets for electric incandescent lamps. Bott.

1046. Method and electromagnetic cut-out for automatically disconnecting charged conductors in the event of breakage or short-circuit, applicable to overhead systems of electric traction and the like. Quin.

1564. Electric striking mechanism for clocks and the like. Whidbourne.

2423. Manufacture of filaments for incandescent electric lamps. Mullard.

3365. Telephone systems. Sinclair and Aitken.

4747. Means for counterbalancing the frictional resistance in alternating-current motor meters. Siemens Bros. and Co., Limited. (Siemens und Halske Aktien-Gesellschaft.)

5029. Regulating apparatus for arc lamps. Leitner.

5034. Electrolytic electrical meters. Bastian.

5065. Arc lamps. Belfield. (Davis and Conrad.)

5705. Manufacture and production of electrodes for secondary batteries. Pieper.

6022. Primary, voltaic, or galvanic batteries. Lafargue and Drouet.

6025. Draw and junction boxes for electric mains. Sykes.

9712. Telephones and circuit arrangements and relays therefor. Lodge.

18847. Electric batteries. Fuld.

22686. Magnetic brakes. Pitt. (The Elektrizitäts Aktiengesellschaft, vormals Schuckert und Co.)

23503. Devices for controlling the operation of electric motors. Lake. (See.)

23534. Governors for air-compressors driven by electric motors. The British Thomson-Houston Company, Limited. (Libby and Potter.)

23983. Coin-controlled telephones. Thompson. (Kahrs.)

24641. Secondary batteries. Edgerton and Masters.

24655. Electric cables. Greenfield.

24992. Telegraphic receivers. Giorgi.

25479. Electric igniter or sparker for gas, oil, or vapour engines. Canfield.

25567. Apparatus for transmitting motion to a distance by means of electrical energy. Siemens Bros. and Co., Limited. (Siemens und Halske Aktien-Gesellschaft.)

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1899.	Corresponding week 1898.	Increase or decrease.	Total receipts for half-year. 1899.	1898.
		£	£	£	£	£
Birmingham Tramway	Feb. 4	3 550	3,487	+ 63	18,591	17 558
Blackpool and Fleetwood Tramroad	,, 4	172	—	—	737	—
Bradford City Trams	,, 5	145	—	—	6,733‡	—
Bristol Tramways and Carriage Co.	,, 3	2 275	2,276	- 1	—	—
City and South London Railway	,, 5	1,135	1,063	+ 72	6,688	6,456
Dover Tramways	,, 4	125	101	+ 24	712	538
Dublin U.T., elec. cars	,, 3	826	718†	+ 108	3,837	3,541†
Dublin S.D. Electric Tramways	,, 3	551	397	+ 154	2,905	2,066
Halifax Corporation Tramways	Jan. 25	295	—	—	7,884*	—
Liverpool Overhead Railway	Feb. 5	1,273	1 283	- 10	7,824	8,130
South Staffordshire Tramways	,, 3	587	603	- 16	2,898	2,957

* Since June 29, 1898. † Including horse cars. ‡ Since July, 1898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	20-21
Bournemouth and Poole Electric Supply, Limited, Ord.	10	12½-13½
—— 4½ per cent. Cum. Pref.	10	10½-11½
British Electric Traction, Limited, Ordinary, Nos. 1-80,000	10	17-18
—— 6 p. c. Cm. Pf., 80,001-40,000 (all paid)	10	13¾-14
—— 5 per cent. Perpetual Debenture Stock	10	120-122
Brush Electrical Engineering, Limited, Ordinary	2	1¾-2⅛
—— Non. Cum., 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	114-116
—— 4½ per cent. 2nd Debenture Stock	100	101-104
Callender's Cable Company, Debentures	100	110-113
—— Ordinary	5	10½-11½
Central London Railway, Ordinary	10	9½-10½
——	8	7⅞-8⅛
—— Pref. Half-Shares	3	3⅛-4
——	5	4-4½
Charing Cross and Strand	5	11-12
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	9-10
—— 4½ per cent. Debentures	100	114-116
City of London, Ordinary	10	23-24
—— ,, 90,001-100,000	10	22-24
—— 6 per cent. Cumulative Pref.	10	15½-16½
—— 5 per cent. Debenture Stock	100	125-130
City and South London Railway, Consolidated Ordinary	100	71-73
—— Ordinary	3	4⅛-5⅛
—— 4 per cent. Debenture Stock	100	133-135
—— 5 per cent. Pref. Shares	10	14½-15½
—— ,, ,, '96	10	14-15
County of London and Brush Prov. Elec. Light Co., Ord.	10	12½-13½
—— ,, ,, No. 80,001-40,000	10	12-13
—— 6 per cent. Cum. Pref.	10	14½-15½
Crompton and Co.	3	2⅛-3⅛
—— 5 per cent. Debentures	—	98-101
Crystal Palace District, Ordinary 5 per cent. Stock	100	130-135
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2½-3
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	97-99
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5-5½
Electric Construction, Limited	2	2½-2⅝
—— 7 per cent. Cumulative Pref.	2	3-3½
—— 4 per cent. Perp. 1st Mort. Deb.	100	103-105
W. T. Henley's Telegraph Works, Ordinary	10	25-26
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	111-116
House-to-House Company, Ordinary	5	9-10
—— 7 per cent. Preference	5	9½-10½
Imperial Tramways, Limited	6	20-21
India Rubber, Gutta Percha, and Telegraph Works	10	22-23
—— 4 per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	13-14
London Electric Supply, Ordinary	3	3½-4
—— 6 per cent. Pref.	5	6½-7
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	103-105
Metropolitan Electric Supply, Limited, Ord., No. 1-62,500	10	18½-19½
—— ,, ,, No. 62,501-85,000	4	12-13
—— 4½ per cent. First Mortgage Debenture Stock	100	118-121
National Telephone, Ordinary	5	5½-6
—— 6 per cent. Cum. First Pref.	10	14-16
—— 6 per cent. Cum. Second Pref.	10	13-15
—— 5 per cent. Non. Cum. Third Pref.	5	5½-6½
—— 3½ per cent. Deb. Stock, Red.	100	99-101
Notting Hill Electric Lighting Company, Limited	10	17½-18½
Oriental, Limited, 1879	1	1½-1⅝
—— £5 Shares	5	7½-7⅞
—— £4½ Shares, New	4½	6½-6⅞
Oriental Telephone and Electric Company	1	⅞-1
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6½-7½
Royal Electrical Company of Montreal	1½	160-165
—— 4½ per cent. First Shares Mortgage Debentures	100	107-109
South London Electric Supply, Ordinary	3	3⅛-3⅜
St. James's and Pall Mall, Limited, Ordinary	8	16½-17½
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	37-41
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	100	109-112
Westminster Electric Supply, Ordinary	5	15½-16½

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NOTES.

The Glasgow Philosophical Society.—In connection with this society, a lecture by Mr. A. A. Campbell-Swinton has been arranged for March 1. The subject of the lecture will be "Electrical Discharges in Vacuo and the Röntgen Rays."

The Pacific Cable.—Mr. Chamberlain on Tuesday last, in answer to a question by Mr. Hogan, stated that as yet no decision had been come to by the Imperial Government as to the action it would take with respect to the proposed co-operation with the Governments of Canada, Australia, and New Zealand for the construction of a British-Pacific cable.

Restricted Competition.—We regret to learn that the Vestry of Fulham has confirmed the report of their consulting engineer advocating that the electric lighting tenders should only be obtained from a limited number of firms. We trust that the firms excluded will communicate with the Vestry direct on the subject, or ascertain from the consulting engineer the reason why they were not allowed to tender.

A Good Example.—A good example has been set to companies by the National Electric Supply Company, Limited, at Preston. At their general meeting a vote of thanks and confidence was accorded to the engineer and his assistant and to the secretary for their loyal services to the company. The general rule is to carry a vote of thanks to the directors and to ignore the men to whom the success of the undertaking is mainly due.

Dr. Obach's Bequests.—The will of the late Dr. E. F. A. Obach, who for so many years was chief of the guttapercha and experimental department of Messrs. Siemens Bros., shows that he has had the welfare of his colleagues in mind. Thus he leaves to the Siemens Engineering Society his scientific technical library, upon condition that it shall be continued as the Obach Library, and that a catalogue shall reach the hands of all the members. Dr. Obach's special library on indiarubber and guttapercha, together with the samples of plants, etc., is to go to the Botanical Museum at Berlin.

Electric Lighting at Yokohama.—A curious cause of breakdown is described in the last number we have seen of the *Indian Engineer*. It would seem from our contemporary's description that the electric lighting of Yokohama is carried out by overhead wires which are not insulated. The recent failure of the light is said to be due to the intelligent youth of Japan flying an exceptional number of kites at a certain festival. The introduction of the electric wires hampered the kites' fliers, and we regret to say that the reverse was also true, as the tails of these kites became so entangled with the wires for the incandescent service that the current had to be interrupted.

Lunar Heat.—The Earl of Rosse made an interesting communication to the Camera Club last week on the heat radiated from the moon. He explained how largely thermopiles were used in measuring the radiant heat from the heavenly bodies, and expressed the opinion that although the collimator was more sensitive, the thermopile when attached to a telescope was more easy to work and perhaps more reliable. As regards lunar heat, the Earl of Rosse concluded from experiments which he described that the whole of the heat radiated from the moon was derived directly from the sun. This conclusion was arrived at from experiments obtained during lunar eclipse.

Mr. W. H. Preece.—Mr. W. H. Preece, C.B., F.R.S., having attained his sixty-fifth birthday, has been obliged to resign his position of engineer-in-chief and electrician to the General Post Office. This procedure is necessitated in consequence of the laws concerning all Civil servants, and it only remains to be seen in which way the Government can retain Mr. Preece's services without infringing more than the letter of the regulations. It is, however, generally assumed that he will be retained as consulting engineer to the Postmaster-General, practically to continue the system with which he has been so closely connected ever since its coming under the control of the Government.

The Madras Electric Tramways.—The report of the Madras Tramway Company for 1897 and 1898 has just been issued, and we gather from *Indian Engineering* that brighter days are in store for the company. A contract is about to be entered into between it and the British Electric Traction Company for the provision of the necessary funds to complete the equipment of the electric tramways in Madras. The total number of passengers carried during the year was no less than 3,643,000, an increase of almost 1,000,000 over the number carried during the previous year. Our contemporary holds out hope to the shareholders that one day they may get a dividend.

The Yorkshire College Engineering Society.—Mr. E. Talbot on Monday last gave an interesting address before the above society on the electric tramways in Leeds. The lecturer described in detail the installation now belonging to the Corporation, and the various steps by which its final form had come to be adopted. Thus, while the accumulator and the conduit systems at first sight appeared to have advantages which the overhead trolley system did not possess, the expenses met with in the construction and maintenance of those two systems were much higher than with the overhead. Mr. Talbot instanced the success in Leeds as a further proof that the trolley system was in every way a most practical one.

Guard Wires.—We gather from the *Yorkshire Post* that at Leeds a new system of preventing any broken telegraph or telephone wires from coming in contact with trolley wires of electric tramways is to be adopted. It seems that the earthed guard wires previously used in Leeds have been a source of danger owing to fracture. One end of the wire so broken would come into contact with the live wire, and, hanging down into the street, was capable of giving a nasty shock. It seems to us, however, that if both ends of these guard wires were earthed the main fuses would be blown in any case. The new system to be used consists in placing a wood guard strip between the trolley wires at such a height above them as to prevent any falling wires coming into contact. This system has been tried at Liverpool, where it was said to be a success; but personally we much prefer the earthed guard wires.

American Pacific Cable.—President McKinley is doing his best to urge on the construction of the American Pacific cable on the same grounds that we have so often advocated for the construction of a British Pacific cable. In his message to Congress he points out that, as a consequence of the ratification of the treaty of peace with Spain, the United States have come into the possession of the Philippines. He also urges that the only cable communication with Manila is at present by means of cables having their stations in foreign countries, and that there exist no telegraphic means whatever of communicating with Hawaii and Guam. The message to Congress points out that the cable may be constructed by Government or under a concession made by the latter to a private firm. Neither of these courses is given preference to in the message. President McKinley also points out that at least two years must elapse after an order is given before

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the entire system can be in working order, and he therefore advocates prompt action on the part of Congress.

The Municipal Electrical Association.—A new secretary has been elected for this association in the person of Mr. E. T. Ruthven Murray, who will in future attend to all the business matters connected with it. These should be addressed to 21, Acton-lane, Harlesden, N.W. This move has been made in consequence of the resignation of Mr. A. B. Mountain, who for the past two years has held the honorary post of secretary. During that time great strides have been made by the association, which has become an active power in electrical matters. Although it is usual to credit the president and council with all such progress, and to look upon their secretary rather as their mouthpiece, we are sure that all the members of the Municipal Electrical Association will agree with us when we say that a lion's share of the credit should be given to Mr. Mountain. We trust that the association during the secretaryship of Mr. Murray will make as much progress as it has done in the past.

Electricity in Egypt.—On Sunday last the Duke of Connaught laid the foundation stone of a new dam crossing the Nile at Assouan, thus inaugurating a work which will have a vast fertilising effect in Egypt. The magnitude of the work we have hardly space to expatiate upon, beyond giving the following few figures, which will be of interest from the fact that they indicate that a large system of electrical distribution can be supplied from this new dam. The length of the dam, which will be built on the solid granite, will be a mile and a quarter. It will be 80ft. wide at the base, and 80ft. high, and will hold up a head of water 46ft. higher above the dam than the discharge. As the discharge is to provide for 54,000,000 tons of water per hour at full Nile, the vast amount of energy which will then be running to waste is easily calculated. In this work, which has been given to English contractors and designed by English engineers, we have another token of the fact that our occupation of Egypt is not likely to end for a few years to come.

Series-Parallel Lighting.—The system of street-lighting in use at Kingswood, near Bristol, was once much boomed in the general Press. The technical Press did not share the same belief in the design of the system as to its efficacy, and the latest news from Kingswood is not reassuring. The syndicate which have been in possession of this system of street-lighting, which they and their experts expected to revolutionise the industry, have been trying for years to dispose of their gold mine, as far as Kingswood is concerned, to the District Council. At last the Council have refused to purchase, and in the meantime the plant has gradually deteriorated. The crisis, however, arose from financial reasons, owing to a mortgage being foreclosed. At the time of the boom figures were given to show that large profits were being made, but presumably the accounts did not allow anything for depreciation or renewals. We trust that Kingswood will now be lighted electrically from a municipal supply.

Prepayment Electricity Meters.—In our last volume reference was made to the Long-Shattner electricity prepayment meter, and we pointed out that a hard-up consumer was able with this meter to obtain a poor light from a few lamps on credit. This was so because the lights were not cut out when the amount of electricity prepaid for had been supplied, but a resistance was switched into the circuit, which lowered the voltage, and so indicated that more money was required. If the number of lamps in use at the time were few the voltage was small, and the consumer might prefer to put up with a poor light and defer a further payment until he was in funds. The firm manufacturing these meters have, however, added a device to prevent this. For that purpose two resistances are used. One of these is a high resistance, so that it prevents a fairly high voltage being obtained, even if only one light is on. If, however, three lights are switched on, this high resistance is short-circuited by a relay. This addition ought to prevent the meter being used as anything but a prepaid one.

A.M.I.E.E.—Before the discussion was commenced on the wiring rules at the Institution of Electrical Engineers on Thursday, the 9th inst., Prof. Silvanus P. Thompson, who was in the chair, announced that some 284 associates had been recommended by the council for transference to the class of associate membership. Prof. Thompson explained that this matter had been placed in the hands of a sub-committee who had felt it their duty to deal with the large number of applications they received. No less than 400 applications had come to hand up to that time, and out of this number 284 had been passed. In other cases the committee had written for information from the old associates. We, however, gather from the remarks that a certain number of applications will not be entertained, and it seems to us that this is in direct contradiction to the new rules, which only specified the age limit as a qualification for those associates who were elected prior to Jan. 1, 1899. Although we quite agree with the committee in their desire to keep up the standard of those admitted to the class of associate membership, we trust that their refusals will not be found to be *ultra vires*.

Telephones at Syracuse (U.S.A.).—We gather from the *Electrical Engineer* of New York that a new telephone exchange has recently been opened in the above town. The points which specially interest us in the description are the following: A common battery return is used in the town, with which no batteries are required at the subscriber's end of the line; with this system the exchange is called when the receiver is lifted from the hook on the subscriber's telephone; the system of distribution consists in the use of underground wires from the station to distributing points at different parts of the city; at these points high masts are put up, from which overhead wires radiate to various subscribers; a complete system of notifying faults is in operation, which could be copied with advantage in this country. When a subscriber has complaint to make he is switched to the "complaint operator," who makes a triplicate note of the nature of the failure. One of these notes is retained, and the other two go out to various inspectors. Should the complaint operator not receive back one of these to fill in to the effect that the fault has been rectified within 24 hours, he makes further complaint to the general manager of the company.

Repayment of Loans.—We learn that the London County Council have not approved at present of the proposal made by Mr. Wright that the loan for the electric lighting of Whitechapel should be granted on the annuity principle. It will be remembered that Mr. Wright pointed out the advantage of not having to pay back any portion of the principal during the first few years of working. The County Council offers to issue loans to the extent of £60,500 upon the instalment system, and we understand that a period of 42 years will be allowed for the repayment. The usual clause is inserted that if any works fail to be renewed during the currency of the main period, the cost of renewal shall be a maintenance charge, and shall not be made the subject of a fresh loan. The loan will be issued in amounts of not less than £10,000, and the County Council is prepared to meet the Whitechapel Board of Works to the extent that no repayment shall commence until the expiration of three years from the quarter-day before the

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date of the advance of the first portion of the loan. It will be seen from this that although the exact terms asked have not been obtained, the capital charges during the first three years will be lower than on the regular instalment system.

New Telegraphic Route to India.—We gather from a letter which the Director of Telegraphs at Teheran has written home, that Mr. W. King Wood is now somewhere in the wilds of Persian Beluchistan prospecting for a telegraph line overland to India. This he is to complete this month, after which he will submit his report. The Secretary of State and the Government of India will consider it, and, if they judge it feasible, the Director of Telegraphs will have to approach the Persian Government and draw up a convention. That will occupy the next year or two, no doubt, and he says he shall consider it lucky if he gets to work in the autumn of 1900. It will cost from £120,000 to £150,000. He hopes they may be able to complete it without loss of life, but that is too much to expect in that wild country. The line will start from Kashan, 160 miles from Teheran, and will go by Nain, Yezd, Kerman, Bam, Regan, Basman, Kwash (Washti in some maps), to Ladis, on the frontier of British Beluchistan; thence to Quetta by Nushki. An alternative line goes from Regan by Basman, to Bampur, thence to Gwadur, on the Mekran coast, where the existing line will be struck; or it will keep inland by Kuhah and Kej to Las Beyla, and thence to Karachi. If these lines are erected, the Department may gradually give up maintaining the cables in the Persian Gulf, and get at the various ports by branch lines from the interior.

Utilisation of Exhaust Steam.—Mr. J. H. Harding read a paper on this subject before the Great Western Electrical Association at Milwaukee last month. Mr. Harding is the superintendent and manager of La Porte Electric Company, which company uses the exhaust heat from their electric light station for heating buildings round it. He states that it is possible to heat buildings within a mile of the station, which thus gives a large field to draw custom from. In considering the question generally, it seems to us that Mr. Harding neglects altogether the fact that condensers might, and often are, used in an electric lighting plant, as he speaks of feed heaters as being the only means of using exhaust steam. The system actually employed by the company in question consists in the transmission of hot water. The heat of the steam is transferred to a column of water, which is circulated through a supply and return pipe connected to the various buildings to be heated. The electric lighting station at La Porte is placed at the highest point in the city, and hence, with a system of steam distribution, it would be difficult to get the condensed water returned to the station. This method of distribution is called by the author the "Yaryan" system, and he claims in its favour that as the water is returned to the station after it has passed the buildings to be heated, it suffers no waste of heat except the amount radiated from the pipe line and that sold to the customer. For instance, if water is sent out at 160deg., the return water would be about 130deg. It would only then require to be heated up 30deg. to be again sent round the line.

Electro-Harmonic Society.—The following is the programme for the ladies' night concert to be held at St. James's Hall Restaurant on Friday evening, Feb. 24, 1899, at eight o'clock. Part I.: duo concertante for pianoforte and violoncello (Mendelssohn), M. B. Albert and Mr. Alfred E. Izard; song, "A Corn Song" (S. Coleridge-Taylor), Mr. Charles Copland; pianoforte solo, "Valse de Concert" (Wieniawski), Mr. Alfred E. Izard; humorous recitation, "The Phonograph Dog" (Snazelle), Mr. W. G. Churcher; quartettes (*a*) "Song without Words" (Mendelssohn), (*b*) "Moorish Serenade" (R. Chapi), the Gomez Clarinet Quartette; song, "Spring is not Dead" (Sir A. C. Mackenzie), Miss Mary Hay; violoncello solo, "Fantasie Originale" (B. Albert), M. B. Albert; humorous sketch, Mr. George Schneider. Part II.: duet, "It was a Lover" (Walthew), Miss Mary Hay and Mr. Charles Copland; song, "Awake" (Pelissier), Mr. Charles Copland; quartette, "Invitation à la Valse" (Weber), the Gomez Clarinet Quartette; humorous recitation, "Wild West Dramatics" (Wood), Mr. W. G. Churcher; new song, "The Stile in the Lane" (A. A. Needham), Miss Mary Hay; violoncello solos (*a*) "Romance" (Goltermann), (*b*) "Les bons Vivants" (Albert), M. B. Albert; humorous sketch, Mr. George Schneider. We are also informed by Mr. Gatehouse that he is organising a benefit concert for M. J. Greebe, who for many years has taken an active part in the concerts of the society. This is to be held on the 28th inst., at 8 p.m., in the Myddleton Hall, Upper-street, Islington. Mr. Gatehouse hopes it will be well patronised, as M. Greebe is now unable to retain his prominent position in the world of music owing to declining years and other infirmities.

The Light Railway Commissioners.—The decision of these Commissioners with respect to the proposed light railway between Camborne and Redruth rather surprises us. The verdict is said to have been "that in the opinion of the Commissioners the proposed railway from Camborne to Redruth would form a too great competitor with the Great Western Railway Company." The Commissioners also add that further difficulties, caused by the narrowness of the streets, would present themselves if the proposed line were constructed. We understand from the local papers that the decision has raised a considerable amount of indignation in the district, which would have benefited by the introduction of this railway. Leaving this on one side for the time being, the question arises how far the fact that the proposed line would have competed with the Great Western Railway Company should influence the decision of the Commissioners. Assuming, for instance, that the Great Western Railway Company itself had been the promoters of the light railway to any extent, would, then, the Commissioners have found that the other objections raised were sufficient to prevent the railway company doing the work themselves? If the answer to this is "No," we hold that in this case the powers vested by the Board of Trade in the Railway Commissioners have not been well exercised, as clearly the interests of the public rather than that of a profit-earning company ought to be considered. At the last meeting of the Cornwall County Council this matter was discussed with vigour, and several members complained of the obstruction which that body had put in the way of the proposal. There is little doubt that this obstruction was responsible for the wording of the report with reference to the width of the roads.

The Nernst versus the Welsbach.—Anyone listening to the interesting paper read before the Society of Arts last week by Mr. James Swinburne on the Nernst electric lamp, must have been impressed by the similarity of materials used in this lamp and those of which the Welsbach mantle is made. We understand that this material is used also in the new electric lamp designed by Mr. C. Stearn, of the Zürich Electric Lamp Company. The full details of the latter invention are, for certain business reasons, not to be published at present. The general principle underlying the invention, however, is that of incandescing a mantle of refractory oxides by means of a discharge on to it of cathode rays. The question then arises as to how far the three different systems of using these refractory oxides to produce light are likely to have

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advantages the one over the other. Thus, although the Nernst at present is only credited with a life of 500 hours, it is in that respect considerably better than the Welsbach mantle. These mantles have, in our opinion, depreciated of recent years in the matter of endurance, and they also undergo changes which cause a large decrease of their light-giving properties with time. From these changes, or, at least, from the diminution of light accompanying them, Mr. Swinburne assures us that the Nernst lamp is free. The next question arises as to the method used to heat these oxides up to the high temperatures. In this respect Mr. Stearn claims to be able to get one candle for every watt expended. Here, again, it seems to us that either of the electrical methods of heating will, when developed, possess great advantages over the Welsbach gas-burner. These advantages lie largely in the fact that the thickness of the materials used will not be limited, and that in consequence greater mechanical strength can be obtained.

The London County Council and Electric Lighting Orders.—At the meeting of the London County Council on Tuesday last, recommendations were passed as to the grounds on which opposition is to be offered to the various applications from electric lighting companies for provisional orders in new districts. The recommendations of the Council are said to be framed in the interests of the consumers, but in one case at least we see no reason whatever, as far as the consumers are concerned, for the recommendation. The first proposal is that no order shall be allowed to pass unless the maximum price the consumer shall pay is 6d. per unit or under. The next provision is to the effect that continuous currents shall be used, because these are said to be the most satisfactory. Here we think the Council is quite beyond its powers, and also that by passing such resolutions more harm than good is done both to electric light consumers and to the community at large. A further point made is that the County Council's tramway interest shall be guarded both as regards tramways now owned by them and also any tramways which they may acquire in the future. Here the County Council ask that electric light mains and works shall not be placed in such positions as would hamper the Council from using electric traction on the tramways. The Board of Trade does not agree with this clause, which is so broad and general in its terms that we are quite sure it would be best left out. The further requirements suggest that while competition between companies may be desirable, there shall be no competition between the local authority and a company unless the company is the first in the field. Otherwise, if the local authority has electric light works, no order is to be granted to a company. We trust the Board of Trade and Parliament will not accede this point, as it would establish a very bad precedent for differential treatment.

Groundless Vibration Reports.—We print in another column the report of Mr. T. W. E. Higgens, the surveyor to the Chelsea Vestry, and Dr. Parkes, their medical officer, as to certain alleged nuisances said to be caused by the working of the Chelsea Electricity Supply Company's central station. We are glad to note that the verdict of these gentlemen is the Scotch one of "not proven." It is admitted that a certain amount of vibration is felt in a few houses at odd times—how is this to be avoided in a city like London?—but it seems quite clear that the reckless romancers who state that persons in the vicinity of the station have "their lives made miserable" by its working are not supported in such a declaration by the responsible officers of the local authority. Mr. Higgens has a theory that a certain amount of vibration may occur when one or two engines are working at one end of the concrete block upon which the engines are placed, but that this vibration ceases when a number of engines are working. The point is an interesting one, and we should like to know whether any central-station engineers entertain such an idea. When an electric lighting company has spent vast sums of money for the erection of a central station, it is only right that they should not be worried and harassed by any small property owner who may fancy he has some kind of grievance. We, therefore, trust that the report in question will convince the general public in Chelsea that the electric light company have erected their new station in a satisfactory way, and that they have adopted proper precautions to prevent vibration arising. We must add, however, that we think that the directors of the electric light company would have been better advised if they had allowed the engineer and medical officer of health any opportunity they might desire for experimenting. In this respect the work carried out by the Kensington and Knightsbridge Company on the question of vibration, as reported in our first issue for 1897, clearly shows that such vibratory effects are quite preventable.

Institution of Mechanical Engineers.—The annual meeting of this institution was held on Thursday and Friday last week in their new building at Storey's gate, S.W. Mr. Edgar Worthington, the secretary, on Thursday presented the fifty-second annual report, which showed that the membership in all classes had reached 2,684, representing a net gain of 191 on the previous year. The receipts for the year were £8,452, and the expenditure £7,588, leaving a balance of £863. The total investments and other assets amounted to £66,462. References were made to the experiments carried on by Prof. Beare at University College as to the value of the steam-jackets, and to those of Sir William C. Roberts-Austen, who had carried to a successful conclusion a long series of experiments made at the Royal Mint on the behaviour of steels during cooling. Congratulatory allusion was made to the summer meeting held at Derby, and it was stated that the next similar meeting would be held at Plymouth. The report was adopted, after which Mr. Johnson vacated the chair in favour of the president-elect, Sir W. H. White, who thanked the members for the honour which they had conferred upon him, and assured them that he would do all in his power to promote the interests of the institution. On the motion of Sir Frederick Bramwell, seconded by Sir W. H. Carbutt, a vote of thanks was accorded to the retiring president for his services during the past year. The new building is splendidly fitted and decorated, and is in every way suited to the requirements of the institution. It is lighted throughout by electricity, the current being supplied from the Westminster mains at a pressure of 200 volts. The meeting hall is lighted by eight 100-c.p. incandescent lamps arranged in a circle in the centre of the ceiling, and when all are switched on no better effect could be desired. The dining hall is lighted by small clusters of lamps fixed in the ceiling, each cluster having an outer cut-glass cover, which, combined with the marble facing of the walls, presents a very pleasing aspect. Lamps are also placed so that they can easily be switched on to light the stairs and other similar places. Electric hoists and book-lifts are also used in the building. The ventilation of the building is effected by means of a Walker 4ft. fan, which drives the air up through ventilators fixed in the various rooms.

Institution of Junior Engineers.—The Institution of Junior Engineers held a joint meeting with the discussion section of the Architectural Association at the

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Westminster Palace Hotel on Friday evening, when a paper on "Factory Design" was read by Mr. J. H. Pearson, a member of both societies. The chair was occupied by Mr. Basil H. Joy, the president of the Institution of Junior Engineers, and the paper dealt chiefly with requirements in the design for factories for London and its immediate vicinity. In introducing the subject, the author insisted upon the importance of a close relationship between the architect and engineer, as it was only by consultation together and united action, especially with regard to buildings of the factory class, involving the employment of machinery, that a satisfactory result could be arrived at. The sections of the London Building Act, 1894, which had special reference to buildings of the factory type were touched upon, and the different kinds of buildings classified. It was shown how the design and construction were affected not only by the character of the machinery to be installed, but also by the form of power adopted for driving it. Systems in use at the present time were briefly reviewed, preference being given to electricity. Referring to foundations, wherever the nature of site subsoil was at all doubtful, a continuous bed of concrete over the whole surface was advised, as by that means a uniform pressure of the loads upon the foundation was secured. Fire-resisting floors and staircases having been discussed, the author proceeded to consider details for the construction of roofs, partitions, windows, and skylights. Furnace chimney shafts received attention at some length, as did also the questions of ventilation, sanitation, and fire protection, with special reference to the Factory Act of 1895. The construction of a factory with which the author had been associated was described and illustrated, and an interesting account given of the method of putting on an additional top floor without meanwhile interrupting in any way the business ordinarily carried on, and without taking to pieces the existing roofs, which were raised by screw-jacks. An animated discussion followed. It was announced that the institution would hold a conversazione on Saturday, March 11, and that at the ensuing meeting a paper on "The Direct Production of Electricity from Carbon" would be read by Mr. W. R. Cooper, M.A., M.I.J.E.

The Electroplating of Iron Ships.—Our namesake of New York in its first issue for February quotes from a couple of reports recently sent in to the United States Government by two of their officers on the efficacy of a system, invented by Mr. T. S. Crane, of copper plating the hulls of vessels. The vessel under test was electroplated in February, 1895, and has been in regular use ever since without having been cleaned. In the waters in which this vessel has been plying it is customary to clean the hulls of ordinary ships very frequently. The report concludes by stating that, so far as the investigations were made, nothing could be found which could be considered a serious factor or objection to the copper-plating of the bottom of an iron or steel vessel. The engineers also report that not less that $\frac{1}{16}$in. of copper should be allowed in plating, and that if this thickness is well put on, the vessel will be practically secure against any corrosive effects due to electrolysis. As to the way in which this ship was electroplated, the following few details may be of interest to our readers: In the work flexible, shallow, box-shaped baths were used, open at one side. Each bath contained a copper electrode and the plating solution, the bath being made watertight by suitable flexible packing at the edges. Several of these baths were used in the plating of the vessel when in dry dock or upon the stocks, the cleaning of the hull at any one time being only necessary in the places where the baths are to be applied. The baths, which were made flexible in order to follow the curvature of the vessel, were readily supported against its side, on its bottom, and along its keel, and in other difficult situations by comparatively simple means—such as tension ropes, screw shores, or by magnets attached to the frame of the bath. The vessel was made the negative pole by connection with an electric generator; the plating bath furnished the positive electrode, and the plating of the entire hull was readily accomplished by shifting the baths from the plated to the unplated sections, and slightly overlapping upon the sections already placed so as to form a continuous coating. It has been found that a current rate of $7\frac{1}{2}$ amperes per square foot and a difference of potential of $1\frac{1}{2}$ volts are sufficient to deposit a perfectly uniform, smooth, and adherent coating to the metallic surface of a vessel. In order that the density of the solution may be kept uniform during the plating process, circulation is effected by permitting the solution to flow into the bottom and out near the top of the bath.

Edinburgh Public Lighting.—We have just had our attention called to a report of the gas engineer of the city of Edinburgh upon a recent tour of inspection he made on the Continent. The object of his trip was to compare the systems of public lighting used in the towns and cities visited. The engineer concludes that as regards gas lighting no city or town was found to be so miserably lighted with gas as the towns of Edinburgh, Leith, and the surrounding districts. On the other hand, no town was seen where the electric light was used to so great an extent as in the main streets of Edinburgh. We regret that the engineer does not add that the main streets of Edinburgh which use the electric light are the best lighted streets he saw in the course of his travels. He proceeds to quote from a report recently presented to the municipality of Paris on the subject of street-lighting, in which the opinion is expressed that that city stands "above Vienna, Budapest, Rome, London, Glasgow, and most of the large towns of England. Recuperative gas lamps were a great advance in their time, and nowhere have they been seen used in a way to compare with Paris, either as regards the extent of use or the improvements introduced. Barely two years ago Berlin, which had not then the Welsbach burner, was less well lit than Paris. Munich, Milan, and Edinburgh have a more brilliant appearance, especially in the part the stranger sees, but it is not thought that a wise administration ought to follow their example. The towns which are now really better lighted than Paris are Berlin, Hamburg, many of the towns of North Germany, and, to a less degree, Liverpool. These towns, limiting the use of electricity and developing incandescent gas lighting, have found in the present condition of science the best solution of the problem how to do well and cheaply." While the Edinburgh gas engineer may have arrived at this conclusion, we certainly think that figures in support of the low cost should be obtained from foreign sources. We know that in at least two German towns great disputes have arisen between the gas companies and municipalities over the supply of incandescent mantles for the gas lamps. The authorities complained that these mantles were not replaced when the lights fell below the guaranteed candle-power, and unofficially we learn that the gas companies complained that the mantles and the labour of replacing them cost practically the same amount as was received from the municipal authorities. Until the Nernst lamp is placed on the market as a commercial commodity we quite agree with the Edinburgh gas engineer that incandescent gas lamps are cheapest for use in side streets. But as soon as electric lamps of from 1 to $1\frac{1}{2}$ watts per candle-power are obtainable, the life of gas as a street illuminant will be very brief indeed.

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THE LIMITS OF SPARKING WITH CONTINUOUS-CURRENT DYNAMOS.

BY GISBERT KAPP, M.I.C.E., M.I.E.E.

A useful paper on the above subject was recently read by our old friend, Mr. Gisbert Kapp, before the Society of Electrical Engineers in Berlin, the text of which, as subsequently communicated through the *Elektrotechnische Zeitschrift*, we venture to abstract below :

Endeavours have been made of late to represent what occurs during the commutation of current in strictly mathematical terms, whereby the self and mutual induction in the coils, their resistance, the resistance of the constantly changing contact surface between brushes and commutator segments, etc., are embodied in the formulæ. This method of treating the subject possesses much interest for the electrical engineer with a mathematical bent. The practical man will, however, in the majority of cases, find the formulæ too complicated, and refrain on that account from using them. He will either work without the aid of formulæ—that is to say, entirely according to his own experience—or he will employ simply the pet rule of thumb of the particular drawing office concerned. The theory of sparkless commutation which I shall here evolve seeks the happy medium between these extremes; on the one side the strictly mathematical method of calculation, and on the other the mere rule of thumb.

Such a rule of thumb, which it may be observed has rendered excellent service in the past and still enjoys extensive application, consists simply in allowing a certain minimum for the induction under the leading pole-corners, some 1,500 lines where drum armatures are concerned and 2,500 for ring armatures. As holds good for all approximations, this one is serviceable so long as confined to similar cases. It is quite possible that a rule which cannot be scientifically verified or which, regarded from a strictly scientific standpoint, is even incorrect, may nevertheless yield satisfactory results in practice. The merit does not, however, lie in the rule itself, but in its limitation to certain cases. Where, for instance, the rule in question applied only to machines possessing in common a drum toothed armature, two conductors per commutator segment, carbon brushes, approximately the same peripheral velocity of the commutator, and approximately equal current densities over the armature circumference, we should find that the sparking propensities of a certain machine might be exactly predetermined. That does not prove, however, the general reliability of the rule: it only proves its correctness when applied under certain restrictions.

I shall now attempt to substitute for this rule of thumb, which, as we have seen, only gives accurate results when applied conditionally, a generally applicable formula based on scientific reasoning, and, indeed, so simple that the practical man will not shun its employment. The latter condition can naturally only be complied with at the cost of accuracy, since the phenomena appertaining to the commutation of current are by no means simple, and when complex phenomena are to be represented by a simple formula, it stands to reason that this formula can but be a more or less rough approximation. For the rest it is certainly desirable, but at the same time not absolutely necessary, to determine the sparking limit with mathematical exactitude, for in practice the endeavour will naturally be to keep as wide of this limit as possible. The main advantage accruing from the possession of exact knowledge as to the sparking limit would consist then in enabling us to adopt a definite coefficient to represent security from sparking, somewhat after the manner in which the breaking load of a certain part may be used in connection with a coefficient of safety. So long, however, as the coefficient of safety relative to sparking is large enough, we do not need to bother ourselves about its real value. This is so, because having regard to the fact that sparking is not only dependent on the construction of a machine, but also to a very considerable extent upon its treatment.

Following up the above remarks, which are intended solely to make clear the intent and extent of the proposed investigation, I will now proceed to the subject of my paper.

Let S = the number of segments in the commutator;
s = the number of segments per pole;
p = the number of pairs of poles;

$$S = s\,2\,p.$$

q = the number of active conductors per segment (the smallest possible value of q is 1 for ring armatures and 2 for drum armatures);
$z = s\,2\,p\,q$ = the number of active conductors counted round the entire armature circumference;
n = the number of commutator segments short-circuited by a brush;
L = the length and D the diameter of the armature.

Let us consider, in the first place, the conductors belonging to any one segment of the commutator. The current in these induces a field whose value depends upon the volume of current in adjacent conductors, the length of the armature, and the method of winding (drum or ring, toothed or tunnelled armature). The conductors belonging to a segment constitute a coil; each side of the coil contains, in ring armatures, q wires, and in drum armatures, $\frac{q}{2}$ wires. Obviously, the self-induced field of a side of a coil is proportional to the product,

$$i\,q\,L,$$

where i represents the current in one wire. The energy stored up in the side of a coil is proportional to

$$q^2\,i^2\,L.$$

By the process of commutation, this energy must be first converted into mechanical and then back again into electrical energy through the influence of the commutating field.

If T represents the time occupied in commutating, then the electrical energy must be converted into mechanical energy during approximately $\frac{T}{2}$. Thus during the initial half of the period of commutation, the current opposes the E.M.F. induced by the commutating field, hence the coil tends to drive. During the second half of this period the current must increase from 0 to i, its flow being in the direction of the induced E.M.F.—that is to say, the coils act as a break. Thus, an exchange of energy takes place between the coils and driving engine which can naturally only be brought about through the action of the commutating field. If B represents the induction of this field, then the energy imparted to or taken from the coil may be expressed by

$$\int_0^{\frac{T}{2}} q\,B\,v\,L\,i\,dt,$$

where v denotes the linear velocity of the conductors. B and i are functions of time whose nature we are unable to specifically determine. We only know that B increases in value with the time, whereas i decreases at first with the time to zero, and then increases again in inverse direction. If we limit our observations to the second half of the period of commutation, counting the time from the moment in which $i = 0$, we may then say that i and B increase with the time; the first from zero upwards, and the latter from a fixed value. Suppose, now, the energy given out in $\frac{T}{2}$ time be less than that which should be stored up in the coil, then the current will not have attained the full value, i, upon the emergence of the respective commutator bar from under the brush which it must have a moment later. The coil is not sufficiently prepared, so to speak, for its entrance into the circuit of the armature, and a spark arises. Or should more energy be given out than has been stored up, making B too great—that is to say, making the current greater than necessary—then upon the entrance of the coil into the armature circuit it must suddenly be reduced to its proper value, whereby a spark is caused, as in the previous case. We thus see that sparkless commutation can only be attained when an even balance exists between the energy given out by the coil and that stored up in the same after its entrance into the armature circuit. Strictly speaking, the energy imparted should be increased by the amount corresponding to the heating of the conductors and contact surfaces of the brushes. This

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is, however, so slight that it may be neglected here in order to avoid complex calculations.

Although not able to state the true nature of the functions B and i, we may nevertheless assume in general that the solution of the integral, by omitting one of the numerical coefficients dependent on the nature of these functions, gives for the energy stored

$$q\,i\,\mathrm{L}\,\mathrm{B}\,v\,\frac{\mathrm{T}}{2},$$

where B denotes the mean value of the induction within the sphere of commutation, which must naturally be smaller than that which exists under the leading pole-corner given by the expression

$$\mathrm{B}_a' = \mathrm{B}_a\left(\frac{\mathrm{X}-\mathrm{X}_q}{\mathrm{X}}\right).$$

In the latter formula B_a represents the induction in the air-gap under the poles, X the ampere-turns necessary for the armature and air-gap, and X_q the cross ampere-turns of the armature.

According to the law by which the current increases with the time the energy stored varies. For instance, under the assumption that i and t are proportional, the amount of energy transferred would work out less than if we assumed the current to be a sine function of the time and in the ratio $\frac{1}{2} : \frac{2}{\pi}$. But it is not necessary that we make any assumption relative to this point, since in establishing a balance between energy given out and the energy which should be stored up we must any way introduce a coefficient based upon experience. We, therefore, write:

$$q^2\,i^2\,\mathrm{L} = \mathrm{C}\,q\,i\,\mathrm{L}\,\mathrm{B}\,v\,\frac{\mathrm{T}}{2};$$

$$q\,i = \mathrm{C}\,\mathrm{B}\,v\,\frac{\mathrm{T}}{2}.$$

Here $v\,\frac{\mathrm{T}}{2}$ equals the distance traversed by the active wire during the second half of the period of commutation; hence it equals $n\,\frac{\beta}{2}$, where β represents the width of the segments relative to the armature circumference.

Further,

$$\pi\,\mathrm{D} = \mathrm{S}\,\beta = 2\,p\,s\,\beta = 2\,p\,s\,\frac{q}{q}\,\beta = \frac{z}{q}\,\beta;$$

whence

$$\frac{n\,\beta}{2} = n\,q\,\frac{\pi\,\mathrm{D}}{z}\,\frac{1}{2};$$

$$q\,i = \mathrm{C}\,\mathrm{B}\,n\,q\,\frac{\pi\,\mathrm{D}}{z}\,\frac{1}{2};$$

$$\frac{z\,i}{\pi\,\mathrm{D}} = \frac{\mathrm{C}}{2}\,\mathrm{B}\,n.$$

$z\,i$ is the total volume of current in the armature, whence $\frac{z\,i}{n\,\mathrm{D}}$ represents the linear density of current, Δ, relative to the armature circumference,

$$\Delta = \frac{\mathrm{C}}{2}\,\mathrm{B}\,n.$$

By substituting C_0 for $\frac{2}{\mathrm{C}}$ we may also write

$$\mathrm{B} = \mathrm{C}_0\,\frac{\Delta}{n},$$

where B represents the mean induction within the sphere of commutation, which must naturally be less than the induction B_a' under the leading pole-corner. Hence we obtain

$$\mathrm{B}_a > \mathrm{C}_0\,\frac{\Delta}{n}$$

as a condition necessary for sparkless commutation, where C_0 is a coefficient based on practical experience, which depends upon the type of armature, not its dimensions or load.

As will be observed, this formula differs from the rules of thumb mentioned elsewhere merely in that it comprises the density of the current and number of commutator segments covered by the brush. We will now examine into the accuracy of the formula's construction. This is the case if C_0 is an actual coefficient—that is to say, an unknown number. In order to verify this point it is only necessary to substitute values for B_a' and Δ according to the absolute system of measurement (M mass, L length, T time).

The dimensions relative to the induction, as is known, are $\mathrm{M}^{\frac{1}{2}}$, $\mathrm{L}^{-\frac{1}{2}}$, T^{-1}; those of a current, $\mathrm{M}^{\frac{1}{2}}$, $\mathrm{L}^{\frac{1}{2}}$, T^{-1}; and consequently those relating to the linear density of the current, $\mathrm{M}^{\frac{1}{2}}$, $\mathrm{L}^{-\frac{1}{2}}$, T^{-1}. Hence the dimensions pertaining to the linear density of the current and those of the induction actually agree, and since n is an unknown quantity, C_0 must be likewise unknown. In other words, the construction of the formula is correct; the rule of thumb, on the other hand, incorrect; since, according to the latter, an induction must be dimensionless. If, in spite of this, the old rule has rendered good service, it is simply owing to the fact that Δ and n do not vary much in machines of similar type.

If we set down the dissimilarity in the form of an equation,

$$\mathrm{B}_a' = \mathrm{C}_0\,\frac{\Delta}{n},$$

then C_0 may be regarded as a kind of elastic coefficient, whose magnitude denotes the degree of security against sparking. The greater the value chosen for C_0 in designing a machine, or the greater the C_0 which calculations respecting a finished machine give, the further is the machine removed from the sparking limit—in other words, the more may the machine be overloaded.

The above equation gives a necessary condition, but not the only requisite condition for sparkless running. One immediately recognises this from the circumstance that the equation does not embody the number of armature bars per commutator segment. Now every practical man knows that sparkless running is the more difficult to attain the less the number of segments per pole—that is to say, the greater the number of bars falling to a segment.

In the derivation of the formula it was presupposed that the commutating field, whose mean induction was denoted by B, actually exists, and is not distorted through the self-induced field of each active wire to any considerable extent. A certain distortion is, naturally, always present; it must, however, of necessity remain slight—that is, the condition upon which the validity of the above formula rests. The distortion is influenced by two factors: firstly, the intensity; and secondly, the superficial extent of the self-induced field. As regards the intensity of this field, it has already been taken into account for B_a' in the derivation of the formula. Hence we have now to consider its superficial extent, and this is obviously dependent on the breadth of the commutator segments and the number of the same which the brush short-circuits. Since the brush covers n segments, the width of the self-induced field, supposing it to be at rest, cannot be greater than $n\,\beta$. However, the field oscillates to and fro through the distance β with the turning of the armature, since upon the one side new segments are continually entering under the brush and leaving on the other side. The sphere within which the self-induced field can exert a disturbing influence upon the commutating field is thus proportional to $(1+n)\,\beta$. In order to prevent this to-and-fro oscillation of the self-induced field from causing sparks, the sphere—*i.e.* $(1+n)\,\beta$—must be small compared with the extent of the commutating field measured round the circumference. This commutating field is, however, proportional to the air-gap, δ, between the armature and pole, so that by the omission of a constant we may set down as the second condition for sparkless running

$$\delta > \beta\,(1+n).$$

As is well known, it is sometimes possible to remedy the sparking of a machine by setting the pole-corners slightly aslant relative to the armature conductors, or by planing the same so that the air-gap at the leading corner is somewhat greater. Both methods effect a somewhat greater extension of the commutating field. Should such means be resorted to, a value must naturally be selected for δ in the above expression which is correspondingly greater than the

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actual distance between the armature and middle pole-surface. As

$$S\beta = \pi D,$$

consequently

$$\delta > \frac{\pi D}{S}(1+n);$$

whence by introducing the radius of the armature, R, and an elastic coefficient, C_1, we obtain a second condition for sparkless running:

$$1 = C_1 \frac{\delta}{R} \frac{S}{1+n}.$$

The smaller C_1 turns out in an actual machine, the more efficient will the latter be in respect to sparkless running. Thus the conditions are that C_0 must be great and C_1 small to ensure sparkless running of the machine. But the question now arises, how great and how small? This question can only be answered on the authority of experiments. I have determined mean values for C_0 and C_1 from experiments with my own machines, and the results of experiments with other machines kindly communicated to me by colleagues. These I shall presently give. First of all, however, I must recall something which I have neglected for the purpose of avoiding too much complication in the derivation of the two conditional equations—namely, the resistance between brush and commutator. Should this be considerable, it will exert a "steadying" effect just as the well-known and frequently-used resistance between coil and segment of the connecting pieces. The steadying effect of the resistance principally concerns the second condition:

$$1 = C_1 \frac{\delta}{R} \frac{S}{(1+n)},$$

since the disturbing influence of the self-induced field which overlaps the commutating field is thereby lessened. Further, since the contact resistance of carbon brushes is greater than that of metal brushes, C_1 may be greater relative to the first than with the latter.

The mean values deduced from the above-mentioned experiments are:

$C_1 \leqq 0{\cdot}4$ for metal brushes.

$C_1 \leqq 0{\cdot}8$ for carbon brushes.

$C_0 \geqq 12$ for smooth wound ring armatures.

$C_0 > 24$ for toothed wound ring armatures.

$C_0 \geqq 9$ for smooth wound drum armatures.

$C_0 \geqq 15$ for toothed wound drum armatures.

It is to be observed that these values exert a mutual influence. If it is found, for instance, that C_0 is considerably greater than the lower-limit value, then C_1 may be made greater than the upper-limit value. Or, if C_1 is much smaller than the upper-limit value proves, then C_0 may be also made smaller than the lower-limit value.

A NEW GENERAL FORMULA FOR TRAIN RESISTANCE.*

The alchemists of old sought diligently for the philosopher's stone, the inventors of a later age for perpetual motion, and engineers of the nineteenth century have been almost as eager to obtain a general formula which shall reconcile all existing data and experiments upon train resistance. The first two objects of effort are now known to be unattainable, and the third has until now baffled the best minds in the railroad profession. Only a month ago *Locomotive Engineering*, which for years past has devoted special attention to this subject, said editorially: "We do not believe that it is possible to devise a formula that will show an approximation of the resistance due to different kinds of trains at different speeds when train tons are the basis of calculation."

A general formula which appears to be applicable to passenger trains of all weights, running at all speeds up to the highest limits so far reached, has been lately worked out, however, by John Lundie as a result of a long series of test of trains in actual service, and is here given to the engineering public for the first time. His methods of obtaining data are decidedly different from, and much more satisfactory than, those commonly employed hitherto, where indicator cards of engines drawing trains at constant (?) speed on level (?) track have been made the basis (with an arbitrary allowance for engine friction) of estimates of resistance per ton moved. In order to be of any value such tests must be made in long-distance runs, and it is almost impossible to find 100 miles or more of absolutely level track for the purpose, while it is also difficult to obtain perfectly uniform speed even on a dead level. Mr. Lundie's method of determining train resistance is based on an examination of the speed curves of a train when coasting from any speed to a dead stop. The possibilities of such a method will be instantly evident to an engineer, and it may be said at once that the results warrant a decided predisposition in its favour. It is not only possible to obtain the gross resistance due to track and journal friction and air resistance combined, but to

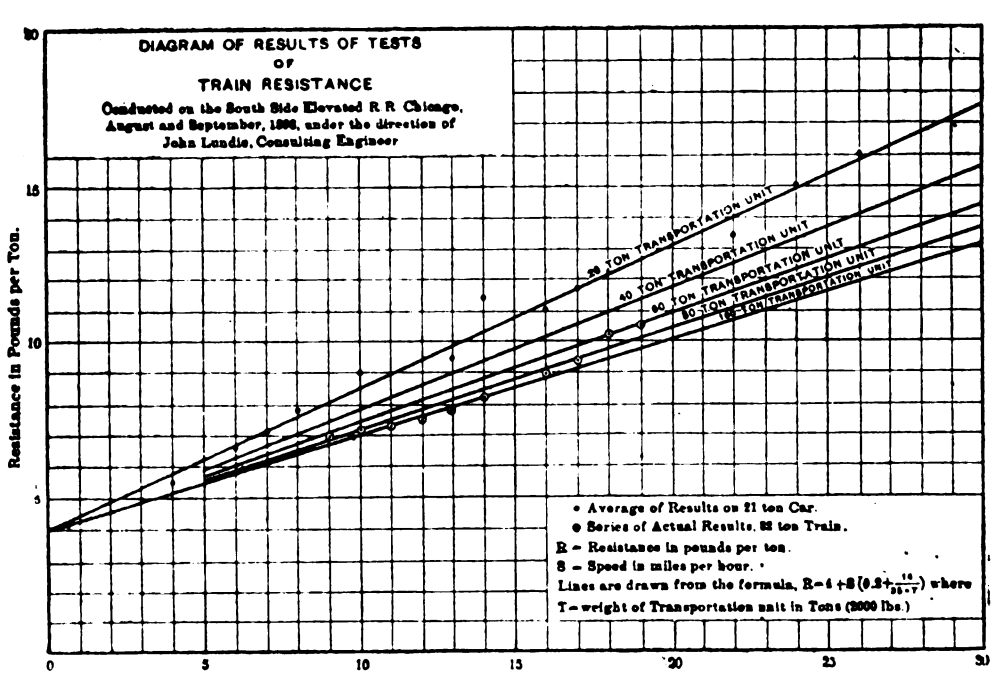
DIAGRAM OF RESULTS OF TESTS
OF
TRAIN RESISTANCE
Conducted on the South Side Elevated R R Chicago, August and September, 1898, under the direction of John Lundie, Consulting Engineer
Resistance in Pounds per Ton.
Speed in Miles per Hour.
30 TON TRANSPORTATION UNIT
40 TON TRANSPORTATION UNIT
50 TON TRANSPORTATION UNIT
60 TON TRANSPORTATION UNIT
100 TON TRANSPORTATION UNIT
• Average of Results on 21 ton Car.
⊕ Series of Actual Results. 82 ton Train.
R = Resistance in pounds per ton.
S = Speed in miles per hour.
Lines are drawn from the formula, R = 4 + S(0.2 + 10/35.T) where
T = weight of Transportation unit in Tons (2000 lbs.)

FIG. 1.

* From the *Street Railway Journal* of February, 1899.

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TABLE SHOWING APPLICATION OF LUNDIE FORMULA TO TRAIN RESISTANCE TESTS.

Test made by	Year.	On	Mem.	Average speed. Miles per hour.	Train weight. Tons.	Train resistance— Observed.	Lundie formula.
William Stroudley	1885	London, Brighton, and South Coast.	Single test	43·3	376	13·2	14·1
Angus Sinclair	1892	New York Central	Mean of six tests	70	270	19·03	21·1
,, ,,	1892	,, ,,	Single test	69·6	270	19·8	21·2
P. H. Dudley	1882	,, ,,	Single test	51·43	313	16·9	16·35
,, ,,	1889	Philadelphia and Reading	Single test	60	242·5	18·35	19·0
,, ,,	1889	,, ,,	Single test	63·5	242·5	19·8	19 9
,, ,,	1892	C. R. R., N. J.	Single test	63·2	213	19·0	20·2
Clark formula	—	—	—	10	100	7·74	7·04
,, ,,	—	—	—	10	200	7·74	6·6
,, ,,	—	—	—	10	300	7·74	6·4
,, ,,	—	—	—	20	100	9·5	10·06
,, ,,	—	—	—	20	200	9·5	9·2
,, ,,	—	—	—	20	300	9·5	8·8
,, ,,	—	—	—	30	100	12·42	13·1
,, ,,	—	—	—	30	200	12·42	11·8
,, ,,	—	—	—	30	300	12·42	11·3

differentiate between the air and the friction elements. The frictional resistance of a train being reasonably constant within somewhat wide limits of speed, the speed curve should be a nearly straight descending line from full speed to a point somewhat near a full stop. Now, the actual speed curve dips below this straight line, as seen in Fig. 2, clearly showing a decreasing retarding force, due to air resistance, with decreasing speed.

In Fig. 1 are shown in graphic form the results calculated from more than 150 runs made by Mr. Lundie with trains of different weights on the South Side Elevated Railroad of Chicago. It will be seen that these results, expressed by the location of points on the diagram, cluster around "straight line curves," and that these lines intercept each other, with surprising accuracy, at a single point located at a definite distance above the origin. This indicates, of course, that the first step in obtaining the final formula has been reached in the establishment of a constant representing the minimum possible train resistance for all speeds and weights, and it is interesting to note, by the way, that in none of the recorded experiments so far made on passenger or freight trains of all weights has the resistance per ton been less than the figure indicated by this constant—4lb.

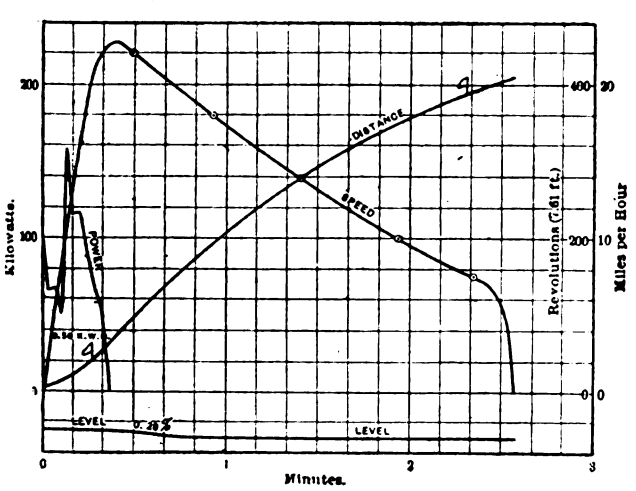

FIG. 2.

Mr. Lundie's formula is as follows:

$$R = 4 + S\left(0{\cdot}2 + \frac{14}{35 + T}\right);$$

where T = the weight of the transportation unit in tons (2,000lb.);
R = resistance in pounds per ton;
S = speed in miles per hour.

It will be seen at once that, unlike most previous formulæ, there are here two variables after the constant—namely, speed and train weight. Many other investigators have endeavoured to accomplish this, but unsuccessfully, and in the formula which has been in most general use in engineering handbooks, that of D. K. Clark, speed only appears as a variable. From a careful study of his results, Mr. Lundie developed the formula on the following mathematical basis: the expression by which "S" is multiplied is proportional to the tangents of the angles made by the lines developed for different weights, as shown in Fig. 1, and is the characteristic of a rectangular hyperbola which (throughout the range of tests made) co-ordinates quite accurately the relations between train weights and the inclinations of the lines mentioned for corresponding weights. The term 0·2 is an intercept on the axis of y; 14 is the constant product of x and y, with the intersection of the asymptotes as origin; and 35 is an intercept on the axis of x.

The test of any formula lies in its application. Gauged by this test, Mr. Lundie's formula unifies in a remarkably close manner nearly all recently published experiments, together with other formulæ of more limited application, as will be seen by an inspection of the accompanying table. The Stroudley, Sinclair, and Dudley tests of train resistance scheduled in this table were brought together by A. M. Wellington in the *Engineering News* in 1892, and referred to as intrinsically worthy of confidence on account of the careful manner in which they were made. To these we have added further experiments made on the Philadelphia and Reading Railroad in 1889, and on the Central Railroad of New Jersey in 1892, so that a fairly complete range of train weights from 200 to 400 tons, and of train speeds from 40 to 70 miles per hour is given in the table. The Lundie formula checks up all these tests very closely, though in all but one case the results obtained by its use are slightly higher than the observed results. In this connection it may be noted that Mr. Lundie obtained his speed figures by positive methods, having found that speed recorders for variable speeds are not sufficiently accurate owing to the inertia of the moving parts.

These tests are all for heavy railroad passenger trains, upon which Mr. Lundie himself has made no experiments. For trains of from 20 to 100 tons, and for speeds of from five to thirty miles per hour, the Lundie formula is accurate, inasmuch as it is obtained directly from 150 or more observations made by Mr. Lundie in Chicago, as before stated. For lighter units still, the formula agrees with the results of private tests made by several of the great electric companies, and checks very well indeed the Clark formula

$$\left(R = \frac{S^2}{171} + 7{\cdot}16\right),$$

bearing in mind that the latter is generally admitted by engineers to be from 1lb. to 2lb. too high.

Now, it need scarcely be pointed out that when a formula of this general kind, deduced on mathematical principles from a large series of experiments within a comparatively narrow range of action, is found to be equally applicable over a much wider range, a strong presumption in favour of the soundness of its underlying principle is established. It seems practically certain, therefore, that the Lundie formula is thus applicable to the whole range of passenger train traction on straight, level, exposed track in a calm atmosphere. It cannot, however, be said to be applicable to street cars running on gritty or dirty rails, and, in fact,

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it is unfortunately too probable that no formula whatever can be devised for street railway work for which a large factor of safety would not have to be allowed in practice to provide for great differences in condition of track.

An interesting question now arises as to whether the Lundie formula can be made, with some modifications, applicable to all kinds of train transporation, freight as well as passenger. It does not check the most recently obtained data for exceedingly heavy trains. Tests on the Chicago, Burlington, and Quincy Railway, made by the old method of engine indicator diagrams, checked by dynamometer car, show that a 940-ton train of loaded freight cars, running at 20 miles an hour, has a resistance on a straight, level track of 5 5lb. per ton. By the Lundie formula this would have been 8·3lb. per ton. An extremely heavy train of freight cars on the New York Central, weighing 3,428 tons, had an average train resistance, at 20 miles per hour, of about 4lb. per ton, or the limiting resistance by the Lundie formula as expressed in the first constant. Other tests on fairly heavy freight-train work recently made have shown approximately 6lb. per ton as an average, when track conditions were good, but these results vary greatly with the condition of the track.

Now, it being reasonable to suppose that with the heaviest freight-train work the train resistance will approach the minimum, and the New York Central experiment above referred to indicating that this minimum is Mr. Lundie's first constant of 4, it would seem that the latter's first constant within the parentheses—namely, ·2—must be inapplicable to very heavy freight-train work, and should be, in fact, modified by a variable, probably T. It would be interesting, therefore, to bring together and plot, in diagrammatic form, reliable results of a large number of freight-train tests taken with different weights and speeds, to see if a modification of the Lundie formula cannot be made for general application to the heavy class of work, as well as light, and we are inclined to believe that were this experimenting once done there might quite possibly be found a common ground of reconciliation between the two grades of service, by which a formula possessing the general characteristics developed by Mr. Lundie could be made applicable to the entire range of railroad transportation.

We believe this formula to be so valuable a part of the technical equipment of a railroad engineer that we earnestly hope it will excite the widest possible comment and criticism in the engineering Press to the end of bringing out all the evidence bearing upon its reliability.

INSTITUTION OF ELECTRICAL ENGINEERS.

Rules for the Regulation of the Wiring of Premises for Connection to Public Supply Mains.

BY J. PIGG, ASSOCIATE.

(Concluded from page 175.)

Another point may be shortly referred to in connection with the wording of specifications in which pressures for testing purposes are to be higher than the working pressures. For instance, we find the following: "The whole of the lamps or appliances for utilising the energy having been connected to the conductors, and all fuses being in place, an E.M.F. equal to twice the *E.M.F. which will be ordinarily used.* . . ." It need hardly be pointed out that installations taking power from public supply mains have a difference of potential established at the terminals, but not an *E.M.F. in ordinary use.*

It will be observed that in several of the specifications the insulation resistance required for motors is to be "equivalent to the number of lamps as represented by the *energy* required for the motor."

If *energy* is measured by its power to do work, the element of time will require taking into account, and it would be possible to so proportion the relative times of the use of the lamps and the motors respectively as to make the insulation resistance which the latter should have under the rules of any desired value. Obviously, the specifications should have reference to the "power" required for the motor.

Besides the differences already touched upon, a study of the specifications reveals numerous other differences of greater or less importance. To deal with these in detail would be tedious in the extreme. There are considerable differences in the insulation resistances exacted for conductors. These range from 2,500 megohms to 300 megohms as minima in different specifications. In many specifications different values of insulation resistance for conductors are assigned for use in different positions, and differences exist amongst these. In some cases tests are specified for ensuring the quality of the cable, and details of time of immersion, temperature of water, time of electrification, and testing pressure are all duly set forth; and in some cases the maker's certificate that these conditions have been duly complied with *may* be required, presumably as a guarantee! In some cases different tests are specified for lead-covered cables; in one specification "lead-covered wires should not be used under any circumstances."

Some slight differences exist with reference to joints, and the methods to be followed, but the surprising point in this respect is the number of specifications which ignore joints altogether.

Differences also exist in the maximum current density allowed; in the maximum "drop" to the farthest consuming device; and in the percentage conductivity, with or without a standard. Other differences with respect to conductors exist in the specification for the smallest wire to be used, and in the smallest unstranded wire. Again, "bunching" of "positive conductors together, or of negative conductors together," may only be done, in some cases, by "permission." But wires which under certain conditions are practically at the same potential, may, under other conditions of ordinary use, have the full difference of potential between them. It does not follow that a wire has a potential of the same sign whether the consuming device is in operation or not.

Differences also exist with reference to cut-outs, ceiling roses, and lamp switches. In some cases double-pole cut-outs are specified; in other cases there must be two single-pole cut-outs. Ceiling roses in some cases must not be provided with fuses; in other cases they must have them. In one case the only possible interpretation of the rule requires two single-pole cut-outs to be provided for every ceiling rose. On the other hand, the writer heard of, but did not see, a specification which called for ceiling roses with two fuses in the fitting. Differences exist in the specifications for lamp switches chiefly in the length of "break" required. In one specification the use of double-pole switches, or two single-pole switches, is preferred throughout the whole installation. In some cases the specifications require "the metal part (of switches and cut-outs, etc.) preferably arranged so that the screw heads, and so forth, do not come through to the bottom of the base; should they do so, the holes must be filled up with plaster of Paris, well shellaced, or some equivalent material." The writer has seen such fittings so protected, with large breaks, insulated covers, and everything handsome about them, which, when fixed, provided a distance of about $\frac{1}{16}$in. between the live parts of the switch and the head of the screw fixing the switch on the block. In the case of some so-called high-insulation ceiling roses, the wires are required to pass through holes separated by a wall of about $\frac{1}{16}$in. thick, and in many cases the size of the holes has been found insufficient to allow the wires to pass through without stripping off the insulation.

Differences also exist in the requirements for main switchboards. In most cases where all three cables on a three-wire system are taken for connection to an installation, the use of three poles, single or coupled together, is specified; in other cases, the use of a treble-pole main switch is not recommended; and in still other cases, each side is to be treated as a separate two-wire system, and complete disconnection provided for.

Other instances of differences of practice might be readily adduced; but probably sufficient has been already given to show the desirability of more concerted action in drawing up rules for the regulation of such work as has been considered. It is true that, in some cases, specifications do

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bear a certain resemblance to each other, but the resemblances are not necessarily the result of concerted action, but are more probably due to different specifications being drawn up under the direction of one person. Of the necessity for the taking of counsel together for the drawing up of rules which may, at least, form a basis for securing greater uniformity in such specifications there can be very little doubt. Differences of opinion are, no doubt, indicative of originality of thought, but such differences may be eliminated in consultation. Rules drawn up as the result of a conference between those responsible for the issue of specifications for the guidance of those to whom the work is entrusted, could scarcely fail to secure a greater degree of uniformity than exists at present.

Resumed Discussion.

A meeting of the Institution of Electrical Engineers was held on the 9th inst., Prof. Silvanus P. Thompson in the chair, when the adjourned discussion on the wiring regulation rules was resumed.

Prof. W. E. Ayrton remarked that, in the course of the few words he said at the previous meeting, he suggested it would be desirable to obtain information as to why such totally different standards of insulation per lamp should be specified by the various supply companies and insurance offices. No answer up to the present time had been forthcoming, and he had endeavoured to find out whether any common system or reason seemed to have influenced the companies in the selection of the particular standards. One reason for selecting a very different standard of insulation resistance per lamp suggested itself to everyone. It was that, although lamps might be supplied to houses furnished with the same declared pressure, in some cases the pressure might be low the whole way between the house and the central station, and in the other case the low pressure at the consumer's terminals might be obtained after some transformation in the cellar or elsewhere. Take the cases of Nottingham and Oxford, showing a wide variation—namely, 75 megohms per lamp for the former, and 12·5 megohms per lamp at Oxford. But the curious thing was that Nottingham was on the low pressure and Oxford on the high. Take the case of the Westminster Supply Corporation. It was a low-pressure system throughout, but varied from 60 to 112 megohms per lamp according to the number of lamps installed, so that he was still at a loss to know how these specific standards were arrived at by supply companies. In places like London and in other towns a number of districts were joined. Indeed, in London there were districts throughout which two companies could supply. Imagine two houses on opposite sides of the same street, built similar in character, having the same number of lamps, wired in the same way by the same firm. He would ask his hearers to assume that the insulation resistance was 20 megohms per lamp. Everything worked very well, and the contractor was instructed to pass on to the house across the way, which was also supplied on the low-pressure system. In the second case the contractor might be told the work was extremely bad, and the company would decline to pass it. Having referred to other inconsistencies, he went on to explain that his observations last week had evidently created a wrong impression—namely, that he was in favour of a low standard. What he really did say was that he was in favour of a high standard. In regard to the question of wire, various numbers, varying from 1,200 to 300 megohms per mile as the insulation of resistance, were given. All sorts of numbers, and fairly high numbers, were specified as the insulation of resistance per mile when the wire was tested in a certain way. Now, he would like to ask whether consulting engineers as a rule were in the habit of testing any of the wire that was supplied on their specification, and if so, what was the result? Having the good fortune to have at his command a very well equipped electrical laboratory, he had made it a point of cutting off samples of coils of wire and thoroughly testing them. He would take up a number of pieces of wire, and give the result as to how they were related to the specification. He would take them at random. In all cases this pressure for test, the temperature and the minimum insulation resistance were specified. Several of these pieces had been supplied by contractors. Now, the one he had just taken up had only $\frac{1}{200}$ of the insulation resistance specified; the next had only $\frac{1}{1000}$. Another piece was specified to have the not very high insulation resistance of 300 megohms per mile after having been in water 24 hours, the testing pressure being 400 volts in this particular case, and a minute electrification of 60deg. F. It was only flexible wire. One of the wires in the sample had an insulation of, not 300 megohms, not 100 megohms, not one megohm, but of 23,700 ohms: another wire had 1,000 ohms. The result was ridiculous. Each wire was cut into six or seven pieces and a bit of each was tested, showing that they were practically the same. They might think that such a high standard was not required, but his contention was that if they asked for a certain kind of wire this ought to be supplied.

Mr. J. S. Raworth thought two of the papers which had been brought before the Institution were very mild, but that the third, introduced by Mr. Wordingham, contained an altogether new proposition. But then Mr. Wordingham had been to Manchester—that worst of all centres of municipalisation—because there they persuaded the ratepayers that what was done for them was all for their benefit. Now, he could only suggest that if Mr. Wordingham's ideas were carried out by engineers, this little island of ours would be made more of a purgatory than it was at present. They would obtain power to enter houses and dictate exactly as to what kind of fittings they should use and what they should not use. He then referred to the changed condition of the electrical industry compared with what this once was. Manufacturers now made electrical fittings quite as well as gas fittings were made, and quite as ornamental. In the face of all this, how was it that electrical people were the only people that were noted for running down their own trade? But, taking the worst of electrical fittings, were they as bad and dangerous as, for instance, a water-slide chandelier, or a swivel-erected bracket standing out from a window between two lace curtains? The permission of a fire officer was not necessary to be obtained for the use of either of these methods. The very worst electric lighting installation in the world was enormously safer than the best of arrangements for gas burning. Yet the insurance companies made no rules for gas installations.

Mr. L. B. Atkinson said the previous speaker had to some extent covered the ground he had intended to touch upon. He did not desire to critically examine any of the rules put before them, because there was a much broader point involved. The papers, particularly Mr. Pigg's, served to illustrate the fearful and chaotic condition into which the question had got, particularly with reference to fire insurance companies. He concluded by criticising what were really the three sorts of rules before them—the Institution rules, the fire office rules, and the supply companies' rules.

Mr. G. H. Cottam said he was once called in to examine the wiring of some premises where the consumer had added on lights without previous notice and contrary to rule. He had no main switch, and the speaker was surprised to see stated on the door of this consumer's house that he was agent to the Phœnix Fire Office. As regards ceiling roses, he thought that fuses should never be placed in them on account of their inaccessibility. He envied a station engineer like Mr. Wordingham, who had the time to draw up such minutiæ as he had presented. He expressed a hope, however, that the Institution would not accept this as a guide. From what had come under his notice in regard to the matter, he was reminded more of grandmotherly Germany or autocratic Russia than of free England.

Mr. J. D. F. Andrews said that if the Institution were to have any rules at all, he thought these should be rather of an advisory nature, and not to be understood as being in any way compulsory, as he thought had been somewhat suggested by a previous speaker. He certainly considered that the rules should not deal with details, as in the present state of the electrical industry it would be almost impossible to devise rules which could control or regulate all systems. For instance, in one rule No. 16 wire was suggested as the largest wire that should be used as a single conductor. Now, he had been accustomed to use No. 12 with considerable advantage. With regard to earthing, he thought there was a general feeling that the time might arrive when earthing would be possible. It was true he quite recognised the magnitude of the difficulties which were to be met with in doing this, but he thought conditions might be devised whereby earthing could be instituted with perfect safety. He believed some of the chief objections to earthing referred to electrolysis, and he enunciated methods for guarding against this. One way was not to have a conductor exposed to earth, but only to expose it at certain points; another method might be, he thought, to use an iron earth-plate, and he proceeded to explain why he believed this. He also suggested that the earth-plate might be somewhat coated so as to avoid electrolysis. Of course, the most perfect way of earthing would be to take an earth concentric system throughout. The advantages of earthing were very great. Every house would be practically self-testing, and consequently they would be able to reduce the working expenses of superintendents and continual testings by experts. Above all, there would be introduced the concentric system on a large scale, which had some very obvious advantages over all other systems of wiring.

Mr. S. Mavor thought there was no reason whatever why a code of rules drawn up by the Institution should not be adopted by the fire offices, for he did not think rules issued by any other authority would bear the same weight as those issued by the Institution. He then proceeded to criticise Mr. Wordingham's paper, and the question of municipalities obtaining compulsory powers for enforcing their rules, so that every little municipality would draw up its pet set of rules, and, according to Mr. Wordingham, have statutory powers to enforce them. To him (Mr. Mavor) such a state of affairs seemed to be quite absurd. With respect to insurance offices, the rules of the Institution really covered all the requirements of those offices, and they ought to be adopted. A recently-issued rule of the insurance offices relating to the enclosing of motors—an important matter—was, as it now stood, a very bad one, and was enforced without reason in many instances. It was an extremely vexatious rule, and a committee of fire officers sitting to frame such rules would do well in future to confer with the Institution of Electrical Engineers before issuing them.

Mr. J. N. Shoolbred, among other things, referred to the question of wiring rules and supply regulations. These, to his mind, differed considerably, and a person should distinguish between them and not complicate them. While the wiring rules affected the insurance companies, the supply regulations were really intended to safeguard and control the installation and matters of that kind. He thought the regulation recently issued by the Board of Trade with regard to the earthing of the middle wire at central stations would be found to have a considerable bearing on the wiring rules later on,

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Mr. A. A. C. Swinton said it appeared to him that nearly the whole of the rules made by some municipalities were *ultra vires*. All the supply company and municipality could do without special powers, as at Manchester, was to enforce so much of the regulations as to ensure that what the consumer had on his premises or works did not interfere with the supply. So long as he did this he did not think anyone could have anything to say to him. Of course, it was quite a different thing with reference to the insurance companies; though he had usually found that with an insurance office which made any objection to any particular point, you had only to mention that there were other insurance companies. This was quite sufficient to make the office agree to what you wanted, provided it was reasonable.

Mr. Arthur Wright now thought central-station engineers had no business to enforce fire risk rules. They all appreciated the work done by the Institution and Mr. Wordingham in drawing up rules which they could recommend to consumers when called upon to do so, but a great many central-station engineers did not consider it in their province at all or to their interest to enforce wiring rules, as this duty obviously belonged to the fire offices. Central-station engineers' duties were to see that the pressure was maintained fairly constant, that no user should take current so intermittently as to interfere with the pressure, and that the leakage of the whole system should not be serious. The exact amount of the leakage permissible in each installation was a very difficult point to decide at present, but in his opinion an insulation of 10 megohms per point wired was quite safe and easy to obtain in all ordinary installations. He considered that central-station engineers had as much as they could thoroughly do in getting all the business that was waiting for them, in providing the necessary plant in advance; and it was to the interest of everybody concerned to encourage and help wiring contractors as much as they could, rather than to hamper them by framing quite an unnecessary series of fire rules. Why should central-station engineers take upon themselves the duties of fire office inspectors? Fire offices were very wealthy institutions and could well afford to pay their own officials, whereas central-station engineers were as a rule badly paid, considering their own tremendous responsibilities. He thought that most of these elaborate fire risk rules were apt to interfere with the proper development of business, as the general public were sure to think electricity a very dangerous commodity if it required 47 or 48 pages of rules to ensure its safety. Those central-station engineers who had sufficient plant should, in his opinion, occupy their time in developing their business, and not do anything to restrict same. Central-station engineers who were in the habit of insisting on the fire risk rules being strictly carried out should remember their own case a little more, and try to imagine what their own business and position might become if all the restrictions of the Electric Lighting Acts and the Board of Trade regulations were rigidly enforced. For instance, how many of them would escape the legalised fines for allowing pressure to depart beyond the stipulated amount from the standard, or the heavy fines that could be enforced on their not giving a supply at the proper pressure when called upon to do so? He would not discuss the very interesting and important question of the desirability of earthing the neutral in three-wire systems—in the first place, because he hoped someone would read a paper at the Institution on the subject shortly, and, secondly, because it might lead the present discussion off the main question as to the wisdom of supply bodies enforcing fire rules on to the less important side track of neutral earthing.

Mr. W. M. Mordey pointed out that Manchester had a municipal gas supply as well as a municipal electricity supply, and asked why gas, which was dangerous, appeared to be supplied without any restriction, while electricity, which was safe, was hampered by these restrictions. He was informed that the only restriction on gas users was that the work had to be done by a certified plumber. Well, they all knew what a certified plumber was.

The discussion was continued by **Mr. S. Evershed**, who agreed with the no-rule party, and **Mr. H. H. Berry**, who voiced the troubles of the contractor who had to supply to so many standards, after which

The **Chairman** said that some time ago, when fire rules were being discussed in another place, a question was put with reference to a large hotel on the Thames-embankment which had violated all fire rules. The insurance company was informed that if they did not accept the installation as carried out the insurance would be placed elsewhere, and he knew of several other cases where installations were laid and going on in safety which were not under any fire rules at all. He could conceive no more likely source of danger from fire than the wood casing, which unhappily was now too much used. Had he the drawing-up of fire rules he would not allow an inch of wood casing anywhere.

Mr. R. E. Crompton, in reply, said the discussion had shown decisively that they were in favour of uniformity being obtained by the adoption, as far as possible, of the Institution rules. He therefore moved the following resolution: "That this meeting is of opinion that the Institution should take such steps as it thinks best to secure uniformity of rules by pressing on supply companies, municipal engineers, and fire offices the advantage of adopting rules to be drawn up by the Institution based on the present ones."

The **Chairman** said it was unusual to put such a motion, but as it directly told the Council what it was desired the Institution should do, and as it did not take anything out of the power of the Council, it would be in order to put the resolution.

Mr. J. Pigg, when called on, said he would send in any observation he might make on the discussion to the *Journal* of the Institution.

Mr. C. H. Wordingham, in his reply, said he would first deal with the speakers at the previous meeting. Mr. Drake, as a wiring contractor, approved generally of the course he (Mr. Wordingham) had taken; but there seemed to be a fear that something of the nature of corruption might arise if a dishonest inspector had to make a test. This, however, was impossible, because definite tests were laid down, and nothing was left to the discretion of the inspector. Major-General Webber had continued the discussion, and the speaker here explained that the rules he had prepared were not intended as a model for all central stations, but only for Manchester. Mr. Bathurst wanted no rules. In this respect he was like a good many other people, but he did not think it would be found possible in a large station to wholly dispense with rules of some kind. Having criticised Mr. Bathurst's criticisms with respect to the testing of fittings, he referred to earthing and insulation, and said an average of the insulation resistance of 20 well-executed installations had been the basis of his figure of 50 megohms. Mr. Wallis-Jones and Mr. Brown had alluded to earthing frames of motors, and the speaker said he considered it was a very great safeguard. After one or two references to Mr. Galsworthy's allusion to the improvement of insulation resistance—a very important matter in regard to damp buildings—Mr. Wordingham next dealt with Mr. Raworth's observations, which, he said, were amusing if the wit was not absolutely refined. As other speakers followed on the same lines, he would reply to them all at once. They were not central-station engineers, and he ventured to differ from their line of argument. The first failure they seemed to have got hold of was that he advocated the making of rules by municipal engineers. They all practically said there should be no rules. But he could not believe that they seriously meant there should be none at all. There could not be better evidence in regard to this matter than that the Council of that Institution had seen fit to draw up rules. The only effect of having no rules would be that the market would be flooded with cheap German rubbish, and that the jerry wiremen would have it all their own way. He could see in regard to such rules no unwarrantable interference with the liberty of the subject, but rather some means afforded for protection against fraudulent people.

The resolution, as worded above, which embodied a slight modification by Prof. Ayrton, was then unanimously carried, and the proceedings terminated.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

141. What effect would the general introduction of an incandescent lamp taking 1½ watts per candle-power have on the financial prospects of central supply stations?—P. T.

142. How would the above lamp affect the design of a system of electric light mains?—P. T.

ANSWERS.

Question No. 136.—What position should an oil-filter occupy in relation to boilers, hot-well, and condenser: and why?

Best Answer to No. 136 (*awarded* 10*s.*).—In most cases where oil-filters are used, the filter is placed either (1) between the feed pumps and the boilers—*i.e.*, on the delivery side of the feed pumps—or (2) between the hot-well and the feed pumps on the suction side. In the first case all the oil which is passed through the condenser by the exhaust steam, and any additional oil which is taken up by the feed water from the pump rods and glands, is intercepted before it reaches the boilers. This form of filter is subjected to practically the same pressure as that on the boilers. In the second case the water takes up a certain amount of oil from the working parts of the pump, and, of course, delivers this to the boilers. This form of filter is subjected to very low pressure.

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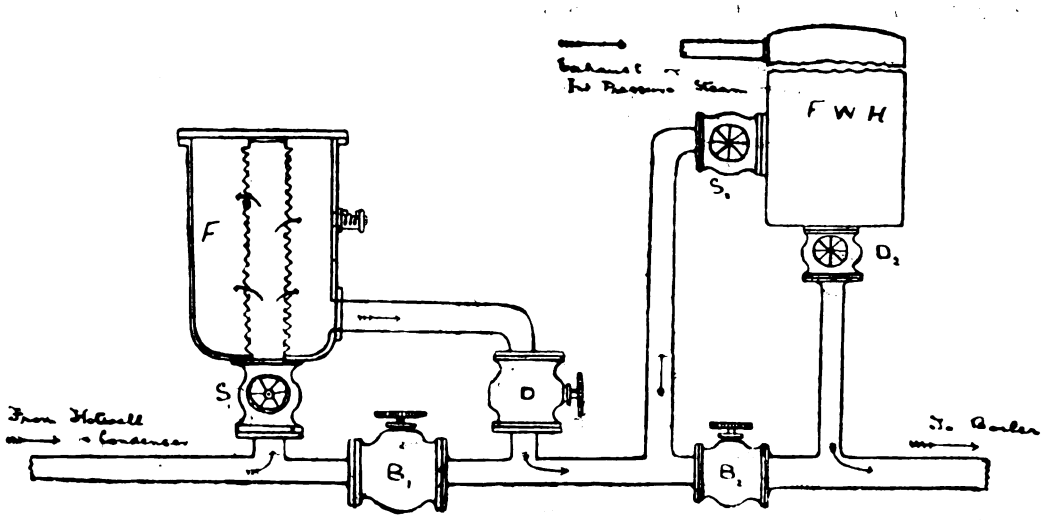
If the principal consideration is the protection of the boilers from the introduction of even the small quantity of oil which would be received by the feed water in its passage through the pump, then case (1) is the best arrangement, as most filters now made of the high-pressure type are perfectly reliable under the high pressure at which they require to work, and of course with this arrangement no oil can find its way to the boilers except what gets through the filter. If the condenser is also to be protected from grease—which is a frequent cause of loss of vacuum, and a constant source of expense owing to the necessity of taking out and cleaning the tubes—then some form of filter is used, suitable for insertion between the main exhaust pipe and the condenser. The filter, placed in this position, protects the condenser as well as the boiler, but the latter gets the oil from the pump, as above explained. This latter is such a small amount as to be practically negligible when the advantage of keeping the condenser free from oil is considered.

fatty matter will leak through the filter into the boilers as these oils become assimilated into the feed water. Pure mineral oils have not this property, and ought always to be used.—R. W. WILSON.

Answer to No. 136 (*awarded* 5*s.*).—In marine practice the most general arrangement is to place the filter between the hot-well and feed heater, as illustrated in the accompanying diagram. The condensed water at the bottom of condenser is drawn through the foot-valve of air-pump on the up stroke, and is forced through the valves of the bucket on the down stroke, and on the succeeding up stroke is lifted through the head-valve into the hot-well, which is usually cast in one and forms a part of the condenser. From the hot-well the water is forced by the feed pumps through the oil filter up to the feed heater and thence direct to the feed check on boiler.

By-pass valves should be fitted to allow the water to pass direct from pumps to boilers, the filter and feed heater being effectually shut off by the supply valve, S_1 and S_2. The



F, Filter. F W H, Feed-water heater. S_1 S_2, Supply valves. D_1 D_2, Delivery valves. B_1 B_2, Bye-pass valves, allowing water to pass straight through from pumps to boilers.

So far as the writer is aware there are very few cases in practice of the filter being placed directly between the exhaust main and the condenser. In the *Transactions* of the Institution of Engineers and Shipbuilders in Scotland, vol. xlii., Part IV., Mr. W. Crockatt describes a type of combined steam separator and oil-filter which appears to have given complete satisfaction. The arrangement consists of a conical enlargement of the main exhaust pipe, with a series of spiral vanes, which give to the exhaust steam a circular motion, throwing the water and oily particles to the outside of the pipe, whence it trickles down into a "gallery," the steam passing through the central pipe into the condenser. The sludge "gallery" is connected with a filter of wire gauze covered with a woven fabric to act as a filtering medium. This filter intercepts all the oil and dirt, and passes the water into the condenser by means of a connecting pipe. The auxiliary engines' exhaust pipes are led into the main just above the separator. Mr. Crockatt mentions that this form of separator had been in use for over four years in a steamship, and that "no soda or other detergent had ever been used to clean the condenser tubes, nor had they been drawn, yet the vacuum could be easily maintained as high as on the vessel's trial trip. The boilers had been examined regularly, but not a trace of grease had ever been detected. The indicator diagrams showed that no back pressure was caused by the vanes in the exhaust pipe. That method of separating the oil, etc., had obvious advantages over the feed-water filter. It kept the condenser tubes as well as the boilers clean, and it kept air and feed-pump valves free from grease."

To sum up, the writer's opinion is that the delivery side of the main feed pumps—*i.e.*, between the pumps and the boilers—is the best position for a filter of the ordinary type, but an arrangement which would also prevent the oil getting into the condenser would be preferable, provided such an apparatus could be obtained to work satisfactorily without causing back pressure. Again, no matter where the filter be placed, if vegetable oils be used in the engines advantages of this arrangement are: (1) oil and other impurities in the feed are arrested at the earliest opportunity—viz., as soon as the water leaves the hot-well—thus preventing the accumulation of oil and other deposits in feed heater; (2) the temperature of the water on leaving hot-well is usually about 130deg., and at this temperature is not injurious to the life of the filter, as might be the case with some filters and with water heated up to 212deg. F. S. D. PEARCE

Question No. 137.—What are the relative advantages of chimneys *v.* forced-draught apparatus for boilers?

[The first two answers published to this question are considered to be of equal value, so that 7*s.* 6*d.* has been sent to each competitor.]

Answer to No. 137.—A general solution to the question whether or not it is advisable to adopt a system of forced draught in a central station is that it will be found advisable when the saving in cost, by using an inferior and thus cheaper class of fuel, or by being enabled to burn a larger quantity of a better-class fuel per square foot of grate area, is such as to pay for the increased capital outlay and the annual cost of power necessary to produce the artificial draught. Consider, then, under four different heads, the cases in which it will probably pay to lay down a system of forced draught:

1. *Fuel.*—When it is required to burn very hard coal, coal dust, coke, breeze, house refuse, or other combustible matter which could not be efficiently burned in an ordinary furnace. It is on account of the hard nature of the American coal that the question of forced draught has received greater attention in the United States than in this country, where its use has chiefly been restricted to gasworks, where coke and breeze are available, and to cotton mills, etc., where combustible material of various kinds can be utilised which would otherwise be wasted. Now, however, that municipal bodies are recognising in combustible house refuse a means of generating light forced draught is

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being more and more resorted to, and there are several electric lighting stations working more or less satisfactorily upon this system. In the majority of central stations, the dimensions of the chimney-stack will have to be large enough to carry away all smoke, flue dust, etc., and sufficient draught produced in this manner to burn the ordinary class of bituminous coal, and where this fuel can be obtained at a reasonable price there seems little to be gained by further increasing the cost and complication of the plant by the introduction of forced draught. Some engineers recommend forced draught whenever economisers are used, being of opinion that the extra heat obtained for heating the feed water by the gases being drawn slowly and at high temperature through the pipes, is productive of economy. This is to a great extent a matter of opinion, and it is extremely doubtful if there is any real economy in it. Of course, if the introduction of an economiser so obstructs the flues as to interfere with the draught of the furnaces, then rather than dispense with the economiser have forced draught. In considering the question when any class of fuel is available, it must be remembered that more water can be evaporated per pound of cheap fuel with the aid of forced draught, but requires a larger grate area per pound of fuel burnt. The following results of tests made by the late Mr. E. B. Cox, and published by Mr. Snow in the *Electrical Engineer* (New York), will show this :

Class of fuel.	Rate of combustion per square foot per hour.	Pounds evaporated from and at 212deg.	Water gauge of draught.	Maximum size of coal particles.
Pea coal.....	13·63	8·56	·375	$\frac{7}{16}$in.
No. 1 Buckwheat	13·58	7·94	·500	$\frac{9}{16}$in.
No. 2 ,,	11·40	8·60	·625	$\frac{5}{8}$in.
No. 3 ,,	11·34	8·65	1·040	$\frac{3}{4}$in.
No. 4 Buckley ...	9·44	8·75	1·125	$\frac{7}{8}$in.

2. When it is required to increase the capacity of an existing plant by consuming more fuel per square foot of grate area. This is found very convenient where more steam power is required, and space will not permit of extensions. The practical limit to this is, of course, the maximum heat to which it is found advisable to subject the furnace.

3. When a wide and perfect regulation of draught is necessary, irrespective of weather, etc. This is sometimes of great importance to central stations, as it is often required to force the boilers for a short time during a fog or thunderstorm, and this can readily be done by means of forced draught.

4. To produce a draught when it is not possible to build a chimney of sufficient capacity to do this in the ordinary way. This is a condition that seldom occurs on land, but it has sometimes to be encountered. Take, for instance, the case of Torquay, where the local authorities would not permit the chimney to rise higher than 60ft.

Supposing it is decided to employ forced draught, we have three systems from which to choose, each of which has its particular advantages :

1. Forced draught produced by means of a fan or fans blowing air into closed ashpits and forcing it through the grate. This system is generally arranged so that the air is blown into a main duct with openings into the various ashpits, the openings being provided with iron doors operated by means of levers or other mechanism from the boiler fronts, so that the draught can be cut off entirely or regulated at the stoker's will. An example of this is Howden's system.

2. Another system also involving the use of a fan or blower is that known as "induced draught," examples of which are the Ellis-Eaves and Martin systems. The fan in this case, instead of forcing the air through the closed ashpits, is placed in the boiler uptake, thus drawing the air up through the grate. It is used chiefly in connection with boilers of the marine type. When adopted with water-tube or Lancashire boilers, partitions are usually built in the boiler brickwork through which the air passes, and is thus warmed on its way to the furnaces. Its great disadvantage is that the fan is exposed to the full effect of the gases, thus shortening its life. There is also a greater inrush of cold air when the furnace door is opened for firing.

3. The other system of forced draught is that produced by means of a specially constructed steam-blower. This system has much to recommend it, especially where there is only a small number of boilers. It is easily regulated, small in first cost, and takes little for repairs. It requires no driving machinery, and is more efficient in steam consumption than either of the other systems, taking only about 2 per cent. of total evaporation. Meldrum's system is an example of this method. As high as 3in. water pressure has been obtained with these blowers. By carefully considering the foregoing it will be possible to arrive at a fair estimate of the success likely to attend the introduction of forced draught in any particular case.—F. A.

Answer to No. 137 (*awarded* 7*s.* 6*d.*).—The following answer to the above question is based on what is contained in Chapter XI. of Prof. J. A. Ewing's "Steam-Engine and other Heat-Engines," to which reference should be made for a more extended treatment of the subject. The matter may be considered from two standpoints—the theoretical and the practical. Theoretically, the forced draught is unquestionably better than a natural chimney draught, in whatever way the forced draught be obtained, whether by allowing a jet of steam to escape up a chimney from the boiler, or by allowing the exhaust steam to force the draught, as in a locomotive, or by the use of fans, such as are used in marine practice. A comparison of the two systems will immediately show the superiority of the forced draught.

For every pound of coal burnt, an average of about 12lb. of air are required for complete combustion. In addition to this, about 12lb. more are necessary as "air of dilution"—that is to say, that while 12lb. contain all the oxygen necessary for complete combustion, the burning cannot take place quickly enough to utilise this as fast as it enters, and hence an excess of oxygen is required. All this air has to be heated up to the temperature of the burning fuel, and hence anything which will lessen this quantity of air will also lessen the heat absorbed in heating it up, and will, in fact, increase the temperature of the furnace gases, and therefore also the effectiveness of the heating surface. A forced draught will accomplish this, because it concentrates and localises the combustion, and hence requires less excess of oxygen. As a matter of fact, about 18lb. are sufficient as compared with 24lb. This, too, will reduce the actual volume of the hot gases, and hence less heat will be lost by the escape of the gases after as much heat has been extracted from them as is possible by the heating surface and feed-water heater, if there be one.

Another advantage arises from the fact that the forced draught makes the pressure above the grate much lower than a natural draught would, and hence compels more air to enter through the fuel, which means that a larger quantity of fuel may be burnt effectively per square foot of grate area. A chimney draught burns about 20lb. per square foot hour, but a forced draught will burn at least three times as much fairly perfectly.

Further, when a chimney draught is used, the temperature of the escaping gases must be fairly high, so as to produce the "head" necessary to make the upward draught in the chimney, which depends upon the difference in density between the air inside the chimney and that outside. The maximum draught is produced when the final temperature is 600deg. F., but in practice the temperature is a little less than this to minimise the heat lost in the escaping gases. But with forced draught the final temperature may be much lower, as there is no necessity to make a draught by means of the lightness of the gases. While, theoretically, the final temperature might be about equal to the initial temperature of the feed water, where a heater is used, practically this makes too great a fall, and the temperature is rarely less than 400deg. But this is a distinct gain over chimney draught.

Considered theoretically, therefore, the forced draught is much better than a natural or chimney draught. In practice the theoretical advantage is diminished, so far as increasing the efficiency of the boiler is concerned. As Ewing says : "The draught has generally been forced with

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the object of increasing the power of a boiler rather than of securing a high efficiency. The motive has been to burn more coal per square foot of grate surface . . . so that more water may be evaporated in a boiler of given weight. But . . . to secure efficiency the heating surface must be largely increased that it may deal with the augmented total quantity and higher temperature of the furnace gases. It is clear, however, that the *most efficient boiler* would be one using a strong mechanically-forced draught, with a relatively small area of grate and a relatively larger heating surface, extended by the use of a feed-water heater so that not only the gases should be cooled as far as possible before escaping, but that the proportion of air to coal should be as small as is consistent with thorough combustion."

The net result is that the total evaporative power of a boiler is greatly increased by using a forced draught, while its efficiency is reduced according to the degree to which the draught is forced. But with ordinary forced draughts this reduction is small It becomes serious in the case of torpedo-boats, say, with a consumption of 140lb. per square foot hour, because here the combustion is imperfect, and the temperature is high at the escaping gases. In cases where space is a consideration, a forced draught is a great advantage over a large chimney.

Taking all these considerations together, it seems pretty evident that the chimney draught must take a second place as compared with a forced draught for all-round advantage.—T. C.

Answer to No. 137 (*awarded* 5*s.*).—The answer to this question must depend somewhat upon local circumstances—*e.g.*, in a town where smoke and bad fumes have to be got rid of, a tall chimney is necessary to lead them well away; but in an open, exposed place a tall chimney would be liable to be blown down by the wind. However, assuming external circumstances equally favourable to chimneys and to forced draught, then, with regard to the chimney, the first cost is all that need be considered, because a well-constructed brick chimney is very efficient and needs very little repair, its power for making a draught being very great; and, further, it has the advantage of making no pressure in the furnace as forced draught does, this pressure being a source of danger to the stoker if he should forget to stop the forced draught before opening the doors. I have myself known three accidents from this cause. Again, the natural draught of the chimney is dry, while the steam used to make the forced draught is very apt to make a chimney damp, and so to disintegrate it in a comparatively short time. But, all things being favourable, it is quite possible that where a draught is forced in through the fire-bars by means of steam under pressure, some of the steam may be converted into water-gas by passing through the hot fuel, and this would increase the heat of the furnace; but, again, supposing the chimney not capable of carrying off the gases so produced, an explosion might easily follow with disastrous results. With a forced draught there is a constant expense for steam to maintain the draught, while the maintenance of the draught by the chimney costs nothing for its power, although many tall chimneys are heavy and even dangerous. It must not be forgotten that there are two ways of making forced draught—viz., one acts by steam under pressure issuing from a small nozzle, and blowing air into a closed furnace, so making a pressure in the furnace; the other acts as seen in railway locomotive engines, by allowing the exhaust steam from the cylinders to blow straight up the chimney, and so draw fumes away from the fire, and in this case the furnace is open to the air, and so no pressure is possible in the furnace. With short or very small chimneys forced draught might be necessary, but then I prefer the exhaust type, although it is somewhat noisy, even if the steam is taken straight from the boilers instead of the exhaust from the cylinders, as mentioned above. I consider a good, well-proportioned chimney preferable to all other means for making a draught with stationary furnaces, and I have used all three of the above methods. The chief thing to remember in building a chimney is to be sure to get its sectional area plenty large enough for the work it has to do. Its efficiency depends upon the square of its diameter or its sectional area, but only upon the square root of its height. I do not like furnaces to have any pressure in them, because I think them much safer when exhausted by a good draught in the chimney.—F. G. A.

THE SUPPLY OF ELECTRICAL POWER.

BY ALEXANDER SIEMENS.

Under the auspices of the Liverpool Chamber of Commerce, Mr. Alexander Siemens, on Tuesday last, delivered an address on the subject of "The Economical Supply of Power." Mr. E. C. DANSEN, the president of the Chamber, occupied the chair, and, in his opening remarks, said that during the last few years the practical utility of electricity as a mechanical force had been fully demonstrated, but hitherto there had been serious obstacles to its development—namely, the cost of production and the difficulties of distribution. The large consumer was able to make his own electricity and use it to advantage, but that was impracticable in the case of the small consumer. He was glad to see that there was a prospect of the difficulty being removed, and the inestimable benefits of a cheap source of mechanical power brought within the reach of all.

Mr. SIEMENS commenced his address by the fundamental statement that the progress of the civilised world was based on the substitution of mechanical power for manual labour. He went on to explain that there had been various ways in which inventors had been trying to meet the general demand for mechanical power. There had been hydraulic power and gas power, but electricity possessed great advantages over everything else as a means of distributing power. Properly installed, electric motors were absolutely free from danger, and if anything went wrong it was easy to determine where the fault was. The objection up to now to using electricity for power had been its high price. The means of cheapening it were its wholesale production in a suitable locality and the full utilisation of the plant. Until lately the generating stations had always been placed close to the district in which the electricity was used, and that necessitated their being situated in localities where the ground was extremely expensive. Besides, it had not always been possible to place them in localities where the supply of coal and water could be got in the cheapest possible manner. With the high-tension voltage it was now possible to put a generating station miles away from the place where the electricity was utilised. The most prominent example of this was the station at Niagara, where the water power was utilised for generating electricity, and the current was carried to Buffalo, some 20 miles away. In this country, however, where the supply of water fluctuated considerably at different seasons, it was better to rely on coal for their generating power. It was therefore desirable that they should establish their generating stations not only where the ground was cheap, but where the fuel was close at hand. In this way they would generate the electricity in the cheapest possible way, and with high-tension currents they could easily distribute the power for 20 miles round. One of the objections which had been urged against what he might call these coal-mine generating stations was that they would interfere with established works which had been provided by municipalities. This opened up the very thorny question of municipal trading, upon which he did not wish to enter, but he might say that he saw no necessity for such generating stations as he had indicated competing with the municipalities at all. With the large towns it might be different, but the numerous small communities within the area would be greatly benefited by such a station. A general Bill would cover all the municipalities in the district, and they would have very much less trouble in establishing their electric supplies than if they went themselves for provisional orders. He hoped it would be generally recognised that the best thing to do was to put at the disposal of the people the means of obtaining cheap power, because it was only in that way that competition with foreign countries could be successfully kept up.

A good discussion followed, in which Mr. P. SELLON and Mr. H. GRAHAM HARRIS briefly spoke, and commended the establishment of such generating stations as Mr. Siemens had suggested.—We are indebted to the *Manchester Guardian* for the above abstract.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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TRIALS OF MOTOR VEHICLES.

The programme of the trials of motor vehicles for heavy traffic under the auspices of the Liverpool Self-Propelled Traffic Association, has been issued. In the early days of such trials it is difficult to produce a programme that will please everybody. The Englishman's privilege is to grumble, and therefore we feel justified in complaining of the treatment of electrically-propelled vehicles. The particular points on which these will be judged are four—(*a*) battery power to travel forty miles on one charge; (*b*) nature of the arrangements for varying discharge rate; (*c*) method of carrying the battery and replacing same; (*d*) simplicity of controller. Of course, there are other points common to all vehicles which will be considered, such as economical working, initial cost, etc., but upon these we have nothing to say. Another paragraph of the programme describes the nature of the trials as follows: "Trial runs will be made from Liverpool, over distances of from thirty to forty miles, on two successive days. All vehicles will be required to traverse the prescribed routes without alternative, and to perform such manœuvres as are hereinafter specified. *The distance between any two of the depôts provided for the supply of water will not exceed twelve miles.*" There may be mitigating circumstances not clearly apparent, but otherwise it seems that such a programme practically prohibits any electrically-driven vehicles from competing. The heaviest possible handicapping has been exercised, while justice requires every competitor starting from scratch. If an electrically-driven vehicle is to be self-contained for forty miles, why is a steam-driven vehicle to be allowed to water at the maximum distance of twelve miles? Consider just a moment, that provision decreases the necessary water-carrying capacity by three and one-third times. Never mind about actual figures; only suppose that a hundred pounds of water per mile are used—this requires a water-carrying capacity for one thousand two hundred pounds of water, whereas if the capacity was for the whole run of forty miles it would have to be four thousand pounds. Thus the steam-driven vehicle is handicapped favourably by first taking off two thousand eight hundred pounds weight of water, and, secondly, the weight of the necessary apparatus to hold that water. The electrically-driven vehicle, on the contrary, is unfavourably handicapped by being compelled to carry batteries with a capacity for the forty miles' run. We fail to see any loophole to avoid the conclusion that it is determined beforehand that electricity has no chance in the competition. Such a conclusion is quite true under the circumstances described. It is all very well to say that an article in the general regulations modifies the above. To a slight extent it does, but only to a very slight extent. The clause referred to reads: "The capacity of any water-tanks, whether the same be fitted for feed, cooling, or other purposes, shall suffice for a run of fifteen miles on the basis of the consumption on the trial runs." At the most this would mean—keeping the one hundred pounds per mile for argument—a weight of water of one thousand five hundred pounds, as against the equivalent four thousand. But is it conceivable

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that a competitor would fill up his tank for fifteen miles when, according to the programme, he can get water at the end of twelve miles? You may have the tank capacity for fifteen miles, but there is no necessity to have water for more than twelve miles; and so the first view of the handicapping practically holds. We have no objection to competition, to trials, to prizes, to anything that will bring the public face to face with the advantages of self-propelled vehicles, but we do object to any competition being unfair to any one class of vehicles it seeks to enter the competition.

It has long been a source of wonder to us what the men who are exploiting self-propelled vehicles desire. They seem to be acting upon no principle, with only a general and very vague idea that the thing is good and ought to go. Might we suggest that the first thing is to produce something that will economically supplant horse traffic. When that is produced, long-distance traffic and other considerations may become ripe for discussion and experiment. As it is, by trying too much, the adoption of that which would come comparatively easy is delayed. We have several times considered the prevailing conditions of horse traffic, and the direct and indirect benefits that would accrue from its abolition. If the men so actively engaged in developing self-propelled traffic would moderate their promises, and consider the system to be replaced more closely, we should probably move faster.

WIRING RULES.

The discussion of the three papers on the regulation of wiring for electric lighting purposes at the Institution of Electrical Engineers last week was brought to a fitting conclusion by the resolution proposed by Mr. Crompton. We trust that all those present, whether fire insurance officers, municipal electrical engineers, or contractors, will take it that the resolution so unanimously passed is binding on them individually, and that in this way a step may be made in the right direction. The discussion during the evening hinged at times round the "municipal trading" question. Mr. J. S. Raworth directed the matter into this groove by one of his amusing speeches, in which he extolled the safety of electricity and then denounced the dangers arising from the use of gas. Then he wanted to know, if a consumer of gas had such facilities for burning his house down, why should a user of electricity have his very few opportunities taken away by the avaricious municipalities? Again, if Mr. Wordingham's rules were adopted generally, the electrical manufacturer would not be able to sell bad accessories and fittings! Mr. Mordey, Mr. Evershed, and Mr. Wright, later in the evening followed faithfully on the red-herring trail laid by Mr. Raworth, but we noticed that no contractor complained of the Manchester tests. The complaint made by one speaker representing the contractors was of the great difference in the standard requirements as to the length of a fuse. This, however, does not occur in Mr. Wordingham's tests, under which fuses and switches are made to break certain definite currents and certain voltages. We agree with the last-named gentleman in that such tests benefit everyone except the jerry contractor.

REVIEWS.

The Practical Electrician's Pocket Book and Diary for 1899. Edited by H. T. CREWE, M.I.M.E. S. Rentell and Co. Price 1s.

We have received a copy of the first issue of this little pocket book and diary, which has been organised by the editor of our contemporary *Electricity*. As regards the diary itself, the space provided for each day is too small to be of much service, but the general information in the first part of the book is useful and handy for reference. This information is rendered rather inaccessible by the want of a good index. The list of provincial towns in which an electrical supply is available is useful as giving both the voltage supply of the system, the frequency of the alternating currents used, and the maximum price per unit. In the early pages we note a directory which is headed "Where to Buy," and we see that at present only three consulting electrical engineers are exposed for sale. In other departments also, this directory should be extended very largely, if any good is to come from it. For instance, under the heading of "Dynamos," out of seven firms given, only one can be considered representative of English manufacturers of dynamos on a large scale. Again, electric lighting wires and cables appear to be only supplied by one firm. A directory of this kind should be at least fairly representative to be of any service whatever to those who consult it.

FORTHCOMING EVENTS.

FRIDAY, FEB. 17.

North-East Coast Institution of Engineers and Shipbuilders. At 7 p.m., at Marine School, Ocean-road, South Shields, resumed discussion on Mr. Tom Westgarth's paper on "Works' Organisation."

SATURDAY, FEB. 18.

Royal Institution.—At 3 p.m., Lord Rayleigh, M.A., D.C.L., F.R.S., on "The Mechanical Properties of Bodies."

MONDAY, FEB. 20.

Society of Arts.—At 8 p.m., Cantor Lecture, Mr. Archibald Sharp on "Cycle Construction and Design."

TUESDAY, FEB. 21.

Royal Institution.—At 3 p.m., Prof. E. Ray Lankester, M.A., LL.D., F.R.S., on "The Morphology of the Mollusca."

Institution of Civil Engineers.—At 8 p.m., further discussion on paper by Mr. Jeremiah Head, M.I.C.E., and Mr. Archibald P. Head, A.M.I.C.E., on "The Lake Superior Iron Ore Mines and their Influence upon the Production of Iron and Steel."

Society of Arts.—At 8 p.m. (Applied Art Section), Mr. Cyril Davenport on "Vitreous Enamels."

WEDNESDAY, FEB. 22.

Liverpool Engineering Society.—At 8 p.m., Mr. Oswald W. Young on "Some Observations on the Rating of Machinery."

Society of Arts.—At 8. p.m., "Electric Traction and its Application to Railway Work," by Mr. Philip Dawson.

THURSDAY, FEB. 23.

Royal Institution.—At 3 p.m., Dr. Allan Macfadyen, M.R.C.S., on "Toxins and Antitoxins."

Institution of Civil Engineers.—At 8 p.m., Dinner, by Mr. W. H. Preece, C.B., president, to the council and honorary members.

Institution of Electrical Engineers.—At 2 p.m., Transcendent Electric Lamp Company meets at the works, Brook Green, Hammersmith.

FRIDAY, FEB. 24.

Royal Institution.—At 9 p.m., Prof. Oliver Lodge, D.Sc., LL.D., F.R.S., on "Coherers."

Institution of Civil Engineers.—At 8 p.m., students' meeting and paper on "The Loss of Heat from Buildings," by Mr. R. Gordon Mackay, student.

SATURDAY, FEB. 25.

Royal Institution.—At 3 p.m., Lord Rayleigh, M.A., D.C.L., F.R.S., on "The Mechanical Properties of Bodies."

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THE GENERAL ELECTRIC COMPANY'S ANNUAL DINNER.

The ninth annual dinner of the staff of the General Electric Company was held at the Trocadero Restaurant on Saturday last, when Mr. Max Byng presided. As is usual on these occasions, the staff invited their lady friends, and a large number of prominent gentlemen connected with the electrical industry were invited by the directors of the firm. In fact, the faces seen at the high table would have almost led one to fancy that an Institution dinner was being held. This impression, however, was dispelled after the speeches had commenced. We need only add in this respect that the utterances at the dinner were interesting. Among the guests we noticed Mr. R. E. Crompton, Mr. and Mrs. Dane Sinclair, Mr. R. W. Wallace, Q.C., Sir J. Pender, Mr. W. M. Mordey, Mr. and Mrs. Manville, Mr. Rennie, Mr. Crookes, Mr. Miller, Mr. Erskine, Mr. L. Aron, Mr. A. Walton, Mr. Dobson. Mr. and Mrs. Jago, Mr. W. B. Esson, and many others.

After the toast of "The Queen" had been proposed and honoured, the CHAIRMAN proceeded to give "The Visitors." He referred to the regrettable absence through illness of his brother, but all would be pleased to hear that the treatment Mr. G. B. Byng was receiving in Germany was having the desired effect. They of the General Electric Company were always pleased to have visitors come to see them, and believed that a kindly interest in their customers had helped the extension of the firm very much. He coupled with the toast the names of Mr. Crompton and Mr. Dane Sinclair. When referring to Mr. Crompton as a military man, he expressed the opinion that military methods and training produced good men in every way.

Mr. R. E. CROMPTON, in reply, said he was pleased to be with them that night as the representative of the Electrical Engineers Royal Engineers Volunteer Corps. As regards his position, he would be only too pleased to take up the rank of colonel, and for this reason—all that was required by the War Office was that the number of efficient recruits should be increased so that the corps should be of full strength. He would tell them, however, that they wanted good men. With the proposer of the toast, he very much regretted the absence of Mr. G. B. Byng, and he hoped during the evening they would have an opportunity of drinking to his health.

Mr. DANE SINCLAIR, in his reply, claimed the right to speak for the ladies in appreciation of the custom to admit them to these annual dinners.

Mr. H. HIRST then proposed "The Staff," and referred to the regrets that they had not Mr. G. B. Byng with them. These regrets were all the more profound on account of the deep respect and admiration which he had inspired. He had just received a telegram from Mr. Byng wishing them a happy evening, and expressing his desire to be with them again. There was no doubt that that gentleman's inspirations had permeated the members of the whole staff, and he looked to the younger men to keep up the corporate feeling which was so much needed in such a large business as that. Mr. Hirst then laid down 10 maxims which he thought should guide them in their business life. These ran somewhat as follows: Treat all your customers as gentlemen; take infinite trouble over small things; don't mind grumbling customers; merit confidence; treat suppliers of goods with equal courtesy as you would a customer; control your temper; keep personalities out of business life; improve yourself in your knowledge of your profession; try and be gentlemen.

Mr. BEVIS, Mr. T. HAWKINS, and Mr. WARD replied for the staff, representing respectively the London departments, the manufacturing branch at Manchester, and the local branch managers.

The next toast, also proposed by Mr. HIRST, was that of "The Allied Companies," to which Sir JAMES PENDER and Mr. R. W. WALLACE responded.

Having thus disposed of the speech-making, which had been kept down to very small limits, an excellent smoking concert was commenced. The programme of this is too long to reproduce here, but the artistes gave every satisfaction. During the short interval between dinner and the concert the tables were rearranged to enable those present to arrange themselves in groups for general conversation. A pleasant evening was concluded just about midnight, and even then a few items had to be eliminated from the programme.

SIMPLE SIGNALLING THROUGH A SINGLE WIRE.

As mentioned in a previous contribution to this journal, this method of obtaining communication through a single wire, without any return circuit, depends on the production of Hertzian waves at one end of the wire, and their utilisation, after transmission through the wire, for the purpose of working a coherer circuit at the other end. As the foregoing statement involves the dismissal of the battery current so far as its circuit through the connecting wire between two points of communication are concerned, it may be convenient here to detail a root experiment, which will indicate the principle on which this method of communicating at a distance rests. In Fig. 1 is shown a

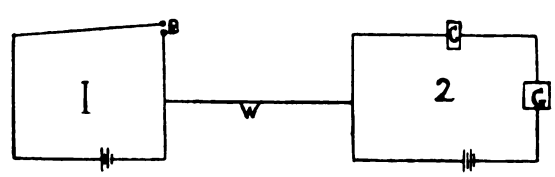

FIG. 1.

circuit, 1, in which is included a break, B. Another circuit, 2, has included in it a coherer, C, and a galvanometer, G. Joining the two circuits is a wire, W. We will assume, to begin with, that G indicates a state of deadness in C. If the contacts at B are now brought together, no alteration in G is as yet observable, but on separating the contacts at B, G indicates the passage of a continuous current. In other words, C has been energised by the Hertzian waves produced on breaking of circuit at B. How these waves are produced is not the purpose of this article to consider specially, but if a self-induction be included in the circuit 1, their production is rendered more certain, and this would seem to point to a direct connection between the waves and the degree of sparking at B on the rupture of the circuit. Having now recognised the possibility of producing action at a distance on the basis of the foregoing experiment, it will now be possible to construct on this foundation many and varied methods of communicating messages through a single conductor. One method, as already mentioned, has been detailed in a former issue of this journal. Another method is now shown in Fig. 2, in which provision is made for a constant

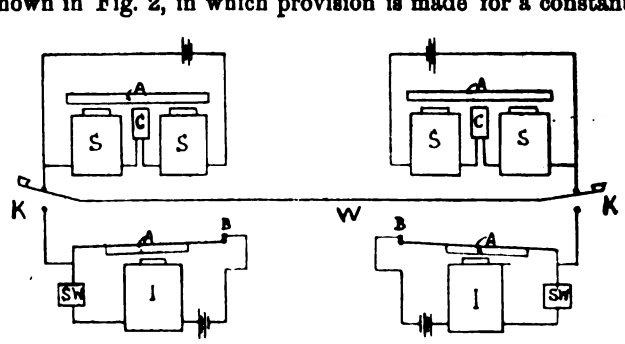

FIG. 2.

generation of waves, which can be sent at pleasure into the connecting wire between the two stations for the energising of the coherer circuit at the farther end. Two circuits are shown at each end of a single wire, W. One of these circuits has included in it a coherer, C, and a sounder, S, the armature, A, of which is arranged to beat on the coherer, and in this way break its own circuit, and so become again sensitive and responsive to further influences. The other circuit has included in it a switch, S W, and an interrupter, I, the armature, A, of which makes and breaks the circuit at B. A Morse key, K, is interposed in the manner shown, for the purpose of allowing only the farther sounder to be actuated. If now

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(S W being on and I at work), the key, K, is manipulated for ordinary Morse signalling, the waves generated at B are thrown into the wire, W, and being transmitted to the end of the wire, there actuate the coherer, C, and the sounder, S, which will respond to the movements of K.

ELECTRICITY IN THE POST OFFICE.

BY W. H. PREECE, C.B.

Before the Liverpool Engineering Society last week, Mr. Preece delivered a most interesting lecture on the above subject, in which he stated that the length of telegraph wires in this country had increased while under Post Office administration from 60,000 to 300,000 miles. During the same time telegraph business had increased four times as fast, and the fact that four times as much work was now done by the same length of wire was due to improvements made by officers of the postal service. These improvements had never been patented, and they were unrewarded. He mentioned, as an instance, that the Wheatstone instrument when invented transmitted messages at the rate of 80 words a minute. It now transmitted at 600 a minute. The Government, however, paid nearly £6,000 a year in royalties on American patents. The telegraphic improvements of the Post Office had led to the development of the provincial daily Press; the Press service was carried on at a great loss; and all the Department got in return was a great deal of splendid abuse. Referring to the telephone, he denied that the patent had ever been offered to and declined by the Government. There was not a responsible officer in the Post Office who had not done his best to secure that great invention for the country, but they had always been thwarted. A lot of the trouble about telephones arose from the fact that the users were not always gentlemanly towards the lady operators. Still, there were 158,997 telephones at work in this country. As to trunks, the Post Office in 1897 took over 29,000 miles of wire. The length had since been increased to 56,000 miles, and the receipts had doubled, since the telephone had applied to it a system of automatic signalling which had since been adopted in America as the greatest improvement in telephony. Mr. Preece went on to refer to cabling by telephone, as to the development of which over very long distances he took a sanguine view. He also dealt with the economies effected in the use of electricity for telegraphic purposes. The Post Office now produced its own electricity at 1d. per Board of Trade unit, and were replacing the old primary cell batteries by accumulators. The electricity produced by primary cell batteries cost 6s. per Board of Trade unit, as against 1d. under the new system. Already 62,782 batteries had been replaced by 2,784 accumulators. There still remained about 300,000 batteries to be replaced by one-twentieth of that number of accumulators. Mr. Preece afterwards dealt with the use of copper for telegraph and telephone wires as compared with iron, an improvement which he claimed had been introduced by the Post Office of this country. It was the use of copper which allowed of long-distance telephoning. Referring, in conclusion, to wireless telegraphy, he pointed out that it was already in use between forts at Lavernock, on the Glamorgan coast, and Flat Holm, an island in the Bristol Channel. It had never been known to fail, and was independent of daylight or darkness, dry weather or wet, fog or clear air. He considered that wireless telegraphy had a great future.

LIVERPOOL SELF-PROPELLED TRAFFIC ASSOCIATION.

TRIALS OF MOTOR VEHICLES FOR HEAVY TRAFFIC.

The following are the particulars of the competition to be held in conjunction with the annual show of the Royal Lancashire Agricultural Society in August this year:

The chief object of the trials is to encourage the development of types of heavy motor wagons suitable for trade and agricultural requirements in the neighbourhood of Liverpool, which shall be capable of economically taking the place of horse haulage and of competing with the existing railway rates in the transport of heavy loads of goods over distances of up to 40 miles. Trial runs will be made from Liverpool over distances of from 30 to 40 miles on two successive days. All vehicles will be required to traverse the prescribed routes without alternative, and to perform such manœuvres as are hereinafter specified. The distance between any two of the depôts provided for the supply of water will not exceed 12 miles. Route maps will be issued for each course on the mornings of the respective runs. The evaporative efficiency of the boilers will be tested. The trials will begin on the morning of Monday, July 31, 1899, and will conclude on the afternoon or evening of Wednesday, Aug. 2, 1899.

The following gentlemen have accepted their nomination as judges: Mr. M. C. Bannister, A.M.I.C.E.; Mr. Everard R. Calthrop; Mr. S. B. Cottrell, M.I.C.E.; Prof. H. S. Hele-Shaw. LL.D., M.I.C.E., honorary consulting engineer to the Royal Lancashire Agricultural Society; Mr. Boverton Redwood, F.R.S.E., F.I.C.; Mr. Henry H. West, M.I.C.E. At these trials the following awards will be made: the Royal Lancashire Agricultural Society offer one gold and one silver medal in each of the four classes. These medals will be accompanied by the diplomas of both bodies. The awards will, if possible, be made on Thursday, Aug. 3, 1899. A report on the trials will be issued by the judges and circulated by the association.

The following general regulations are applicable to all vehicles:

1. The vehicle shall be self-propelled. It shall be propelled by mechanical power alone, but there shall be no restriction on the source of such power or the nature of the agents used.

2. The vehicle shall be capable of going anywhere that a horse-drawn vehicle carrying the same load is ordinarily required to go, and of being placed in the same positions and withdrawn therefrom without external assistance. The particular manœuvre most generally called for is to work into and out of a loading berth when cramped for room. This requirement arises in the case of embayments, or of confined spaces between other vehicles in a line receiving or discharging goods. Carters usually back into such positions obliquely, and bring the vehicle into line by turning the leading wheels at right angles to the rear wheels and again backing, but it is open to competitors to perform the manœuvre as they think best.

3. The vehicle shall be capable of working into and out of an embayment of one-and-a-half times its own length.

4. The vehicle shall be capable of starting from rest on and mounting a gradient of 1 in 10.

5. The capacity of any water-tanks, whether the same be fitted for feed, cooling, or other purposes, shall suffice for a run of 15 miles on the basis of the consumptions during the trial runs.

6. Such portion of the platform of the vehicle as is designed to carry the load shall be level, and the height of the floor line, measured either when light or laden, shall be not less than 3ft. 6in., and shall not exceed 4ft. 3in.

7. The vehicle shall conform in all respects to the requirements of Locomotives on Highways Act, 1896, and, in the case of its being oil-propelled, of the "Regulations as to Petroleum" issued by the Home Secretary under Section 5 of this Act.

8. All working parts shall be properly cased.

9. Provision shall be made for the testing of the quantity of water evaporated.

10. All manœuvres shall be performed by the vehicle when fully laden and provisioned.

11. The vehicle shall remain on exhibition in the showyard from Aug. 3 to 7 inclusive, and the competitor shall abide by all the regulations of the Royal Lancashire Agricultural Society, copies of which may be obtained from the secretary of the society, Mr. James Birch, 34, Castle-street, Liverpool, any time after April 1, 1899.

VEHICLES ELIGIBLE FOR COMPETITION.

Class.	Minimum load.	Maximum tare.	Minimum level platform area.
A	2 tons	2 tons	50 square feet.
B	3½ ,, ...	3 ,, ...	65 ,, ,,
C	5 ,, ...	3 ,, ...	80 ,, ,,
D	6½ ,, ...	4 ,, ...	110 ,, ,,

Rules and Conditions.

1. The vehicle shall carry at least the minimum weight of goods specified for its class, or any weight in excess declared by the competitor throughout the continuance of the trials. Suitable ballast will be provided by the association.

2. Each competitor shall himself make all arrangements for the necessary staff and appliances to work his vehicle or vehicles. Accommodation for the vehicles in Liverpool will be provided by the association. Vehicles intended for trial shall be registered as "arrived" at the showyard of the Royal Lancashire Agricultural Society, Wavertree Recreation Ground, Liverpool, not later than noon on Friday, July 28, 1899.

3. Two official observers will accompany each vehicle during

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the trial runs to take notes of behaviour, fuel and water consumption, etc., and no repairs will be permitted without their knowledge and consent.

4. Any vehicle withdrawn from competition during the trials, except under the written authority of the judges, shall be ineligible for a prize or for commendation.

5. Twenty photographs of each vehicle shall be furnished by the competitor not later than July 14, 1899. These must be delivered in good order at the Liverpool Royal Institution, addressed to the Hon. Secretary, Liverpool Self-Propelled Traffic Association.

6. Entries shall be made on printed forms (to be obtained from the hon. secretary), and shall be accompanied by an entry fee of five guineas per vehicle, which will include the competition and stand accommodation during the show. Entries will be received, under cover of a registered letter, by the Hon. Secretary, Liverpool Self-Propelled Traffic Association, the Royal Institution, Colquitt-street, Liverpool, any time prior to 12 noon on the last day of May, 1899.

7. A complete list of particulars, together with drawings, shall be lodged with the honorary secretary not later than July 14, 1899, and further detailed drawings shall be submitted to the judges, in confidence if required, while the trials are in progress or at their conclusion. The description must be printed, and 200 copies must be furnished. The tare weight of the vehicle, both exclusive of any water or fuel and in complete running order, must be given, also, as briefly as possible, any special features of construction or working to which the competitor desires to draw the attention of the judges.

8. Each competitor shall arrange to have his vehicle or vehicles ready for inspection by the judges at 3 p.m. on Friday, July 28, 1899, in the showyard, when the dimensions, capacities, and weights will be taken by the observers.

9. All vehicles shall be stored overnight at the depôt or depôts provided by the association.

10. If necessary, lots will be drawn to determine the order of starting. It is intended to begin the runs shortly after 9 a.m. on each of the two days, the vehicles following one another at intervals of about 10 minutes.

11. At the conclusion of the trials any vehicle, or motor, or part thereof, shall be opened up, in confidence, for inspection by the judges, if required.

12. Each vehicle will be allotted an official number, which shall be displayed during the continuance of the trials.

The judges reserve to themselves the right of absolutely disqualifying any competitor for any infraction of these rules. While obeying in all respects the instructions of the judges and the conditions of the competition generally, it is to be fully understood and agreed by every competitor that no responsibility, legal or otherwise, is to attach either to the judges, the Liverpool Self-Propelled Traffic Association, or the Royal Lancashire Agricultural Society in respect of anything, or for any damage or injury caused to any person or thing, but that all responsibility of every sort and kind, whether pecuniary or otherwise, and all risk of damage to the competing vehicle, is to attach to the competitor, and is to be borne by him.

The following are the points which will be taken into consideration by the judges in making the awards:

(*a*) *Cost.*—Economy of working, including attendants.

(*b*) *Control.*—Stopping, starting, changing speed, steering, and reversing, particularly under adverse conditions, such as on inclines, in confined spaces, or on greasy surfaces.

(*c*) *Working.*—Adhesion on greasy surfaces when light and when laden; noise, smell, visible vapour, dust, or other nuisance when travelling; number of mechanical operations requiring attention from the driver; efficiency of brakes; time occupied in preparing the vehicle for service on the road; speed—within legal limits; ability to travel between the depôts without taking or receiving supplies of fuel, oil, gas, electrical, or chemical materials or electrical current, water, or of any agent employed for actuating the motor or assisting its working; ability to travel between the depôts without stopping to effect repairs, adjust parts, apply lubricants, or for any other purpose or cause not provided for in the itinerary; freedom from a breakdown of any nature.

(*d*) *Construction.*—Efficiency of wheels; nature and efficiency of gearing; strength of frame and working parts; quality of workmanship; efficiency of springs; freedom from complicated or over-refined parts; facility with which repairs can be effected; capacity of bunkers or oil-tanks; ratio of available platform area to extreme moving area in any horizontal plane; ratio of tare to weight of freight carried during the trials.

(*e*) *Steam-Propelled Vehicles.* — Evaporation efficiency of boiler; ample supply of steam; action of feed pumps or injector; consumption of fuel and water per mile; leakage of steam or water; arrangements for stoking.

(*f*) *Oil-Propelled Vehicles.*—Efficiency of ignition; regularity of carburation and explosions; range and gradation of speed of vehicle, and smoothness with which changes of gear are effected; circulation of cooling water and quantity required; consumption of oil per mile; leakage of pipes or tanks.

(*g*) *Electrically-Propelled Vehicles.*—Battery power to travel 40 miles on one charge; nature of the arrangements for varying discharge rate; method of carrying the battery and replacing same; simplicity of controller.

The decision of the judges, expressed in writing on any point, shall be final and binding on all parties, and they may withhold any award or any portion thereof.

Three printed copies of these rules will be issued with each form of entry, one of which, signed by the competitor, must accompany each entry when forwarded to the hon. secretary. Mr. Lawrence Jones is the hon. solicitor, and Mr. E. Shrapnell Smith hon. secretary for the trials.

PHYSICAL SOCIETY.

The annual general meeting of this society was held on the 10th inst., Mr. Shelford Bidwell, F.R.S., president, in the chair. The report of the council was read by Mr. H. M. Elder. Dr. Atkinson then presented the treasurer's report, and showed that, although there was only a small balance in the bank, the financial position had somewhat improved. The list of Fellows lost to the society by death was read; the obituary includes the names of Latimer Clark, C.E., F.R.S.; Sir James Douglas, F.R.S.; John Hopkinson, D.Sc., F.R.S.; J. E. Myers; Eugene Obach; Henry Perigal, F.R.A.S; and Bartholomew Price, M.A., F.R.S. After some remarks with regard to the library and the subscriptions, votes of thanks were passed to the council, the auditors, and to the other officers of the society. The President then moved a vote of thanks to the Chemical Society for the use of the rooms at Burlington House. Council and officers for the forthcoming year were elected as follows: — President: Oliver J. Lodge, D.Sc., F.R.S. Vice-presidents who have filled the office of president: Dr. J. H. Gladstone, F.R.S.; Prof. G. C. Foster, F.R.S.; Prof. W. G. Adams, M.A., F.R.S.; the Lord Kelvin, D.C.L., LL.D., F.R.S.; Prof. R. B. Clifton, M.A., F.R.S.; Prof. A. W. Reinold, M.A., F.R.S.; Prof. W. E. Ayrton, F.R.S.; Prof. G. F. Fitzgerald, M.A., F.R.S.; Prof. A. W. Rücker, M.A., F.R.S.; Captain W. de W. Abney, R.E., C.B., D.C.L., F.R.S.; Shelford Bidwell, M.A., LL.B., F.R.S. Vice-Presidents: T. H. Blakesley, M.A.; C. Vernon Boys, F.R.S.; G. Griffith, M.A., Prof. J. Perry, D.Sc., F.R.S. Secretaries: W. Watson, B.Sc. (Physical Laboratory, South Kensington); and H. M. Elder, M.A. (50, City-road, E.C.). Foreign secretary: Prof. S. P. Thompson, D.Sc., F.R.S. Treasurer: D. E. Atkinson. Librarian: W. Watson, B.Sc. Other Members of Council: Prof. H. E. Armstrong, D.Sc., F.R.S.; Walter Baily, M.A.; R. E. Crompton; Prof. J. D. Everett, D.C.L., F.R.S.; Prof. A. Gray, LL.D., F.R.S.; E. H. Griffiths, M.A., F.R.S.; Prof. J. Viriamu Jones, M.A., F.R.S.; S. Lupton M.A.; Prof. G. M. Minchin, M.A., F.R.S.; and J. Walker, M.A.

The newly-elected president, **Prof. Oliver Lodge**, then took the chair, and an ordinary meeting was held. In his address he referred to the heavy death-roll of the society during the past year, and to the tribute paid to the memory of John Hopkinson at Cambridge University. Prof. Lodge then commented on the quickness with which scientific discoveries were now applied to practice, and to the interest taken in such applications by men of science. He did not know whether this was due to the example and inspiration of Lord Kelvin or to the progress of education among the public. He regretted that the public were so ignorant of scientific subjects. Rapidly reviewing the work done in physics during the past year, he spoke of the experiments of Righi, Preston, Michelson, and J. J. Thomson, and called attention to a prediction lately published in *Nature* by Prof. G. F. Fitzgerald with regard to the probability of being able to obtain magnetic effects by passing circularly polarised light through absorptive media. After commenting upon the important position now occupied by terrestrial magnetism among the sciences, and to the advantages of the publication now known as *Science Abstracts*, Prof. Lodge said there was one event of exceptional significance to physics that had happened during the past year, an event of which science would feel the effect for centuries to come: the Government had decided to begin to establish a national laboratory. He wished to congratulate Sir Douglas Galton, and himself, on the speedy result of their urging the matter upon the British Association. He thought the thanks of the Physical Society were due to the committee appointed by the Treasury, especially perhaps to Prof. Rücker, as acting chairman of that committee, and to Mr. Chalmers, who represented the Treasury, for the way in which the work had been brought to an issue. There was much for which the present Government deserved praise during the past year; he wished there could be added to their laurels the inauguration of a university for London. Prof. Lodge then went on to the specific subject of his address: the opacity of conducting media to light and to electric waves generally, emphasising the brilliant work of Mr. Oliver Heaviside in unifying phenomena apparently different, discussing the effect of boundaries, and dealing specially with the question, first attacked by Maxwell, of the theoretical opacity of gold-leaf. This part of the address will be published in full in the *Phil. Mag.*

Prof. Ayrton said, with regard to the attenuation of electric waves by the earth, that Mr. Whitehead, some months ago, came to the conclusion that when the primary and secondary coils were placed flat on the earth at a distance from one another, nearly all the energy of the primary was absorbed by the earth before reaching the secondary. The degree of absorption was so great

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that Mr. Whitehead had hesitated to publish his theoretical results until experiments should confirm them.

Prof. Lodge concurred with Mr. Whitehead's result. Three cases were to be considered. In the first, one horizontal coil is superposed to the other, with sea-water or some other absorbing medium between them; in this case the absorption at moderate distances is not excessive. But, of course, if the coils are formed of cable sheathed with iron, as in the recent experiments made by the Royal Commission, the iron itself prevents the progress of electric waves from primary to secondary. In the second case, the coils are wholly in the same horizontal plane. The earth, owing to its great magnitude, behaves almost as a perfect conductor; if the coils are now near the earth, there is no normal magnetic force between them—it is all tangential. In the third case, the coils are opposed to one another, both being vertical and near to the earth. The high conductivity of the earth is here acting to the advantage of wave propagation, for the image of the primary coil is in phase with the coil itself, and the total effect is approximately doubled.

Prof. Carey Foster then took the chair, and Prof. Oliver Lodge read a paper by **Mr. Benjamin Davies** on **"A New Form of Ampere-meter and Voltmeter with a Long Scale."** These instruments are already well known, although no account of them has actually been published. They are of the moving-coil, long-range, portable type, with a very uniform scale from zero to maximum. The magnetic circuit has only one air-gap, which is generally the space between a central cylinder of iron or steel and a concentric tube of iron, modified in various ways for facilitating the adjustment of the magnetic induction and the placing of the coil. The central cylinder is bored axially, and one side of the rectangular coil is pivoted at the top and bottom of the hole thus made. The second side of the coil moves in a circular path in the annular air-gap. Photographs of the instruments in several modified forms were exhibited.

Prof. Ayrton said the instruments appeared to be very successful. He could bear witness of their value, particularly as regards the length of range. The general principle by which long range was to be obtained on moving-coil portable instruments was developed some 10 years ago by M. Carpentier, of Paris, who used a central magnet surrounded by a concentric hollow cylinder, with only one side of the coil in the magnetic gap between them; but it was not then a portable form of instrument, for the coil was suspended. Prof. Ayrton had himself worked in this direction in the "static station voltmeter." In that instrument there were three magnetic circuits arranged to give staticism. This was described in 1892 or 1893.

The **Vice-President** (Prof. Carey Foster) proposed a vote of thanks to the author, and the meeting adjourned until Feb. 24.

ELECTRIC LIGHTING OF CHELSEA.

The following is a report, dated Feb. 3, 1899, to the Vestry of Chelsea by Mr. T. W. E. Higgens, A.M.I.C.E., surveyor to the Vestry, and Mr. Louis C. Parkes, M.D., D.P.H., the medical officer of health, on the alleged nuisances caused by the Chelsea Electricity Supply Company's works in Alpha-place and Manor-street.

On Dec. 6, 1898, we were instructed to report upon alleged nuisances to the surrounding property caused by vibration, smoke, noise, etc., from the works of the Chelsea Electricity Supply Company in Alpha-place and Manor-street, and having given the subject our careful consideration, we now present our report to the Vestry.

In order to make clear the position of electric supply companies with regard to the property surrounding their works, we call attention to the remarks of Sir Courtenay Boyle, the permanent secretary to the Board of Trade, who, in his examination before the Joint Committee on Electrical Energy stated—and we think it is generally admitted—that "generating stations must be an inconvenience, though they need not necessarily be a nuisance," and on being asked (33) "When you say it must be an inconvenience, do you mean from vibration?" his answer was "From vibration, the soot, smoke, and moisture, a considerable amount of smell and noise." It must therefore be taken for granted that it is impossible to erect an electrical generating station without its causing a certain amount of inconvenience to the surrounding property, but that "inconvenience" may not necessarily constitute a "nuisance."

The Chelsea Electricity Supply Company, however, are now in a different position to any other electrical company as regards proceedings for nuisance. Since their Act was passed last year, they appear to be free from an indictment for nuisance and from an injunction, provided that they are not guilty of negligence in carrying on their works. If, for example, it could be proved that their works were not only an "inconvenience" to the neighbourhood, but an actual "nuisance," neither the adjoining inhabitants nor the Vestry could probably take legal proceedings with any chance of success, unless it could be proved that the company were neglecting to take reasonable precautions to prevent annoyance to the neighbourhood. And as the company are under statutory obligations to supply light and power to the inhabitants of Chelsea, the Courts would probably require very strong evidence before they would interfere.

We have thought it well to put this fact very plainly before the Vestry, as we feel that it is only right that the inhabitants in the neighbourhood of the electric lighting station should clearly understand the legal status of the company, and should know the position that they ought to take up if they consider it desirable to combine in order to safeguard their interests.

We also wish to point out that an unsuccessful agitation, and the circulation of such statements as that the residents in the vicinity have their lives made miserable through the working of the station, without any legal redress being obtainable, are calculated to do more harm to the neighbourhood, and thus to the owners of the surrounding property, than the presence of the electric lighting station itself.

As regards the alleged vibration, and its effects upon the adjoining property, we notice, in the first place, its remarkable fitfulness and the very restricted area within which its effects are generally felt. So far as our own personal observations are concerned, we have been unable to discover any vibration which could reasonably be termed an annoyance; but on comparing statements made to us by residents, we find persons living in houses within a few yards of one another directly contradict one another as to the existence of vibration on a particular evening; and even people in the same house do not agree as to whether that particular house experiences any vibration from the electric lighting company's station. A great many persons state that they feel a shaking when the works first start in the evening, or in the early morning. If this is caused by the Chelsea electricity station, it seems to point to the fact that there is more vibration when one or two engines are running than when the station is in full working order. It is possible, that when one or two engines are working at one end of the concrete block upon which the engines are placed, a vibratory impulse is communicated to the engine foundations, whereas when all, or nearly all, the engines are working, they tend to counteract each other, and so do not cause any appreciable vibration of the surrounding earth.

We are, however, of opinion that at present we have not sufficient evidence of nuisance caused by vibration to justify us in engaging technical assistance to examine the construction of the Chelsea Electricity Company's station, supposing that the company would consent to such a proceeding. We think it right, however, to state that in reply to a request to allow an expert to examine their premises, should it be necessary, the company replied as follows:

"Chelsea Electricity Supply Company, Limited, 19, Cadogan-gardens, London, S.W., Jan. 19, 1899. T. W. E. Higgens, Esq., C.E., Surveyor to the Vestry of Chelsea, Town Hall, King's-road, Chelsea, S.W. Dear Sir,—In reference to your letter of the 11th inst., I am instructed to reply that in view of the formal inspection that was held last year by experts under the order of the Court, and also of the exhaustive enquiry by Select Committees of both Houses of Parliament into the question of 'alleged nuisance caused by vibration, etc.,' and of the various decisions that no nuisance existed, my directors do not feel justified in reopening the question, and I am, therefore, unable to comply with your request.—Yours faithfully, Chelsea Electricity Supply Company, Limited (PERCY STILL, engineer)."

As regards the construction of the station, however, we may say that the engines are fixed upon a concrete foundation 10ft. in depth, which rests upon a bed of cocoanut fibre matting 2in. in thickness, between two sheets of lead, this bed of fibre resting upon another bed of concrete 3ft. in thickness. In order to avoid communicating vibration to the surrounding earth, a space about 4ft. is left clear round the concrete bed on which the engines are placed; and the rest of the floor of the engine-room is carried on a cantilever construction, a space of 1in. being left between it and the engine-bed, so that vibration shall not be transmitted by means of the floor. The boilers in use are Babcock and Wilcox water-tube boilers, and Willans three-crank compound direct-driving engines have been adopted as those least likely to cause vibration.

During our investigations we have not found any inconvenience to arise from any noise caused in working the station, neither have we found that the steam or the smoke issuing from the chimneys cause any nuisance to the surrounding neighbourhood.

Complaints have been made to us of fine grit escaping from the chimney and being deposited on the roofs, doorsteps, and streets in the vicinity of the electric lighting station. We have ourselves observed the grit, and feel sure that on some occasions it is permitted to escape. This would, no doubt, be obviated by more careful stoking and regulation of the draught to the furnaces.

It must be understood that this report is concerned with a recent investigation of conditions which practically are still prevailing. We did not feel that it would serve any useful purpose to enquire into alleged nuisances, or damage to property, caused by the working of the station at times considerably antecedent to the commencement of this investigation.

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ELECTRIC LIGHTING AT MAIDSTONE.

Messrs. Kincaid, Waller, and Manville, of 29, Great George-street, Westminster, have prepared a scheme for establishing electric lighting works in combination with a dust destructor at Maidstone, and their report is now receiving the attention of the local authority. In it it is pointed out that six years have now elapsed since the Council obtained its provisional order, and that, owing to the failure of the Corporation to act upon it, the Board of Trade may, if they think fit, now revoke the order at any time. During the last few years "a phenomenal number" of electric generating stations have been erected by local authorities, and in almost every case, the report states, are showing results which justify their existence. Under these circumstances Messrs. Kincaid, Waller, and Manville urge that it is desirable the supply of electric energy for Maidstone should remain in the hands of the Corporation rather than be entrusted to a private company, so that not only may the supply be effected at a cheaper rate than is likely in other hands than those of the Corporation, but also that the profits may be directed towards the reduction of the rates.

The area in which the Corporation is empowered by its provisional order to lay mains comprises High-street, Bank-street, Week-street (from High-street to St. Faith's Church), St. Faith's-street, and Waterside (from St. Faith's-street to High-street). The consulting engineers recommend that the portion of St. Faith's-street from the Technical School to Waterside and Waterside itself should be omitted from the area first dealt with. They name the following streets as the most promising district to be served in the first instance: High-street, Bank street, part of King-street, Gabriel's-hill, and Lower Stone street (as far as Wren's Cross), Week-street (from High-street to Sessions House), Earl-street, St. Faith's-street (from Week-street to the Technical Schools) and the Broadway (as far as the junction of Rocky-hill and Tonbridge). Messrs. Kincaid, Waller, and Manville observe that they have seldom, if ever, seen a town of the size of Maidstone which appears so likely a place for the introduction of an electricity supply.

The three systems of electrical distribution generally in force are (1) the high-tension alternating-current transformer system; (2) the low-tension continuous-current system; (3) the high-tension continuous-current transformer system. After reviewing the advantages and disadvantages of the three systems, the consulting engineers state that the compact arrangement of the borough is specially favourable to the low-tension method, the adoption of which they unhesitatingly recommend. They inspected four sites for the proposed generating station and dust destructor—viz., the Fair Meadow, the Lock Meadow and a small plot of land adjoining in the occupation of Messrs. J. and A. S. Smythe, the site belonging to the Earl of Romney (on the bank of the Medway between the Lock Meadow and Tovil), and the site belonging to Mr. J. Stevens (near the high-level bridge). All the sites, it is pointed out, adjoin the river, and are liable to be flooded at times. The Fair Meadow site has the worst situation in this respect, but its position is such as to call for the least expenditure in the feeder mains to supply the district with electricity. It immediately adjoins that portion of the borough in which the greatest demand for electrical energy will undoubtedly be felt, whilst it is at least as conveniently situated in respect of the residential district on the other side of the river as are the remaining three sites. In regard to the delivery of house refuse, its position is more advantageous than that of any other site. Located opposite the gas-works, the combined destructor and electricity generating station could not be considered to create any nuisance which does not exist at present. In fact, with a chimney 150ft. in height "every confidence may be felt in the absence of any nuisance." Other advantages possessed by the Fair Meadow site, such as its proximity to the baths and surveyor's office, and the suitability of a portion of the meadow for stables and cart yard, are pointed out, and it is estimated that the extra expense of putting the machinery above flood level upon this spot would not be more than £300, compared with the best of the other sites. Under the head of plant and distribution, Messrs. Kincaid, Waller, and Manville propose that a building of sufficient size should be erected to form a combined engine, boiler, and destructor house. They suggest the provision of six destructor cells equal to dealing with 13,000 tons of refuse per annum, with a maximum of 45 tons in any one day, three water-tube boilers, four high-speed or semi high-speed combined engines and generators, two of them having each an output of 220 e.h.p. and the other two of 110 e.h.p., and a battery of accumulators. The plant would practically be duplicate, so that current to 9,000 lamps of 8 c.p. and 24 arc lamps for public lighting could be maintained in spite of any probable breakdown in part of the machinery. It is pointed out that 12,000 lamps may be safely joined up to the mains provided, inasmuch as the total in use at any one time is always from 35 to 50 per cent. less than the maximum number connected. The financial aspect of the undertaking is dealt with in considerable detail.

Under the head of capital expenditure the items are: buildings, £7,500; boiler-house plant and ironworks, £10,000; engine-house plant, £9,600; feeder mains and distribution network (assuming the Fair Meadow site is adopted), £6,714; add 7½ per cent. for contingencies, clerk of the works, and engineering, £2,535—total, £36 349. An addition of £1,664 to the capital expenditure on mains, etc., is allowed for in the event of the Lock Meadow site being adopted. The capital cost of 24 public arc and incandescent lamps with cable communications for the same, is put at £1,287. The annual cost of public lighting is estimated thus: 24 arc lamps of about 1,200 c.p. burning until midnight—say, 30,000 Board of Trade units at 2d., £250; 48 incandescent lamps of 32 c.p. replacing the arc lamps after midnight and burning till sunrise—consuming, say, 13,500 Board of Trade units at 2d., £112; carbons, renewals, and proportion of wages of lamp trimmers, £209—total, £459. This sum is £166. 7s. 9d. in excess of the present cost of gas lighting, which amounts to £292. 12s. 3d. The annual revenue from the electric lighting scheme is dealt with in a further estimate. Twelve thousand 8-c.p. lamps, each consuming 16 Board of Trade units, equalling 192,000 Board of Trade units per annum, at 4d., are estimated to produce £4,800, to which has to be added the cost of public lighting, making together £5,162. The expense of maintenance is put at £2,061 per annum, the principal items being £215 for coal (allowing for steam produced by refuse combustion), £589 for wages, £491 for repairs and maintenance, and £294 for management, office, and legal expenses. The estimated balance of revenue over expenditure is, as will be seen, £3,101. Of this sum £1,975 is written off for interest and sinking fund for a term of 26 years on an annuity basis, with interest at 3 per cent. per annum, or 5¼ per cent. on a capital expenditure, including cost of the public lighting, of £37,636, leaving a net profit of £1,126. In arriving at the amount of current likely to be consumed annually by the lamps in the area named, the consulting engineers state that they have taken into consideration the experience of other places of a like nature, and they think their estimate may be regarded as a reliable one. The streets in which they propose to instal public arc lamps would be lighted immeasurably better than at present by gas. In fact, from dusk till midnight the lighting would be about 16 times as great as at present, justifying the extra expense of £166. 7s. 9d.

The cost of the burning of house refuse forms an entirely separate item from the electric lighting undertaking, and is dealt with accordingly. The use of dust destructors, it is remarked, has largely increased amongst the local authorities throughout the country, until at the present time there is hardly a town of any importance that has not either resolved to erect a destructor or else has one or more actually in operation. The idea of combining electric lighting and dust destruction originated with Messrs. Kincaid, Waller, and Manville, who were responsible for the Shoreditch scheme, which has had "remarkably successful results." After the refuse is burnt, from 25 to 30 per cent. of the original weight is left as residue in the form of well-burnt and very hard clinker. In London parishes there is no use for this, but provincial authorities, instead of paying to have it carted away, use it for forming the bedding of new roads in place of imported material, and the balance used finds a ready market when made up into mortar. It can also be utilised when broken up and mixed with cement for making artificial paving stones, which wear extremely well and have good appearance. The cost of cremating the ashbin refuse at Maidstone is estimated at 1½d. per ton, or a total of £758 for 13,000 tons per annum. For repairs to destructor cells £108 is allowed, bringing the total cost per year up to £866. The saving in the cost of carting refuse to the Fair Meadow in place of the present depôts is put at £350, and the saving in coal necessary for generating steam to drive the electric plant at £295 per annum, the two items making together £645. This leaves £221 as the net extra expenditure in cremating refuse, an amount which Messrs Kincaid, Waller, and Manville suggest will be well spent in achieving the objects sought after. If, after due consideration, the Corporation should think it wiser not to decide to cremate the ashbin refuse of the town, then a corresponding saving in the capital outlay can be made on the undertaking. The consulting engineers are firmly of opinion that the electrical plant they have estimated for will be the very minimum required in the first instance for the supply of the town, and that at no distant date it will have to be considerably added to to meet the increased demand that is almost certain to arise.

COMPANIES' MEETINGS AND REPORTS.

WESTMINSTER ELECTRIC SUPPLY CORPORATION, LIMITED.

The ordinary general meeting of this Company was held on Wednesday last at Eccleston-place, S.W., Lord Suffield, K.C.B., in the chair.

In moving the adoption of the report, the **Chairman** said he thought that they would consider it satisfactory that the Company had been enabled to maintain their position during the past year. The applications for supply still continued, and during the year the equivalent of nearly 50,000 lamps of 8 c.p. were connected, being an increase of 8,000 over the advance shown in the previous year. This bore out a remark which he believed he made at their last general meeting that they had no reason to anticipate a decrease in the demand for supply. The late rise in the price of coal, combined with the coal strike, had alone made a difference to them in the past year of about £3,000, and although he hoped that they would not consider the dividend recommended unsatisfactory, if it had not been for certain difficulties—the coal strike, amongst others—they would, without doubt, have been able to declare a higher dividend. Like other lighting companies, they had found that the absence of fogs during the winter season had affected their revenue considerably; while the reduction from 6d. to 4d. per unit after 4,000 units had been used for lighting in any one year, and to 3d. per unit for motor purposes, had also similarly affected the Corporation.

Mr. Boulnois, M.P., seconded the motion.

In reply to a question by Mr. Reed, the **Chairman** said that it was impossible to conduct such an increased business as they had done without an advance in the expenditure; but he could assure them that the directors were conducting the business as economi-

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cally as they could. It must be remembered that there was a large increase in their business monthly, and, in fact, weekly, and with this, of course, an increase in the expenses must also be expected. In answer to Mr. Makins's enquiry as to the prospects of the Company, he said he regarded the future of the Company as most satisfactory, and could see nothing whatever to prevent their continued success. They were very popular in the area they served, and they had enjoyed an enjoyed an extraordinary immunity from difficulties. There must be some accidents, but on enquiry it was found that they arose very largely through faulty installations, and not from any fault of the supply.

Mr. Jeffries asked whether they going to raise any fresh capital in the present year?

The **Chairman** said that they had no immediate necessity for further capital beyond the £50,000 of debentures.

Mr. Boulnois then stated that in consequence of their increased business they had joined with the St. James's Company in acquiring a site for a joint station outside their own districts in St. John's Wood, but this site was afterwards taken from them by the Great Central Railway Company. They had therefore had to apply to Parliament for another site adjoining, which was slightly larger than the original site and was very conveniently placed near both a great railway and a canal.

The motion was then unanimously adopted, and a dividend declared at the rate of 14 per cent. per annum, less income tax, making 12 per cent. for the year, leaving a balance of £1,000 to be carried forward.

NEWCASTLE AND DISTRICT ELECTRIC LIGHTING COMPANY, LIMITED.

The twelfth ordinary general meeting of this Company was held in the Station Hotel, Newcastle, on Tuesday. Mr. John D. Milburn (chairman) presided. The annual report of the directors was adopted. It stated that the installations connected to the Company's mains during the year were equal to 3,678 10-c.p. lamps, bringing the total up to about 36 278, and 778,828 units of electrical energy had been supplied as against 642,969 units supplied in 1897. During the past year 2,563 yards of main and branch piping had been laid, together with 10,386 yards of main and branch cable. The gross earnings during the year amounted to £7,546. 0s. 1d., and after paying interest, and making provision for depreciation, the directors were able to recommend a dividend of 5 per cent. for the half-year ending Dec. 31 (less income tax), which, together with the interim dividend paid in August last, made the dividend 8½ per cent. for the year.

Sir B. C. Browne was re-elected as a director, and the auditors, Messrs. Strachan and Co., were also re-elected.

COVENTRY ELECTRIC TRAMWAYS COMPANY.

The annual meeting of this Company was held in Bank-buildings, London, on the 9th inst., Captain Davy presiding.

In moving the adoption of the report, the **Chairman** stated that the earnings for the year ending Dec. 4, 1898, amounted to £10,283, against £9,924 for the preceding year, equivalent to 21 per cent. on the ordinary shares on the old capital, after paying 4 per cent. on the debentures and 6 per cent. on the preference shares. The new lines were rapidly nearing completion, and it was hoped that the full 10½ miles would be in operation shortly. The accounts submitted showed a sum of £2,673 available for dividend on the shares. Of the total capital of £112,000 only 9,600 shares of £10 each had been issued, and of these shares 8,000 were fully paid up, representing £80,000, and 1,600 were half paid up, representing £8 000, making a total of £88,000 paid up, leaving a balance of £8,000 to be paid on the completion of the works. The directors proposed a dividend at the rate of 4 per cent. on the amounts paid up from dates of payment. This amounted to £2,182, leaving £390 to be carried forward. The directors had hitherto received no fees.

The report was adopted.

BRISTOL TRAMWAYS COMPANY.

At the ordinary meeting on Wednesday the report of the directors, which appeared in our last issue, was carried.

At a subsequent extraordinary general meeting a resolution, that the capital of the Company be increased to £750,000 by the creation of 25,000 new shares of £10 each, was carried unanimously.

NATIONAL ELECTRIC SUPPLY COMPANY, LIMITED.

The ordinary general meeting of the members of the above Company was held at 119A, Fishergate, Preston, on Wednesday, Feb. 8, 1899, Mr. J. Booth in the chair.

The **Chairman**, in presenting the directors' report and accounts for the year ending Dec. 31, 1898 (which were adopted), said the Company had obtained a new provisional order enabling them to extend mains into the district outside the borough, and had already carried them as far as Broughton, with a result which had fully justified their enterprise. This year they proposed to carry them through Fulwood and Cadley, where they had the promise of a large number of consumers. They had also erected new machinery at the generating station, and placed orders for new engines and boilers for 700 h.p. The gross profit for the year showed an increase of about £1,200. Thanks to their chief engineer, Mr. Tonge, and his efficient staff, the Company was the most economically worked company of its size in the kingdom.

The following dividends were declared out of the net profits of the undertaking for the year ending Dec. 31, 1898: on the £5 000 preference shares a dividend of 4 per cent. per annum; on the £39,331 5s. ordinary shares a dividend of 2s. 6d. per share for the half-year ending Dec. 31, 1898, which, with the interim dividend already paid, makes a dividend of 5s. per share for the year.

Mr. John Booth was re-elected as a director, and Messrs. Titus Thorp and Ainsworth were re-elected auditors.

A vote of thanks and confidence was accorded to Mr. Tonge (the engineer), Mr. Blackmore (assistant), Mr. Cross (secretary), and the whole of their staff for their loyal service to the Company.

NATIONAL TELEPHONE COMPANY, LIMITED.

The report of the directors for the half-year ending Dec. 31, 1898, states that the income accrued in respect of the business of the half-year amounts to £573,707. 3s. 6d., as compared with £507,602. 17s. 3d. for the corresponding period of 1897, being an increase of £66,104. 6s. 3d. The working expenses for the half-year amount to £312,462. 4s. 4d., as compared with £283,085. 12s. 11d. for the corresponding period of 1897, being an increase of £29,376. 11s. 5d. The net result for the half year (after deducting the Post Office royalties amounting to £54,356 12s. 10d.) is a profit balance of £206,888. 6s. 4d., as compared with £178,457. 7s. 8d for the corresponding period of 1897, being an increase of £28,430. 18s. 8d. The rentals carried forward for unexpired terms of running contracts amount to £536,654. 3s. 4d., as compared with £473,586. 17s. 10d. at the corresponding period of 1897, or an increase of £63,067. 5s. 6d. Out of the available balance of £172,037. 15s. 11d. shown by the net revenue account, the Board will recommend the payment of a dividend at the rate of 6 per cent. per annum. less income tax, on the first and second preference shares; 5 per cent. per annum, less income tax, on the third preference shares; and 6 per cent. per annum, free of income tax, on the ordinary shares. The Board also propose to transfer £50,000 to the reserve fund, and to carry forward the balance of £8,287. 15s. 11d. The sum of £367,201. 7s. 6d. has been expended on capital account during the half-year in the erection of 6,932 additional exchange and private lines, and in the construction of underground lines. During the recent parliamentary enquiry much stress was laid upon the fact that the Company is exempt from the conditions as to service and charges which, in the case of railway, gas, and water companies, are usually imposed by Parliament. Mr. Hanbury in his speech in the House of Commons on April 1, 1898, said: "They (the Company) had not only a monopoly, but one which was not under strict control or under stringent regulations. Railway, water, gas and electric lighting companies were all placed by Parliament under very strict limitations with regard to their capital, dividends, rates, and especially preferences, and on all these points this telephone company was absolutely unfettered. He thought that was a strange state of things." Mr. Hanbury had apparently forgotten that this "strange state of things" was a direct consequence of the action of the Government themselves, who, in several sessions, vetoed Bills lodged by the Company with the express object of obtaining powers to enable them to carry on their business efficiently, and upon such reasonable conditions as might be imposed. In view of what has transpired, the Company have again deposited Bills in order that the complaints against them as set forth by Mr. Hanbury may be removed. The continued and rapid expansion of the Company's business will involve the expenditure of a further considerable amount during the next few years. The funds at present available on the basis of the existing capital powers are already appropriated to works now in progress, and the Board will bring forward at the meeting the question of provision for the future, and in accordance with the accompanying notice will propose a resolution to the effect therein indicated.

KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING COMPANY, LIMITED.

Directors: Alfred Sohier Bolton, Esq.; Sir Frederick J. Bramwell, Bart, F.R.S.; Sir Charles Grant, K.C.S.I.; Granville R. Ryder, Esq.; R W. Wallace, Esq, Q.C.

Report of the directors (with abstract of accounts) to be presented at the twelfth ordinary general meeting to be held at 1, Great George-street, S.W., on Wednesday, Feb. 22, 1899, at 5 p.m.:

During the year the number of houses and shops connected with the system has increased from 1 620 on Dec. 31, 1897, to 1,851 on Dec. 31, 1898, while the number of lamps calculated on the usual basis of 8 c.p. has increased from 137,953 to 156,158. Additional capital required by the Company during the year has been raised by the issue of £12,785 4 per cent. debenture stock, producing £13 807. 16s.. and by the issue of 1,187 second preference shares, producing £7,122. The directors have strengthened the renewal account by transferring to it £5,117. 15s. 11d., making the total amount placed to that account £25,615. 9s. 9d. After providing for the above amount, and paying the dividends on the 6 per cent. first preference shares to June 30, 1898, on the 5 per cent. second preference shares to Sept. 30, 1898, and an interim dividend at the rate of 10 per cent. per annum on the ordinary shares for the first half of the year, the balance standing to the credit of the net revenue account for the year 1898 is £6 300. 10s. 11d. Of the above sum £1,450 has been appropriated to the payment of the first preference dividend to the end of the year, and £400 has to be set aside to meet the portion of the dividend on the second preference shares accrued to the same date, leaving £4,450. 10s. 11d., out of which it is proposed to pay a further dividend on

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the ordinary shares at the rate of 10 per cent. per annum for the past half-year, making, with the interim dividend paid to June 30, 10 per cent. for the year. This will leave a balance of £825. 10s. 11d. Mr. G. H. Hopkinson having ceased to be a director, Sir Charles Grant, K.C.S.I., was appointed to fill the vacancy. It will be observed that after the general meeting there will be an extraordinary general meeting for the purpose of confirming the resolution passed on the 1st inst. relative to the Bill now being promoted by this Company, in conjunction with the Notting Hill Electric Lighting Company, the purport of which has been brought fully to the attention of the shareholders. In accordance with the articles of association, Sir Frederick J. Bramwell, Bart., F.R.S., and Mr. Granville R. Ryder, retire from the directorship, and, being eligible, offer themselves for re-election. The auditors, Messrs. Lovelock, H W. S. Whiffin, and Dickinson, offer themselves for re-election.

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1898.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£6,586	16	1			
Oil, waste, water, and engine-room stores	806	15	4			
Proportion of salaries of engineers, superintendents, and officers, as certified by the engineer-in-chief	1,100	0	0			
Wages and gratuities at generating stations	2,086	6	9			
Repairs, renewals, and maintenance, less received for plant and old material sold: buildings, £683. 0s. 7d.; engines, boilers, and dynamos, £1,646. 5s. 10d.; other machinery, instruments, and tools, £131. 9s. 7d.; accumulators and accessories, £3,442. 12s. 8d.; switchboards, £33. 14s. 3d.	5,937	2	11			
				16,517	1	1
Distribution of Electricity.						
Proportion of salaries of superintendents and officers, as certified by the engineer-in-chief	400	0	0			
Wages and gratuities to linesmen, fitters, labourers	583	7	4			
Repairs, maintenance, and renewals of mains of all classes, including materials and laying the same	230	9	3			
Repairs, maintenance, and renewals of meters	295	3	9			
Sundry expenses	25	16	2			
				1,534	16	6
Rents, Rates, and Taxes.						
Rents payable	260	0	7			
Rates and taxes	3,613	15	7			
				3,873	16	2
Management Expenses.						
Directors' remuneration	1,000	0	0			
Salaries of managing engineer, secretary, accountants, clerks, and messengers	1,716	18	11			
Stationery and printing	317	10	9			
General establishment charges	377	5	7			
Auditors of Company	52	10	0			
Auditor appointed under the provisions of the order	60	0	0			
				3,524	5	3
Law expenses				122	15	10
Depreciation.						
Depreciation in respect of leasehold works	290	0	0			
Renewal and maintenance of buildings, plant, mains, etc., £11,580. 11s. 10d.; less amount expended during the year as above, £6,462. 15s. 11d.	5,117	15	11			
Special Charges.						
Insurances	505	11	6			
Cost of conversion to 200 volts	302	18	5			
				6,216	5	10
Total expenditure				31,789	0	8
Balance carried to net revenue				14,542	11	4
				£46,331	12	0

Cr.	£	s.	d.
Sale of current per meter 5d., 6d. per B.T.U. less rebates and bad debts (units, 2,081,074)	43,561	13	10
Sale under contracts	505	15	6
	44,067	9	4
Rental of meters and other apparatus on consumers' premises, £1,463. 6s. 3d.; and sale and repairs of lamps, etc., £44. 9s. 2d.	1,507	19	5
Leasehold property: rents receivable, £857. 9s.; less repairs, £108. 11s. 9d.; and transfer fees, £7. 10s.	756	7	3
	£46,331	12	0

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	248,435	0	0
Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, etc., on open accounts, to Dec. 31, 1898	7,694	19	11
Net revenue account—balance at credit thereof	6,300	10	11
Renewal fund account—balance at credit thereof	25,615	9	9
Depreciation fund account works on leasehold property	1,783	5	11
	£289,829	6	6

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	263,481	3	6
Stores on hand at Dec. 31, 1898: coal, £214. 12s.; oils, waste, etc., £112. 0s. 2d.; general, £1,020. 3s. 8d.	1,346	15	10
Sundry debtors for current supplies to Dec. 31, 1898	15,163	11	6
Other debtors	463	14	5
Cash at bankers, in hand, and on deposit	9,374	1	3
	£289,829	6	6

BLACKPOOL AND FLEETWOOD TRAMROAD COMPANY.

The ordinary half-yearly meeting of this Company was held on the 10th inst. in the Accountants' Hall, 65, King-street, Manchester, Mr. George Richardson, chairman of the Company, presiding.

In moving the adoption of the report (published in our last issue), the **Chairman** said the report was all the more satisfactory in that it only represented 5½ months' working. The traffic was most satisfactory, and greater than the directors had ventured to anticipate. The Company had made a mistake at the oustet in not having sufficient capital to go on with. Consequently they had decided to increase the capital and to provide increased accommodation in various ways to enable the Company to deal with the enormous traffic in a satisfactory manner. The working expenses came to about 42 per cent.

The resolution was seconded by **Mr. R. H Prestwich** (deputy chairman).

In answer to a question, the **Chairman** said that in a very short time the Company would be able to put 27 cars in use, as against the eight that ran last season.

The report was adopted, and a dividend at the rate of 8 per cent. per annum was declared. Messrs. R. B. Barningham and R. S. Boddington were reappointed directors of the Company, and it was agreed, as Mr. Alexander Bruce had resigned his seat on the Board, to reduce the number of directors to six. The meeting further agreed, on the proposal of **Mr. J. R. Aked**, seconded by **Mr. S. Burrows**, to allow the directors £1,500 for their services up to the end of last December, and £800 per annum in future. Mr. W. Aldred having been reappointed auditor, the thanks of the meeting were accorded to the directors and the staff, and with this the proceedings ended.

LIVERPOOL OVERHEAD RAILWAY COMPANY.

At the half-yearly meeting of the Liverpool Overhead Railway Company, held on the 14th inst. in Liverpool, Sir William Forwood, who presided, stated that the gross profits of £40,655 showed an increase on the corresponding half of 1897 of £3,097. The directors proposed a dividend at the rate of 4 per cent. per annum on the ordinary shares compared with 3½ per cent., leaving £4,586 to be carried forward. Their passenger traffic had increased from 3½ millions to nearly 10 millions in the short space of six years. This justified the belief that any loss of traffic owing to the competition of the Corporation's electric trams to the south end of the city would be amply made up in the general growth of traffic along the dock line. The report was adopted. Sir William Forwood and Mr. H. Brocklebank were re-elected directors. Afterwards a special meeting was held to consider a proposal to introduce into Parliament a Bill "to empower the Liverpool Overhead Railway Company to take on lease certain authorised tramways in the districts of Waterloo-with-Seaforth and Great Crosby, to authorise the construction of additional tramways, and for other purposes." The formal resolution for the promotion of the Bill was carried unanimously.

YORKSHIRE HOUSE-TO-HOUSE ELECTRICITY COMPANY, LIMITED.

An extraordinary general meeting of the shareholders in this Company was held on the 10th inst. at the Great Northern Railway Station Hotel, Leeds, Mr. Grosvenor Talbot in the chair. A grant of £210 was made to Mr. Robert Hammond, the consulting electrical engineer, as an acknowledgment of his services in connection with the formation of the Company.

At another meeting which followed, the resolution passed on Jan. 24 voluntarily winding up the Company was formally confirmed, and Mr. Grosvenor Talbot (the chairman) was appointed liquidator. The directors of the Company, other than the chairman, were, on the motion of the latter, appointed as an advisory committee. Mr. John Gordon, of Leeds, chartered accountant, was appointed auditor to supervise the accounts of the liquidator, and a vote of thanks to the chairman closed the proceedings.

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INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY, LIMITED.

Directors: The Hon. Henry Marsham, chairman; Major Leonard Darwin; A. Westin Jarvis, Esq.; Abraham Scott, Esq.; S. Wm. Silver, Esq.; Matthew Gray, Esq., managing director.

Report of the directors for the year ending Dec, 31, 1898, to be presented at the thirty-fifth ordinary general meeting of the shareholders to be held at the Cannon-street Hotel, E.C., on Thursday, Feb. 23, 1899, at 12 noon:

The accounts show, after provision for doubtful debts, a net profit for the past year of £62,222. 2s. 2d. Adding £13 173. 1s. 1d. brought forward, and deducting £12,500 interim dividend paid in July, there remains a disposable balance of £62,895. 3s. 3d. The directors recommend the distribution of a dividend of 15s. a share, free of income tax, amounting to £37,500. making, with the interim dividend paid in July, a total payment of 10 per cent. for the year, and leaving £25,395. 3s. 3d. to be carried forward. The general business has been more profitable during the past year than in 1897, the selling prices of goods having been advanced to meet the increase in the cost of the raw materials. The cable vessels have been moderately employed. The high efficiency of the Silvertown and Persan factories has been maintained by constant renewals and by the replacing of plant and machinery where improved methods of manufacture have so required. The employment of electricity for the transmission of power is being extended at the works. The Melbourne agency has been reinstated in its original quarters, the burn-out block having been reconstructed. Mr. Silver and Mr. Scott, the directors retiring by rotation, offer themselves for re-election.

BALANCE-SHEET, DEC. 31, 1898.

Dr. Capital and Liabilities.	£	s.	d.
Authorised share capital	812 000	0	0
Share capital—amount paid on issue of 50,000 shares of £10 each	500,000	0	0
Mortgage debentures	300,000	0	0
Reserve fund	450,000	0	0
Debts and loan owing by the Company	55,372	17	7
Bills payable	6,033	7	4
Unclaimed dividends	22	10	0
Profit and loss account—			
Balance at Dec. 31, 1897 ... £50,673 1 1			
Less dividend paid Feb., 1898... 37,500 0 0			
13,173 1 1			
Profit for the year 1898 62,222 2 2			
75,395 3 3			
Less interim dividend paid July 12,500 0 0	62,895	3	3
	£1,374,323	18	2

Cr. Assets and Expenditure.	£	s.	d.
Freehold and leasehold premises (Silvertown, Persan, London, and Liverpool), machinery, and steamships	497,593	15	11
Debts owing to the Company	147,690	18	11
Bills receivable	6,432	9	11
Cash on deposit with bankers, in current account, and in hand	21.955	19	2
Stock-in-trade, including 150 miles of cable laid.	269,202	19	7
Debentures and shares in other companies	211,556	6	0
Cash, stock, debts, etc., at Persan and agencies, after deducting liabilities	219,891	8	8
	£1,374,323	18	2

PROFIT AND LOSS ACCOUNT, YEAR ENDING DEC. 31, 1898.

Dr.	£	s.	d.
Salaries, commission, rent, rates and taxes, repairs, and general expenses	56,296	1	1
Mortgage debenture interest	12 000	0	0
Bad debts	1,094	15	0
Income tax	1,479	11	5
Debenture stamps—balance written off	500	0	0
Depreciation written off buildings and machinery	16,487	17	6
Directors' remuneration	3,358	0	0
Balance—profit for the year	62,222	2	2
	£153,438	7	2

Cr.	£	s.	d.
Gross profit for the year, after making provision for doubtful debts	153,438	7	2
	£153,438	7	2

CENTRAL LONDON RAILWAY COMPANY.

Sir H. Oakley, who moved the adoption of the report (already published by us) at the seventh ordinary meeting of this Company, on Wednesday said the whole of the work was progressing satisfactorily from end to end of the line. As to when the line would be ready for traffic, they had abandoned the hopes of completing by June, and were asking Parliament far an extension of time for another year, although they did not anticipate making full use of the privilege.

Lord Colville of Culross seconded the adoption of the report, which was agreed to.

BELFAST STREET TRAMWAYS COMPANY.

The fifty-third ordinary general meeting of this Company was held on Tuesday at the Offices, Poultry.

Mr. George Richardson, who presided, said that the results of the last half-year were satisfactory. The total receipts had amounted to £64,419, as compared with £60,533, or an increase of about £4,000, and the general expenses to about £14,000, against £13,619. The balance on revenue account was £18,417, against £17,120. The directors had resolved to place £4,000 to permanent-way reserve, raising that fund to £5,000. The Corporation of Belfast were applying to Parliament for power to construct about 9¾ miles of tramways in extension of the Company's system, and negotiations were proceeding with a view to such extensions being worked by the Company, on terms by which the Company will pay to the Corporation 5½ per cent. per annum on the cost of the construction of the extensions, the Corporation maintaining the same, the Company paying all rates, taxes, and outgoings in respect of the working, and being entitled to the entire receipts.

The report was adopted.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Huddersfield.—The Electricity Committee of the Corporation invite tenders for complete switchboard. Tenders by 27th inst.

Croydon.—Tenders are invited for supply of coal for use at the electricity works, Croydon, for the Town Council. Tenders by 20th inst.

Bury.—The Sewage Committee invite tenders for the wiring for lighting and motive purposes at the sewage works. Tenders by 22nd inst.

Edinburgh.—The Council are prepared to receive tenders for installing the electric light at Tollcross tramway power station. Tenders by March 6.

Huddersfield.—The Electricity Committee of the Corporation are prepared to receive tenders for mechanical coking stokers. Tenders by 27th inst.

Ecclesall Bierlow.—The Guardians invite tenders for the supply and erection of an electric light plant at their workhouse, The Edge, Sheffield. Tenders by Feb. 27,

Greenock.—The Board of Police invite tenders for the supply and erection of the various plant (low-tension system) for their electricity works. Tenders by March 3, 1899.

Canterbury.—The Lighting Committee of the Corporation invite tenders for the supply and erection of various plant for the municipal electricity works. Tenders by March 14.

Gloucester.—The Electricity Supply Committee are prepared to receive tenders for the supply and erection of various plant at the municipal electricity works. Tenders by Feb. 28.

Edinburgh.—The Magistrates and Council invite tenders for an overhead travelling crane and storage batteries for their electric lighting station in Macdonald-road. Tenders by Feb. 20.

Bury.—The Sewage Committee invite tenders for the supply and erection of three electric motors at their sewage-disposal works, Livsey Fields, within the borough. Tenders by 21st inst.

Edinburgh.—The Magistrates and Council invite tenders for works in connection with their electric lighting station in Macdonald-road, particulars of which appear elsewhere. Tenders by Feb. 27.

Dublin.—The Corporation invite tenders for the supply of incandescent lamps for working at 200 volts. The total number required is not less than 8,000, of various candle-powers. Tenders by 24th inst.

Oldham.—The Electric Light Committee invite tenders for two Lancashire steam boilers, 28ft. by 8ft. Specification can be seen at the office of Prof. Kennedy, 17, Victoria-street, Westminster. Tenders by Feb. 28

Redditch.—The Urban District Council invite tenders for about 100 alternating-current meters. Particulars can be obtained (£2. 2s.) from Mr. J. A. McMullen, M.I.E.E., Hornchurch, Essex. Tenders by Feb. 27.

San Severa (Italy).—Tenders are invited for the electric lighting of the town. Particulars are to be obtained from, and tenders addressed to, the Corporation (Syndaco) of San Severa, Province of Foggia, Italy, by Feb. 25.

London, N.—The Shoreditch Vestry are prepared to receive proposals and to contract with any person or persons for various articles and works, for particulars of which refer to our advertising columns. Tenders by 28th inst. at 6.30 p.m.

Piedrahita (Spain).—Tenders are asked for the electric lighting of the town. The estimated cost is 33,750 pesetas, and the deposit required is 3,375 pesetas. Tenders are to be addressed to the Syndaco of Piedrahita, province of Avila, by March 9.

Edinburgh.—The Council invite tenders for the following works in connection with their electric lighting station in Macdonald-road: Contract No. 7: Condensing plant, with water-cooling tower, feed-water tanks, and filters. Tenders by March 6.

Wolverhampton.—The Lighting Committee invite tenders for an extension of the electric lighting station, Commercial-road, Wolverhampton. Particulars may be obtained of Mr. J. W. Bradley, C.E., Town Hall, Wolverhampton. Tenders by Feb. 27.

Manchester.—The Tramways Committee of the Manchester Corporation invite tenders for supply of sample electric tramcars,

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Specifications and forms of tender may be obtained on application to Mr. J. M. McElroy, secretary, Tramways Department, Town Hall, Manchester. Tenders by 20th inst.

Pernambuco.—The Government of the State of Pernambuco invite tenders for the construction of an electric tramway to run between that city and Olinda, situated at about three miles distance. Tenders, duly sealed, must be addressed to the Secretaria da Industria, Pernambuco, and should be received there not later than March 18.

Lewes.—The Corporation invite offers from responsible companies or persons willing to establish an electricity supply undertaking under and subject to the provisional order of 1898. Particulars may be obtained at the offices of Mr. F. J. Warden-Stevens, Connaught Mansions, 34, Victoria-street, Westminster, S.W., or at the office of the Clerk, Town Hall, Lewes, on deposit of £5. 5s. Tenders by March 24.

Belfast.—Tenders are invited for the supply and erection of the following, for the Electric Committee: (Section C, 7) water-tube boilers, two 12½-kw. steam dynamos, switchboard. Specification and conditions of contract may be obtained on application to Mr. Victor A. H. McCowen, city electrical engineer, on payment of £1. 1s. per copy, which sum will be refunded on the return of the specification with a bona fide tender. Tenders by 10 a.m. on 23rd inst.

Dundee.—The Gas Commissioners invite tenders for the supply and erection of the following plant at the electric station, Dudhope-crescent-road, Dundee: (Contract No. 12) four Lancashire boilers; (13) two 450-h.p. steam-engines and dynamos; (14) one 700-h.p. steam-engine and dynamo. Specifications, etc., may be obtained from Mr. Walter H. Tittensor, Dudhope-crescent-road, Dundee, on deposit of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders by March 15.

Shanghai.—The Shanghai Municipal Council invite tenders for a concession for constructing and working about 23 miles of electric tramways on the trolley system in the streets of Shanghai. The special attention of tenderers is drawn to the fact that the tender (if any) recommended by the Council will require ratification by the ratepayers. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 being deposited with Messrs. Pook and Co., which sum will be retained by the Council, and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China (telegraphic address Dynamo, Shanghai; "ABC," fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Tramway Concession," must be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, and received by 12 noon on June 30.

Shanghai.—The following resolution in reference to the telephone system in Shanghai was passed at the last annual meeting of the ratepayers of the Foreign Settlements at Shanghai, north of the Yang-king-pang: "Resolution VIII.—That the Council be and is hereby authorised to enter into negotiations with the China and Japan Telephone Company or any other company, and in its discretion grant a franchise with a view to the community being supplied with an adequate and efficient telephone service at a fixed maximum charge." In accordance with the above resolution the Shanghai Municipal Council invite tenders for a concession for a period of 30 years for the exclusive right of establishing and working a telephone system in Shanghai. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 sterling being deposited with them, which sum will be retained and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China. Telegraphic address, Dynamo, Shanghai (ABC, fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Telephone Concession," to be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, by 12 noon on March 31.

RESULTS OF TENDERS.

Morecambe.—The Urban District Council have accepted the terms of Messrs. Stoddart and Co., for free wiring.

Buxton.—The Urban District Council have accepted the tender of Messrs. Vickers, of Nottingham, for the building of the generating station.

Burntisland (Scotland).—The tender of Mr. J. Wishart, Kirkcaldy, has been accepted for electric bells and smiths' work at the new street buildings at the Port.

Gravesend.—Messrs. Stone's estimate of £78. 10s. for 25 arc lamps, including burners, and shifting and fixing five other lamps in the fish market and covered market, has been accepted.

Beckenham.—With reference to the electric lighting tenders it is proposed that the Council entertain the tender of the British Insulated Wire Company, subject to certain details being agreed upon between the officers of the Council and the company.

Edinburgh.—The Electric Lighting Committee of the Town Council have accepted the estimates of Messrs. Redpath, Brown, and Co., Edinburgh, and Arrol's Bridge Company, amounting to over £10,000, for the iron and steel work of the M'Donald-road electric light station.

London, N.W.—The St. Pancras Vestry have received the following tenders for supply of 50 arc lamp columns: McDowell, Steven, and Co., design No. 1 £9. 9s.; design No. 2 £9. 2s. 6d.; W. McFarlane and Co., £9. 14s. and £10 respectively; Falkirk Iron Company, design No. 1 only, £10. The tender of McDowell, Steven, and Co. accepted for design No. 2, £9. 2s. 6d. each.

Burton-on-Trent.—The Committee have received the following tenders for the supply of three boilers at the generating station:

Galloways, Limited	£2 325
A. Anderton and Sons	1,979
Spurr, Inman, and Co.	1,920
Tinkers, Limited	1,875
E. Danks and Co., Limited, Oldbury	1,595

Bury St. Edmunds.—The Electric Lighting Committee have accepted the following tenders: Messrs. Davey and Co., for boiler plant, £1,495; Messrs. Fowler and Co., for engine-house plant, £5,793; the Callender Cable and Construction Company, for mains, £2,994; Messrs. Grimwood and Sons, for buildings, £3,470; payment to engineers, £850; payment to the clerk of the work, £100; payment for legal expenses, £100; payment for incidentals, £448—total, £15,250.

Waterville (co. Kerry).—The Commercial Cable Company have received the following tenders for building cable station, offices, and dwellings for officials at Waterville, co. Kerry:

D. Foley, Waterville	£5,450 0 0
Collen Bros., Dublin	5,050 0 0
Hemmingway, Belfast	4,472 2 2
S. Hill, Cork (accepted)	4 349 0 0
Jones, Dunmanway	4,317 0 0
Healey, Tralee	4 296 16 8

Note.—The above are for cable station only, the dwellings for officials being postponed.

London.—The Metropolitan Asylums Board have received the following tenders for the proposed electric lighting works at the Northern Hospital:

Section 1.—Switchboards, booster, and connections.

Cox-Walkers, Darlington	£463 10 0
General Electric Company, Limited, 69, Queen Victoria-street, E.C.	482 10 0
Verity's, Limited, 31, King-street, Covent Garden	634 10 6
Fuller-Wenström Electrical Manufacturing Company, 28, Brick-lane, E.C.	690 15 0

Consulting engineer's estimate, £600.

Section 2.—Battery.

		A.
Hart Accumulator Company, Limited, Marshgate-lane, Stratford	£318 12 0	£15 4 0
Pritchetts and Gold, Feltham, Middlesex	Informal.	—
D.P. Battery Company, Limited, 66, Victoria-street, S.W.	370 10 0	55 10 0
Laing, Wharton, and Down, 82A, New Bond-street, W.	380 0 0	16 10 0
Chloride Electric Storage Syndicate, Limited, Clifton Junction, near Manchester	410 0 0	25 0 0
Tudor Accumulator Company, Limited, 16, Victoria-street, S.W.	414 0 0	28 0 0
Epstein Accumulator Company, Limited, 34, Victoria-street, S.W.	420 18 0	37 10 0
T. Scott Anderson, Royal Insurance-buildings, Sheffield	450 0 0	55 0 0
Lithanode Electric Storage Company, Limited, 427A, Strand, W.C.	458 9 0	21 0 0
Electric Power Storage Company, Limited, 4, Great Winchester-street, E.C.	457 0 0	39 10 0

Consulting engineer's estimate, £400.
A. Annual maintenance for five years.

Section 3.—Electrical mains.

Callender's Cable and Construction Company, Limited, 90, Cannon-street, E.C.	773 1 6
British Insulated Wire Company, Limited, Prescot, Lancashire	903 15 8
Johnson and Phillips, Electric Cable Works, Old Charlton, Kent	925 0 0
Laing, Wharton, and Down	1,110 10 0
T. Scott Anderson	1,363 0 0
Western Electric Company, North Woolwich, E.	9,604 12 6

Consulting engineer's estimate, £1,100.

Section 4.—Steam exhaust, feed, and drain pipes.

R. W. Blackwell and Co., 39, Victoria-street, S.W.	732 0 0
R Taylor and Sons, Marsden, Yorks	840 0 0
Babcock and Wilcox, Limited, 147, Queen Victoria-street, E.C.	927 0 0
G. Wailes and Co., 258, Euston-road, N.W.	945 0

Consulting engineer's estimate, £400.

Section 5.—Wiring and fittings.

R. Whipp and Co., 43, Cannon-street, Manchester	2,750 0 0
G. Weston and Co., 58, Fenchurch-street, E.C. (accepted)	2,875 0 0
Benham and Sons, Limited, 50, Wigmore-street, W.	2,902 11 8
T. Scott Anderson	2,935 0 0
Wells and Co., Paddington-street, W.	3,081 0 0
G. F. Ratcliff and Co., 558, Oxford-street, W.	3 373 0 0
Laing, Wharton, and Down	3,727 0 0
Drake and Gorham, 66, Victoria-street, S.W.	3,900 0 0
H. G. Ellis and Co., 2, Princes-mansions, Victoria-street, S.W.	4,800 0 0

Consulting engineer's estimate, £2,850.

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Leyton.—The following tenders have been received by the Electric Light Committee for motor-generator, etc.:

Fuller-Wenström Company, 28, Bush-lane, Cannon-street	£105	0	0
Electric Construction Company, Wolverhampton	161	10	0
Brush Electrical Engineering Company	96	0	0
J. Fowler and Co., Leeds	157	0	0
General Electric Company, London	90	10	0

Londonderry.—The Corporation have received the following tenders for the supply of arc lamp globes and carbons during year ending Dec. 31, 1899: 13mm. carbons—Braulik and Co., 217, Upper Thames-street, E.C., 44s. 10d. per 1,000ft. (accepted); F. Henrion and Co., 75, Mark-lane, 34s. 11d.; English Electric Company, Brymbo, 39s. 6d.; Crompton and Co., Chelmsford, 40s.; Cox-Walker and Co., 40s.; General Electric Company, 41s.; Mavor and Co., 41s. 3d.; Brush Company, 41s. 4½d.; Buck and Co., 43s. 10d.; Pollard and Co., 44s. 3d.; Johnson and Phillips, 47s.; Siemens Bros., 55s.; Edison and Swan, 55s. 7½d. 16in. opalescent globes—Irving, Rogers, and Co., 4s. 8d. each (accepted); Edison and Swan, 5s. 3d.; Cox-Walker and Co., 6s.; A. and R. Cochran, 7s. 3d.; Crompton, 7s. 6d.; De Grelle Hondret, 8s. 6d.; Johnson and Phillips, 9s.; General Electric Company, 10s.

Lynn.—The following tenders have been accepted: Messrs. C. E. Spagnoletti and Crookes, of Goldhawk Works, London, for the wiring and fittings for the town hall and municipal buildings—wiring throughout, £202. 10s.; fittings, lamps, etc., £278. 5s. 6d. The work covers the wiring of all the public offices, police offices and cells, superintendent's house, assembly rooms and rooms adjoining, passages, kitchen, etc. The total number of lamps will be 213 16-c.p., and 140 special 5-c.p. imitation wax candle lamps for the candelebra in the assembly and card rooms. For the supply of lamp-posts, brackets, and fittings for the public lamps: Messrs. Siemens Bros. and Co. for 22 arc lamps, and 225 pairs of 16-c.p. incandescent lamps. The total cost will be about £1,900. Messrs. J. and A. Laws, of Glasgow, for the necessary posts and brackets for the foregoing lamps. The total cost will come to £827, which includes the conversion of the existing central lamp in Tuesday Market.

BUSINESS NOTES.

Basingstoke.—The Corporation have decided to apply for an electric lighting order.

Crewe.—The extension of the electric lighting scheme down West-street is being considered.

Portsmouth.—The Town Council have unanimously adopted the overhead system of electric traction.

Dewsbury.—At a recent meeting of the Corporation an increase in the use of electrical energy was reported.

St. Paul's.—The Dean and Chapter have resolved upon an installation of the electric light, which will cost £5,000.

Grimsby.—The Town Council are about to apply for authority to borrow an additional £5,000 or £6,000 for electric lighting.

Rothesay.—The Town Council have decided to adopt an electric lighting scheme for the front of the town at an estimated cost of £1,800.

Devonport.—It is estimated that the cost of carrying out the work included in the Corporation tramways provisional order will be £10,277.

Gillingham.—The District Council have decided to ask Mr. Jasper upon what terms he would be willing to sell his electric light undertaking.

Bangor.—The Local Government Board have sanctioned the loan of £14,150 for the purposes of electric lighting and the purchase of the requisite land.

City of London Electric Lighting Company, Limited.—The transfer books and register of members of this Company are closed until March 1, 1899, inclusive.

London County Council.—At the usual weekly meeting of the Council on Tuesday, it was agreed to lend the Newington Vestry £10,000 for electric lighting works.

Morecambe.—The Electric Light Committee have reduced the price of the current for electric lighting from 6d. to 3d. per unit, the reduction to take effect on April 1.

Yarmouth.—The Electric Lighting Committee are considering the question of extension of plant at the generating station. Thirty additional arc lamps are to be ordered.

Rochdale.—With reference to our note in our last issue, we learn that the Local Government Board have now decided to sanction the loan of £30,000 applied for.

Hampton Wick.—It is proposed that the District Council should approach the Kingston Corporation with a view to having their electric lighting carried into Hampton Wick.

Burton-on-Trent.—The tenders have been referred back for a month on account of a doubt as to whether the firm who had sent in the lowest tender would pay standard wages.

Highland Water-Power Bill.—At a recent meeting of the inhabitants of Onich and North Ballachulish a number of resolutions in favour of this Bill were unanimously adopted.

Maidstone.—The Council are considering a report, a portion of which is given in another column, of Messrs. Kincaid, Waller, and Manville on electric lighting. The estimate is £36,000.

Rawmarsh.—At the monthly meeting of the District Council on Wednesday it was pointed out that in the near future it was proposed to take into consideration the question of electric lighting.

Gosport.—The advisability of making an application for a provisional order for the purpose of lighting the district by electricity has been referred to a committee of the District Council.

Merthyr.—The Urban District Council on Wednesday agreed upon the British Electric Traction Company's terms for their support to the provisional order for lighting the district by electricity.

Darwen.—At the last monthly meeting of the Town Council it was stated that progress was being made with the electricity works, and it was hoped soon to be in a position to supply the centre of the town.

Heacham.—The Parish Council have agreed, in view of the lighting of the parish by electricity, to adopt the Lighting Act if they can make suitable terms with the company which it is proposed to form.

City Lunatic Asylum.—The Corporation of London have decided to make further improvements at the City of London Lunatic Asylum at Stone, which includes an installation of the electric light in the asylum.

Glasgow.—The Electricity Committee have confirmed a minute of a special sub-committee recommending the Corporation to pay £30 000 for the buildings, plant, and rights of the Kelvinside Electricity Company.

Southampton.—The deputation recently appointed by the Town Council, consisting of three members of the Tramways Committee, with one official and the electrical engineer, are to visit Dover, Leeds, Bradford, and Glasgow.

Chichester.—The City Council have instructed the surveyor to prepare plans on a scheme for the consideration of an expert. Under this scheme it is proposed to establish electric light works, with refuse destructor, at St. James's.

Belfast.—The explosion which occurred last week in Ann-street is said to have been caused by an electric spark igniting an accumulation of coal-gas in a culvert. Two pedestrians, a man and woman, were injured, but not seriously.

Ayr.—With reference to the paralleling of Nos. 1 and 2 generators of Ayr electricity works, which had been deferred for several years, the Town Council agreed on Tuesday to empower the Lighting Committee to do the same.

St. James's.—The Vestry have received a letter from the Vestry of St. Martin-in-the-Fields stating that they have requested the London County Council and the City Corporation to oppose the Bills promoted by the National Telephone Company.

Keswick.—The District Council have asked the Keswick Gas Company and the Keswick Electric Lighting Company to tender for public lighting, including the fitting up of the lamps and extinguishing the light, at a certain price per annum.

Hornsey.—With regard to the Highgate and Finchley tramways and the Finchley and Hendon light railways, the Council will be represented at the conference to be held with regard to the former, as well as at the enquiry with regard to the latter line.

North Staffordshire Railway Company.—At the half-yearly meeting of the North Staffordshire Railway Company, the Chairman said that during the past year three of their trains had been fitted with electric light and two more were now being fitted.

Oswestry.—The Watch Committee of the Town Council are considering the advisability, terms, etc., of acquiring the undertaking of the Oswestry Electric Lighting Company. The borough surveyor has been appointed electrical inspector for the borough.

Plymouth.—The Borough Council have practically abandoned the idea of applying to the Board of Trade requiring the Plymouth, Stonehouse, and Devonport Tramway Company to sell to the Corporation the portion of their undertaking within the borough.

Ingleton.—A company is to be formed, to be called the Ingleton Electric Lighting Company, with a capital of £2,500 in £1 shares. A working committee has been appointed by a public meeting to canvass the town and ascertain what share capital can be obtained.

Gateshead and District Tramways Company.—An extraordinary meeting of the shareholders was held at the depôt, Sunderland-road, last week, at which a resolution was passed approving of the Gateshead and District Tramways Bill now before Parliament.

Dukinfield.—A movement is on foot for the erection of a new ring spinning mill. It is intended to have a capital of from £80,000 to £100,000, and to have the concern fitted up in the most modern style, with electric lighting throughout and triple-expansion engines.

Larne.—The Larne Electric Light Works, Limited, have lodged with the Town Council a plan showing the transformers at present on the lamp-posts placed in chambers underneath the footpaths. The Board have referred the plan to the Improvement Committee and surveyor for report.

Taunton.—The Electric Lighting Committee's report to the Town Council states that the accounts of the electric lighting for the year ending Dec. 31 last show a balance to the good on net revenue account of £794. 11s. 9d. An increase in the salary of the electrical engineer is recommended.

Pontefract.—The Guardians have asked Mr. Holiday, jun., of the Ackton Hall Colliery, to report upon the proposed scheme for lighting the workhouse by electricity. The cost of the

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scheme is stated at £1,075, and it is said that in comparison to gas £100 per annum would be saved.

Wrexham.—Mr. W. H. Trentham has been engaged to advise the Council on the proposed electric lighting and refuse destructor, and also upon the advantage or otherwise to the Council to provide motive power for the tramways. (This note erroneously appeared under "Oswestry" in a former issue.)

Rochester.—The city surveyor having reported that the electric light company in laying their mains in King's Head-lane had diverged from the line shown in the deposited plans, and that he had therefore stopped the work, the company has been asked to deposited amended plans for approval.

Whitehaven.—The Corporation have under consideration the question of increasing the voltage of their electric current from 240 to 480 on account of the heavy pull now made on the current in the centre of the borough. This way out of the difficulty would be cheaper than the laying of additional cables.

Colne.—At a special meeting of the Colne Town Council on the 13th inst. it was resolved that application be made to the Light Railway Commissioners for an order, under the provisions of the Light Railway Act, 1896 authorising the construction and working of a light railway comprising four sections of line.

Southport.—At the monthly meeting of the Town Council on Tuesday it was stated that the Council would be able to reduce the rates by a halfpenny in the pound on account of the profits for the year made out of their electric undertaking. At the same time they hoped to reduce the price to their customers.

St. Marylebone.—At the meeting of the Vestry yesterday a report was received from the Works Committee recommending, as regards the question of extending the incandescent scheme of public lighting in Marylebone-road, that the Vestry take no action in the matter pending the result of the Marylebone Electric Light Bill.

Aberdeen.—A sub-committee of the Tramways Committee is about to visit Edinburgh with a view to purchasing second-hand cars which will shortly be for sale. The committee also intend to purchase eight electric cars for the Woodside section. At next week's meeting the question of traction for that section will be discussed.

Barrow.—The Electric Lighting Committee have been authorised to take into consideration at once the desirability of extending the plant sufficiently to cope with the supply for next winter. Alterations to the station estimated to cost £85, and the purchase of furniture to cost £150 for the offices, etc., have been agreed upon.

Eccles.—The recent temporary failure of the electric light is stated to have resulted from a very trivial cause, being ascribed to water which, owing to the cables being laid in exceptionally bad weather, had got into the insulating material near the joints, thus causing short-circuiting and the burning of the cable at those points.

Liverpool Tramways.—At the last meeting of the Tramways Committee the Staff Sub-Committee recommended that the salary of Mr. Collis, assistant engineer of tramways, should be increased by £30 per annum. The Chairman said, with regard to the financial position of the Tramways Committee, that they would have a substantial balance to carry forward.

Bath.—A second company is now proposing to supply the town with an electrical tramway system. The committee of the Corporation who are dealing with the matter have resolved that, if there are to be electric trams in Bath, they must be under the control of the Corporation. A deputation is to visit other towns where trams are worked by the municipality.

St. Olave's.—The Board of Works have given their formal consent to an extra high-pressure supply being given by the London Electric Supply Corporation for the supply of energy, and to the National Telephone Company to lay underground tubes, with necessary manholes, along St. Thomas's-street, Joiner-street, and Tooley-street for an annual rental.

Neyland.—The Parish Council are considering a scheme for electric lighting of the town. The total cost of the scheme is estimated at about £1,000. It is contemplated to provide 16 arc lamps of 1,000 c.p. each, and the plant requisite for generating and conveying electricity over the whole of the town. The yearly cost of keeping up the lighting will be between £80 and £90.

Whitefield.—Mr. W. Nuttall has been elected chairman of the Electricity Committee. With regard to the Lancashire Electric Power Company's Bill, a circular is to be issued asking how many residents and millowners are desirous of having the electric light. The District Council are also enquiring upon what terms the Radcliffe District Council will be prepared to supply them.

Leominster.—At the last meeting of the Town Council, the question of the lighting of the borough was discussed. It was stated that they were about to have additional motive power in connection with the water supply, and it had been suggested that the new power could be used to provide electric light. A resolution to that effect is to come before the next meeting of the Council.

Walsall.—A sub-committee is to be appointed by the Town Council to conduct negotiations and enter into a provisional agreement with the South Staffordshire Tramways Company for purchasing and leasing the lines, and also to confer and advise the town clerk as to the opposition to the company's Bill in Parliament if it should be necessary for the same to be proceeded with.

Appointments Vacant.—The Corporation of Hull invite applications for the post of traffic manager for their tramways at a salary of £300 per annum. Applications must be delivered by 24th inst.—The Corporation of Wigan are prepared to appoint a draughtsman in the borough electrical engineer's department. Full particulars of these and other vacancies will be found in our advertisement columns.

Lowestoft.—At a recent meeting of the Town Council the scheme for the proposed electric trams for the town was agreed to, subject to certain conditions, amongst which was one that the promoters of the company should widen certain parts of High-street. It is now reported that the owners of the property concerned have received notice that their properties will be required for purposes of the undertaking.

Accident on the Liverpool Overhead Railway.—Lieut.-Colonel H. A. Yorke's official report on the collision that occurred on the Liverpool Overhead Railway on Dec. 20 last, when five passengers were injured, places the responsibility on the driver, Garrity, who failed to stop his train at the proper place in Dingle Station, with the result that it came into violent collision with the buffer stops at the end of the station.

Shrewsbury.—At the quarterly meeting of the Town Council it was stated that some difficulties have arisen in regard to the completion of the purchase of the electric lighting works from the existing company, and the final settlement would demand some time. Mr. C. M. Johnston, of Lancaster, has been appointed electrical engineer and manager under the Corporation; 55 applications were received for the post.

Mirfield.—The National Telephone Company are complaining about the intention of the Council to charge the company increased rental for the poles. The Council in their turn complain of the kind of pole used in Knowle-road. The company is now putting up a specimen pole for the Council to see. The company are considering the question of looping the subscribers' lines. The wires at Dewsbury will shortly be put underground.

Birkdale.—The Urban District Council have appointed a committee to consider the following provisional order and Bills now before the Board of Trade and Parliament: (1) the Southport and Birkdale Tramway Provisional Order, 1899; (2) the Southport Tramways Bill, 1899 (empowering the Southport Tramways Company, Limited, to work their tramways by mechanical power and other purposes); (3) the National Telephone Company's Bill (No. 2).

Doncaster Tramways.—The Earl of Jersey (chairman), Colonel Boughey, and Mr. Allen D. Erskine, acting as Light Railway Commissioners, held an enquiry on Wednesday into the application of the Doncaster Corporation to construct tramways within and immediately outside the borough. Lord Jersey intimated that they considered that the preamble had been proved, subject to the reservation with regard to the railway crossing being abandoned.

Kensington.—At a meeting of the Kensington Vestry on the 9th inst., the Vestry decided to abandon their application for powers to supply electricity in the parish, and to support by petition the Kensington and Notting Hill Bill, which empowers the Notting Hill Electric Lighting Company, Limited, and the Kensington and Knightsbridge Electric Lighting Company, Limited, to construct the necessary works for lighting the streets of Kensington.

Paisley.—On Tuesday last the electric light was switched on for the first time in the free library by Mr. Robert Foulds, manager for the contractors, Messrs. Jas. Kilpatrick and Son, Paisley. The whole of the picture galleries and the sculpture gallery were lit. The current is taken from the private installation at the Clark Town Hall. The Electric Lighting Committee have received a statement from Mr. Teague showing extensions of plant required, estimated to cost £8,750.

Perth.—The Police Commissioners have confirmed their resolution to grant their consent to the application to the Board of Trade by the Perth and District Tramways Company, Limited, for authority to change the motive power of the tramway cars from horse power to electric power on condition that the plans and specifications be submitted to the Commissioners for their approval. The Commissioners will not consent to any extension of the time for the purchase of the tramways.

Carlisle.—The electric installation at the Citadel Station, Carlisle, was completed on the 9th inst. the current being turned on by Mrs. Thomson, wife of the secretary of the Joint Station Committee. The platform and approaches are lighted by 67 arc lamps, each of 800 c.p., and there are between 500 and 600 incandescent lamps in the offices, refreshment-rooms, etc. The plant, consisting of three powerful dynamos with two smaller ones, is placed in one of the arches underneath the island platform.

Bootle.—The General Purposes Committee have resolved that, in view of the possible reconstruction of the Liverpool portion of the Stanley-road route for electric traction this year, the Liverpool Tramways Committee be requested to give the committee some idea as to the date about which the work will be commenced, the system which it is proposed to adopt, and the section of the rails, in order that the necessary preliminary arrangements may be made for the reconstruction of the Bootle portion of the route.

The Lancaster Electric Power Bill, 1899.—At a conference held on Tuesday of representatives of the various local authorities whose districts are affected by the above Bill, resolutions were passed authorising a joint committee of urban district councils to oppose this in Parliament. The cost of such action is to be divided in proportion to the rateable values of the districts, and the committee is to consist of representatives of the Councils of Leigh, Failsworth, Levenshulme, Turton, Northwich, Royton, and Whitefield.

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Edison and Swan United Electric Light Company, Limited.—The directors have resolved to make payment on account of the dividend of the current year at the rate of 6 per cent. per annum, less income tax, on the "A" shares in respect of the half-year ended Dec. 31 last. This works out at 1s. 9⅝d. per share on the partly-paid £5 shares, £3 paid, and 2s. 9¾d. per share on the fully-paid £5 shares, less income tax. The payment will be made upon the register as it stood on the 14th inst., and the dividend warrants will be issued on the 24th inst.

Lincoln.—A Local Government Board enquiry was held on Wednesday by Mr. W. O. E. Meade-King, C.E., into an application of the Corporation for power to borrow an additional £19,000 for purposes of electric lighting. The deputy town clerk (Mr. W. T. Page) explained that the capacity of the plant was equal to 5,000 8 c.p. lamps, and there was already a demand for 6,000 such lamps, while it was known other persons intended to apply for the light. Ten miles of cable were required, and that would involve additional plant in the shape of engines, dynamos, and boilers.

Morley.—The Town Council have resolved that the borough electrical engineer be authorised to attend the conference with the Electric Construction Company in London to settle up their contract for the supply of the electrical plant; that in all cases where electric current is supplied for running motors, no charge be made for the running of the loose pulley in connection therewith; that Mr. Clayden be empowered to order the fixing of snow grids to the roof of the electric lighting station, and that the 40 rebate indicator meters be sold to the Wakefield Corporation at a reduction of 15 per cent. on the cost price.

W. H. Wilcox and Co.—This firm have sent us complete illustrations of a double-acting semi-rotary wing pump, which they have introduced for general purposes. The pump is worked by a handle, which is moved to and fro when it is required to be used. The oscillating portion in the centre is equipped with suction valves, much in the same way as have been used in some older types of rotary engines. In this case, however, where a comparatively slow motion is required, the construction is likely to give good results in practice. These pumps can be easily arranged for power work, a number of applications in this way being shown in the list.

Smoke Nuisance.—Mr. Slade has given his decision in the case of the City of London Electric Lighting Company, reported in our last issue. The magistrate, who had visited the premises, stated that he was very pleased with what he saw. He could not, however, take their excuse into consideration; his duty was to see that there was no nuisance. He would not define the cause of the black smoke but he had decided to fine them, the nuisance having been proved before him. This was the third time the company had been summoned. The last time they were fined £5 in each case, and they would now be fined £10 and 2s. costs on each summons—total, £101.

Bristol.—Mr. John Rutherford Blackie having resigned his appointment of chief assistant engineer, Mr. Robert Wilfrid Lucas Phillips, who has been in the Council's employ as an assistant engineer for a period of upwards of four years, has been appointed to the vacant position. A loan of £25,000 is to be applied for, made up as follows: additions to plant at central station, £8,860; additions to the external system, including mains and sub-stations, £4,450; customers' extensions, £8,542; additions to buildings, £3,148. On the winter period of the first year of the installation the earnings amounted to £1,231, and for the like period of 1898 to £10,301.

Midlothian.—The County Council at their last meeting considered a report by the Finance and Law Sub-Committee on the proposed light electric railway between Edinburgh and Musselburgh, stating that a letter had been received from the Edinburgh and District Tramway Company to the effect that the directors had decided not to take any action in the meantime in regard to the proposed light railway between Edinburgh and Musselburgh. The clerk was instructed to communicate with the promoters asking whether they would agree to lay their rails on causway 7in. deep, and to a width of 8ft. on the top of the existing metal bed, and fill up the sides with new whinstone metal of approved quality.

Colwyn Bay.—At the monthly meeting of the Colwyn Bay District Council a letter was read from the Light Railway Commissioners to the effect that the light railway scheme had been further considered by the Commissioners in reference to the proposed deviation of the alignment from that shown on the deposited plans for railway No. 2, and that the Commissioners had reinstated the order authorising the construction of railway No. 2 in accordance with the plans originally deposited, which were considered by them at the local enquiry upon which their decision was given. It was decided to convene a special Council meeting to consider the amended orders as soon as a copy is received.

Greenock.—The Police Board have adopted a plan submitted by Mr. Fedden, the engineer, for a boiler-house, engine-house, battery-room, and offices. The works are to be erected on the yard at present occupied by the master of works at Hunter-place, Harvie-lane, and Dalrymple-street. The cost will be within £5,000—the sum estimated by Mr. Fedden. The plan provides for lighting, power, and haulage. The cost of the electric installation is estimated at £30,000, and if the tramway company is supplied it will come to £20,000 more. At a recent meeting of the tramway company it was unanimously resolved to prosecute the Bill now before Parliament for the introduction of electric traction power on their lines.

Ashton.—The Oldham, Ashton, and Hyde Electric Tramway, Limited, having written that they found it necessary to make application to the Board of Trade for a further extension of time, and asking to be informed when the Corporation would be able to supply the tramways with electric current, the Electricity Committee have replied that they hoped to be able to supply current at the end of February. The tender of the British Insulated Wire Company for making house services has been referred to the Works Sub-Committee with power to act. The question of the charge to be made for the public arc lamps will be discussed next month, and the engineer in the meantime is to ascertain what is done in other towns.

Whitby.—At the Urban District Council meeting last week electric lighting was discussed. The committee in charge of the question had met Mr. W H. Preece, who had urged them to make their own installation, and not let a private company in. He recommended an installation of 5,000 lights at first, working up to 15,000 lights, the works to be as near the harbour as possible for economical working, and the charge to be 5d. per unit, equivalent to 3s. a thousand for gas. A dust destroyer might also be provided in the same connection. As already reported by us, the Council have decided to retain Mr. Preece to make the required report to a future meeting.

Scarborough Electric Supply Company, Limited.—With regard to the report published in our last issue, we are now able to present details of the revenue account for the year ending Dec. 31, 1898, as follows: wages, salaries, rent, rates, etc., £1,273; stores, fuel, lighting, etc., £1,276; maintenance, repairs, and renewals, £337; amount written off office furniture and fittings—depreciation, £13; stationery, office, and general expenses, £71; directors' remuneration for year 1897, £100; or a total of £3,070; to which is added provision for bad debts, £41, and balance for year carried down, £2,332; making a grand total of £5,443, which is balanced by electric energy, etc., supplied, less discounts, £5,271; meter rents and sundries, £172.

Govan.—Arrangements having now been completed with the Town Council to enable the National Telephone Company to place its wires under the streets of the burgh, the company propose to open a telephone exchange on the twin-wire or metallic circuit system within the burgh, in connection with the company's Glasgow system. Ten pounds per annum is to be charged for the first connections, with a reduction for additional connections. This rental includes communication with all subscribers to the company's system within the Glasgow telephone exchange area as defined by the Postmaster-General, including the following places: city of Glasgow, burghs of Rutherglen, Clydebank, Milngavie, Kirkintilloch, Pollokshaws, etc.; also Bearsden, Cambuslang, Kilsyth, etc.

R. Duckenfield and Son.—This Northampton firm, which has its works at 31, Gold-street, have forwarded to us a list of new shades which they have introduced for electric light. These designs, which are all registered, are made to completely enclose the lampholder, although in other cases a half shade, which is fixed to the lampholder in the usual way, can be obtained. When the completely enclosed type is used the upper portion has, of course, to be threaded on to the cord before the lampholder is fixed. These shades, which are made in various colours, have a series of frills round them at different heights, and look well when the lamp is lighted. The only fault we have to find with them is that rather common to any ornamental designs—namely, that an unduly large proportion of the light is absorbed in the shade itself.

Birmingham.—At a recent special meeting of the Public Works Committee of the Corporation, it was decided to recommend to the Council the municipalisation of the tramways. The committee are of opinion that in view of possible early developments and improvements it would be unwise to fix upon any motive scheme at present. The undertaking of the old Birmingham Tramways Company was purchased about three years ago by a Canadian and London syndicate on the basis of a payment of £6 for each £10 ordinary share, which had fallen at one time to about £3. A new company was then floated, and the £5 shares are now quoted at £6. 15s. The capital of the present company is £1,000,000. At present six of the lines are run by steam, electricity by the accumulator system is only used on one, and the cable system on another.

Blackpool.—The Town Council have referred back to the Electric Lighting and Tramways Committee a resolution that Mr. R. C. Quin, the borough electrical engineer, be allowed to accept such consulting electrical work as in the opinion of the Council will not interfere with the due carrying out of his duties, provided that he do not advise on more than one scheme at the same time, and that his salary as borough electrical engineer be £400 a year for three years, Mr. Quin undertaking to remain with the Corporation of Blackpool for such period at that salary. Since the above was written we learn that the Corporation have decided to allow Mr. Quin to devote two days a month to consulting practice. Mr. Quin has accepted a position as adviser to the West Bromwich Corporation at a salary of 5 per cent., the proposed outlay being £50,000.

Newcastle.—At a meeting of the City Council on Wednesday a resolution was passed confirming the report of the committee recommending the adoption of the overhead trolley system of electric traction on all tramways, with a proviso that, while the Council adopted the overhead system of electric traction for their tramways generally, the overhead system should not be constructed in the streets in the centre of the city until the Council had considered and decided whether in those streets some system of electric traction other than overhead traction was practicable to be worked

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in conjunction with the overhead system in the other streets upon the tramway routes, and that the new Tramways Committee be requested to consider the question and obtain the opinion of the city engineer and of an expert upon the subject, and report thereon to the Council as early as possible.

Chesterfield. — The Electrical Energy Committee's report adopted by the Town Council on Tuesday recommended the provision of a generating station and the supply of electricity for public and private purposes in the borough. They considered it advisable that the station should be in the unused portion of the gasworks, and that the Gas and Water Board be asked for permission to erect the requisite electrical plant on the Board's premises on a lease, or on other terms to be arranged. They also passed a resolution in favour of asking Mr. Johnson, of Sheffield, whether he would be prepared, and on what terms, to advise the Council on a scheme and to act as consulting engineer to the committee, and instructing the borough surveyor to apply to Messrs. Siemens and Co. and the Westinghouse Electric Lighting Company to inspect the borough and give specifications and estimates for providing an installation.

Barnsley.—The last report of the Streets, Buildings, and Improvement Committee stated that they had considered the grave objections to the application now being made to Parliament by the British Electric Traction Company for powers to construct tramways in the district, and the grounds on which the Town Council base such objections. Representatives of the Worsborough District Council had decided to recommend their Council also to oppose the application of the British Electric Traction Company, but if no definite progress be made by the Town Council towards the construction of tramways between Barnsley and Worsborough within the next few months the Worsborough Urban District Council reserves to itself full liberty of action. At the next meeting a proposal will be discussed to appoint a Tramways Committee to consider the advisability of introducing a system of tramways into Barnsley.

Light Railways.—The estimates for the Weston-super-Mare, Clevedon, and Portishead Tramways Company, sanction for which is being sought this season, have now been prepared. The total length of these extensions will be just over six miles, and will cost £20,258.—It is intended to apply to Parliament for an Act to construct a light railway from Newry to Tynan, by Bessbrook, Camlough, Newtownhamilton, and Keady, which would connect Newry with the Clogher Valley Light Railway at Tynan.—Sir Courtenay Boyle, who was assisted by Mr. F. J. Hopwood, Sir Thomas Blomefield, and Lord Dudley, on Tuesday last heard the objections to the confirmation of the order relating to the Liverpool and Prescot Light Railway. At the end of the enquiry, Sir Courtenay Boyle said it would be necessary that in Clause 52 of the order the names of the Corporations of Liverpool and St. Helens should be struck out, and Mr. Cripps stated that the promoters had no objection to that. The Board of Trade's decision is reserved.

Ealing.—The proposed construction of a light railway or electric tramway from Acton, through Ealing to Hanwell, was discussed at the last meeting of the District Council. A letter was read from the Hanwell District Council requesting the Ealing Council to join Hanwell in constructing an electrical tramway from the boundary of Acton to Hanwell Broadway, on the basis of an agreement that the expenditure and revenue in connection with such undertaking should be pooled to joint account. This letter was referred to the General Purposes Committee. Correspondence from the Middlesex and the London County Councils and a deputation in opposition and one in support of the scheme were also dealt with, and finally notice was given of a resolution to be proposed at the next meeting of the Council to the effect that, in view of the confirmation of the light railway order between Hanwell and Uxbridge, the Council proceed no further with its opposition of the Acton-Hanwell scheme until it had seen Mr. Clifton Robinson.

Plumstead.—The Electric Supply Committee of the Vestry having visited several electric lighting stations, have recommended that the Brighton installation be taken as the type for adoption in Plumstead, and that it be worked independently of a dust destructor. If a destructor should be erected by the Vestry, any effective supply of steam, the committee suggested, should be debited to the Electric Supply Committee at an agreed price. In the event of the Vestry agreeing to these recommendations, which would involve a greater initial outlay than a plant of the Leyton type, the committee further recommended that the amount of £30,000, already sanctioned by the Vestry and specified in the application for a provisional order, be increased to £50,000. They also recommended that the Marsh site be adopted for the central station. The lamps used in sitting-rooms, halls, passages, and kitchens, which usually required lighting between dusk and 10 and 11 p.m. throughout the year, could be supplied at the average rate of 2¾d. per unit. This, at an average of four hours' use per day, was much less costly than gas.

Islington.—At the meeting of the Vestry to-day the following resolution will be proposed: "That the sums of £38,750 and £7,500 required for electric lighting be taken up by loans and repaid by equal half-yearly instalments of principal and interest combined within a period of 42 years; that the Vestry hereby undertakes that during the currency of these loans no further loan will be raised to replace any of the works' plant and machinery, the cost of which is to be defrayed out of such loans; and that any renewals required during the period of such loan shall be provided out of a sinking fund to be created for the purpose or from maintenance account." At the last meeting of the Vestry a report of the Electric Lighting Committee was adopted recommending the lighting by electricity of Canonbury-road and New North-road (to the boundary of the parish) at a cost of £5,200. It was also agreed that (dating from Jan. 1 last) the charge for public street lighting should be reduced from 5d. to 3½d. per unit, and that the private supply tariff should be altered by the elimination of the 6d. rate as from April 1 next, thus reducing the charges to 7d. per unit for the first hour's consumption of the maximum supply demanded, and 4d. per unit for all current consumed after the first hour.

Chester.—The Electric Light Committee have decided to reduce the price of current from 5d. per unit to 4½d. from March 25 next. The committee have further decided to reduce the charges for motors. Previously the charge for current for motive power was 3d. per unit, but now a graduated scale has been adopted, whereby the rate will be 2½d. per unit for the first 1,000 units used per annum; 2d. for the next 1,000; 1½d. for the next 1,000, and 1½d. for the fourth 1,000 units consumed per annum, and anything above this. The result of the past 12 months' working is eminently satisfactory. After paying the discounts the committee hope to have a sufficient balance to pay interest, sinking-fund charges, to wipe off another third of the preliminary expenses of the undertaking (one-third of the preliminary expenses has already been paid off), and to add £1,000 to the reserve fund. Last year £500 was added to the reserve fund. The Town Council have authorised the Electric Lighting Committee to lay arc mains and distributing mains for supply of public and private lighting, at a cost, including eight Jandus arc lamps, etc., of £2,300. Alterations are to be made to the automatic cut-outs on the switchboard at the electric light station at an estimated cost of £50. It was resolved to petition against the South Lancashire and Cheshire Electricity Company's and the Lancashire Electric Power Company's Bills.

St. Pancras.—At a general meeting of the Vestry on Wednesday last a letter was read from the London County Council agreeing, subject to the consent of the Treasury, to lend the Vestry £30,000 for electric lighting purposes at 3 per cent. per annum interest, calculated quarterly, repayable in 42 years by equal half-yearly instalments of capital and interest combined, the Vestry to defray the costs of the loan; also stating that the Council would lend the money for 42 years on condition that the Vestry agreed to maintain and replace the machinery, etc., during the period covered by the loan. Other correspondence contained an invitation from the Corporation of the City of London asking the Vestry to appoint three representatives to attend a conference of local authorities to be held at the Guildhall to consider the National Telephone Company's Bills now before Parliament; a letter from the Vestry of St. Luke, asking the Council to undertake the opposition to the Bills now being promoted in Parliament by the National Telephone Company; and a notice that a petition will be presented to the Vestry at the next meeting, signed by ratepayers and residents in the Euston-road and neighbourhood, against the proposed removal of the electric arc lamps from the centre of Euston-road. It was also proposed that Mr. R. Minchin, assistant electrician at the Regent's Park station, be appointed electrician in the room of Mr. W. A. Kemm (resigned).

Bradford.—Lieut.-Colonel Albert C. Smith, R.E., the Local Government Board inspector, held an enquiry on the 9th inst. into the application of the City Council, under the Public Health Act and the Electric Lighting Act, for the sanction of the Board for the borrowing of £20,000 for purposes of electric lighting. The Deputy Town Clerk (Mr. F. Stevens) said that the application was for permission to borrow £20,000, but the Corporation desired to increase the application to £21,000. The money was required for the purpose of providing additional machinery to meet the constantly increasing demand for electricity. The particular items for which the money was required were: two 600-i.h.p. engines, costing about £5,200; two dynamos, £5,500; two new switchboards, £250; four spare armatures, £2,500; two 600-h.p. boilers, £4,100; cast-iron pipes, £1,000; increasing the height of the old chimney shaft at Bolton-road electricity works, £200; and one battery of accumulators, £2,250. Evidence was given by Mr. A. H. Gibbings as to the plans of the new machinery, and there was no opposition to the application. At Wednesday's meeting of the Town Council the committee recommended that, unless protective clauses could be agreed upon, petitions should be presented against the following Bills and orders: Great Northern Railway, Spen Valley Light Railway, Midland Railway, Leeds Corporation Tramways, Shipley Electricity, and three Bills promoted by the National Telephone Company. The committee had decided to request the Tramways Committee to pay the difference in cost between lighting the electric tramway routes by electricity and by Bray's gas lamps. The minutes were adopted with the exception of the last clause. Various increases in the salaries of the Corporation staff were granted.

Stourbridge.—At a special meeting of the Urban Council on the 13th inst. a report by the Railway Committee was adopted as to the action taken to obtain certain protective clauses in the Kinver Light Railway Order. These included the widening of the Bridgnorth-road, of which the tramway company will bear half the cost, and the County Council and the Urban Council divide the other half. The Council then considered what action should be taken respecting the proposal of the British Electric Traction Company to run an electric tram service through High-street, Stourbridge, with regard to which the Council has an option under the Dudley and District Light Railways Order, 1898. It was stated that on March 4 the Light Railway Commissioners would hold an enquiry to consider an application for powers to make a railway from the Hayes at Lye, through Foster-street to High-street, Stourbridge, and also to consider the additional railway which the Council asked the promoters last spring to deposit

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plans for from High-street, along Enville-street, to Wollaston, to join the Kinver line. The High-street extension was really inseparable from the question of the two orders for the lines to Lye and along Enville-street. The Council finally agreed to consent to the extension of the tramline from the present terminus through High-street to the County Court in Hagley-street, on terms to be stated hereafter, and particularly on terms that the line to Wollaston and the Hayes be made to the Council's satisfaction.

Wolverhampton.—Mr. George W. Willcocks, Local Government Board inspector, held an unopposed enquiry last Wednesday into an application of the Town Council to borrow £29,740 for purposes of electric lighting. The Town Clerk said the loan was required for enlargement of the generating station, providing a sub-station, and extensions of mains and distributing system. At present the number of consumers in the borough was 270, and the number of units supplied for the year ended March 31 1898, was 291,233, but should the increase in the demand continue the present plant would be inadequate. There would be two separate and distinct generating systems—high and low tension—and the new scheme would facilitate the means of electric traction should the Corporation become the owners of the tramway system in the borough. The Lighting Committee of the Corporation also believed that the new system would effect a reduction in the cost of generating and distributing electrical energy, as it was proposed to increase the capacity of the boiler power by 50 per cent., the generating plant 70 per cent., the storage battery 950 per cent., the length of feeders 500 per cent., and the length of distributors 75 per cent. With reference to a notification of the application which has been made to the Board of Trade for transferring the undertaking of the Wolverhampton and Dudley Tramways Company to the British Electric Traction Company, it is stated that should the Tettenhall District Council lodge a petition against the Wolverhampton Tramways Bill with regard to the line passing through the Rock the clause relating to the taking of the line to Tettenhall will be struck out, and the tramline will terminate at the borough boundary at Newbridge.

Lynn.—The Town Council have agreed that lamp standards shall be placed in the centre of Railway-road and that part of London-road north of Mill Fleet. Instead of wires or wall brackets the arch system is to be adopted for High-street, at an additional cost of £150. From the report of Prof. Robinson, adopted at the last meeting of the Town Council, we learn that Messrs. Siemens Bros. are making satisfactory progress with the mains. As soon as the buildings are roofed in, the contractors for the machinery and for the storage batteries will both be able to push on with their work which is ready. The committee have approved of the regulations to be observed in wiring consumers' premises for electric lighting, motive power, etc. Where the Corporation's distributing mains are close at hand, or within 60ft. of premises proposed to be lighted, no charge whatever will be made to the consumer for bringing the service lines up to the premises to be supplied. A greater length of service lines will be laid free of charge if the revenue to be secured thereby will yield an adequate return on the expenditure. The consumer will be charged for the cost of all work done on his premises. Where the distance from the boundary of the premises to the main switch is less than 30ft., the charge will not exceed 1s. per 16-c.p. lamp supplied or its equivalent. The officers of the Corporation are not permitted to perform any private work for any consumer except under contract with the Corporation. The Corporation will furnish estimates free of charge for wiring consumers' premises. The supply will be by continuous current at a pressure of 200 volts. In special cases the supply will be given at 400 volts, subject to the approval of the Board of Trade. The price of current will be 5½d. per Board of Trade unit for ordinary lighting purposes, and 3d. per unit for motive power and other special purposes requiring a supply for exceptionally long periods.

Opposed Bills.—The Penistone Urban District Council have decided to oppose the National Telephone Company's Bill. The Southport Town Council have sealed petitions to Parliament against the Bills now being promoted by the Southport Tramways Company, Limited, the Southport and Lytham Tramroad Company, the Lancashire Electric Power Company, and the South Lancashire and Cheshire Electricity Company respectively. The Dumbarton Town Council have decided to petition Parliament against the Telephone Bills promoted by the National Telephone Company. The Mansfield Town Council have decided to oppose the General Power Distributing Company's Bill in Parliament. The Grimsby Corporation have decided to oppose the Great Grimsby Street Tramways Extensions Bill. The Ilkeston Town Council have resolved to oppose the General Power Distributing Company's Bill in conjunction with Nottingham and other towns which would be affected by the Bill. The Shrewsbury Town Council have decided to petition Parliament against all the Bills of the National Telephone Company. The Whitechapel District Board have decided to co-operate with other local bodies in opposing the National Telephone Company's Bill. The Richmond Town Council have decided to oppose the National Telephone Company's Bills. Mr. Stuart Wortley has given notice in the House of Commons of his intention to move the rejection of the General Power Distributing Company Bill. The Aberdeen Town Council have remitted to the Finance Committee to watch the National Telephone Company's three Bills and to take such action for the protection of the Council's interests in conjunction with the other burghs affected as they may think expedient. The Coventry Town Council will oppose the Leicestershire and Warwickshire Electrical Supply Company. The Heywood Town Council have decided to petition against several Bills coming before Parliament, including those of the Lancashire Electric Power Company and the South Lancashire and Cheshire Electricity Company. The Dunstable Town Council will petition against the National Telephone Company's Bills. The Accrington Town Council have decided to oppose the Lancashire Electric Power Company's Bill. The Morley Town Council will oppose the National Telephone Company's Bill. The Wirral District Council will oppose the Lancashire Electric Power and South Lancashire and Cheshire Electricity Companies' Bills. The Fairfield Urban District Council will oppose the National Telephone Company's Bill.

PROVISIONAL PATENTS, 1899.

FEBRUARY 6.

2610. Improvements in the manufacture of insulating material for electric cables. George Edward Heyl-Dia, 55, Market-street, Manchester. (Complete specification.)

2627. Electrical central alarm. Johann Wilhelm Hermann Wendt and Karl Ludwig Krausse, 77, Colemore-row, Birmingham. (Complete specification.)

2629. Improvements in the electrolysis or modification of gases and gaseous mixtures or compounds. Reginald John Yarnold, 321, High Holborn, London.

2654. Improvements in electric switches. Edward Lionel Joseph, 115, Cannon street, London. (Complete specification.)

2656. Improvements in electrolysis and in apparatus therefor. William Phillips Thompson, 6, Lord-street, Liverpool. (Dubosc and Bertin).

2657. Improvements in the manufacture of aluminium calcium carbide and other substances by the electric furnace and in apparatus therefor. William Phillips Thompson, 6, Lord street, Liverpool.

2660. Improvements in electrical influence machines. Charles Selim Lemström, 6, Lord-street, Liverpool.

2665. Automatic electrical apparatus for indicating leaks in ships. Wladimir W. Zworikin and Serge de Blumenthal, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

FEBRUARY 7.

2726. Improvements in electrical measuring instruments. John William Flower and Thomas Edward Gambrell, 17, Giltspur-street, London. (Complete specification.)

2741. Improvements in secondary battery plates, grids, and the like. James Sidney Granville Kay, 6, Crookham-road, Hurlingham, London.

2742. Improvements relating to electric floats for theatrical purposes. Edward Wingfield Bowles, 6, Bream's-buildings, Chancery-lane, London.

2745. Improvements in conduits for electric wires or cables. Edward Hill Callaway, 45, Southampton buildings, Chancery-lane, London. (Complete specification.)

2748. Improvements in primary electric batteries. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (La Société d'Etude des Piles Electriques, France.)

2778. Improvements in jointing or connecting electric conductors. Arthur Ellis, 6, Lord-street, Liverpool.

2780. A new or improved electric cut-out. John William Manley, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

FEBRUARY 8.

2794. Improvements in electric traction. William Bullen Day, 2, Rostrevor-terrace, Rathgar, Dublin.

2811. Overhead electric trolley automatic cut-out. Edward Edwards, 9, West-view, Clare-street, South Shore, Blackpool.

2815. Automatic machine for regulating the speed of steam-engines and for controlling the voltage and amperes of electric circuits. Richard Wilby, 17, Bath-street, Park Mount, Batley, Yorkshire.

2825. Signals to indicate the approaching exhaustion of the carbons in electric arc lamps. Ernest Alexander Claremont and Frederick Henry Royce, Cooke-street, Hulme, Manchester. (Complete specification.)

2845. Improvements in secondary batteries and in means for combining electric lamps therewith. Walter Ambrose Crowdus, 45, Southampton-buildings, Chancery-lane, London.

2849. Improvements in electromagnetic apparatus for separating ores. Emil Kraiser, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

2852. An improvement in holders for electric safety fuses. Philip Frederick William Simon and Herbert Henry Berry, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

2872. Improvements in telegraphy. Jacques Jasinski, 46, Lincoln's-inn-fields, London.

FEBRUARY 9.

2906. Improvements relating to switchboards. Charles Horace Cox, 10, St. George's-crescent, Liverpool.

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2916. Improvements in electric switches. Vittorio Giovanni Lironi, Oliver Moon, and John Aloysius O'Loughlin, Luna Electric Works, Harpurhey, Manchester.

2929. Improvements in or relating to insulating blocks connected with holders for incandescent electric lamps. Sidney Herbert Smith, 39, Temple-row, Birmingham.

2932. Improvements in or connected with electric batteries. Alexander David Seton and John Laskey Dobell, 57, Chancery-lane, London.

2934. Improvements in or relating to induction coils. Manes Ephraim Fuld, 31, Southampton-buildings, Chancery-lane, London. (Complete specification.)

2956. An improvement in apparatus for controlling electric motors. Siemens Bros. and Co., Limited, and John Gordon Wilson, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

FEBRUARY 10.

2971. Improvements in arc lamps. Henry John Bagley, 171, Queen Victoria-street, London. (Complete specification.)

2994. Improvements in and relating to electric arc lamps. Philipp Rzepka, 70, Market-street, Manchester. (Complete specification.)

3005. Improvements in and connected with electrical switches. William Henry Lane, Perugia, Sydney-road, Staines.

3007. Improvements in apparatus for the detection of electrical leakage in surroundings in buildings or in the open air. Eva Savary d'Odiardi and William James Bishop, 88, George-street, East Croydon.

3020. Improvements in electrical connections for railway trains. Daniel Cunningham, 171, Queen Victoria-street, London.

3023. Improvements in combined automatic magnetic circuit-breakers and resistance-controlling switch. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Henry Benjamin Cutter, United States.)

3032. Improvements in printing telegraph machines. The Telescriptor Syndicate, Limited, and Alfred Lyster Shepard, 55, Chancery-lane, London.

3047. Improvements in continuous-current dynamo-electric machines. Arthur Osborne Berry, 23, Fitzwilliam-road, Clapham, London.

3051. Electric illuminating apparatus. Sigmund Bauer, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

FEBRUARY 11.

3087. An improved electric fitting for ships' lanterns. Wm. Martin Haddow and John S. Hutchison, 126, Bothwell-street, Glasgow.

3090. Improvements in electrical tap switch-holders. Thomas Marshall, 72, North-street, Shrewsbury.

3130. Improvements in electric lamps. Alfred Charles Brown, 129, Algernon-road, Lewisham, London.

SPECIFICATIONS PUBLISHED.

1898.

1301. Electric signalling apparatus. Herzog.

1535. Incandescence electric lamps and processes for the production thereof. von Welsbach.

1912. Telephones. Andrews.

3198. Manufacture of carbons for electrical purposes. Saunders.

4624. Electrolytic manufacture of alkaline bichromates. Heibling.

4635. Apparatus for travelling through pipes or conduits, more especially intended for use in threading through electric conductors. Edmunds and Howard.

6147. Electrolytical treatment of ores and slimes for the recovery of precious metals therefrom and apparatus therefor. Riecken.

6350. Manufacture of carbons for electric arc lamps. Waddington.

6535. Propelling barges and boats on canals and other waterways by electricity. Kenway and Hughes.

14599. Anodes employed in connection with the electro-deposition of metals. Greenfield.

19855. Manufacture of electrodes for electric accumulators. Lake. (La Société Roger et Rathier.)

21755. Electric meters. Mills. (White.)

22449. Combined brake-pipe and electrical coupling for railway trains. Wild.

23545. Process for obtaining an electrolytic deposit of metallic films on aluminium. Nauhardt.

24196. Electrically heating plates, dishes, and the like. Kahrs.

24795. Method of making insulating conduit tubes. Bollé. (Brandt.)

26026. Galvanic batteries. Heys. (Silberberg.)

26067. Holder for electric glow lamps. Gover and Proctor.

26068. Electrical glow lamp fittings. Siemens Bros. and Co., Limited. (Siemens und Halske Atkien Gesellschaft.)

26116. Galvanic batteries. Heys. (Silberberg.)

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1899.	Corresponding week 1898.	Increase or decrease.	Total receipts for half-year. 1899.	1898.
		£	£	£	£	£
Birmingham Tramway	Feb. 11	3 689	3,519	+ 170	22,280	21,077
Blackpool and Fleetwood Tramroad	,, 11	143	—	—	881	—
Bradford City Trame	,, 5	145	—	—	6,733‡	—
Bristol Tramways and Carriage Co.	,, 10	2,356	2,296	+ 60	—	—
City and South London Railway	,, 12	1,119	1,058	+ 61	7,807	7,514
Dover Tramways	,, 11	141	105	+ 36	853	643
Dublin U.T., elec. cars	,, 10	860	663†	+ 197	4,697	4,206†
Dublin S.D. Electric Tramways	,, 10	596	363	+ 233	3,501	2,429
Halifax Corporation Tramways	,, 8	272	—	—	3,462*	—
Liverpool Overhead Railway	,, 12	1,223	1,380	- 157	9,047	9,510
South Staffordshire Tramways	,, 10	553	580	- 27	3,449	3,537

* Since June 29, 1898. † Including horse cars. ‡ Since July, 1898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	21½-22½
Bournemouth and Poole Electric Supply, Limited, Ord.	10	12½-13½
—— 4½ per cent. Cum. Pref.	10	10½-11½ xd
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	17-18
—— 6 p. c. Cm. Pf., 30,001-40,000 (all paid)	10	13½-13¾ xd
—— 5 per cent. Perpetual Debenture Stock	100	121-123
Brush Electrical Engineering, Limited, Ordinary	2	1¾-2¼
—— Non. Cum., 6 per cent. Pref.	2	2¼-2¾
—— 4½ per cent. Debenture Stock	100	111-115
—— 4½ per cent. 2nd Debenture Stock	100	101-104
Callender's Cable Company, Debentures	100	113-116
—— Ordinary	5	12½-13¼
Central London Railway, Ordinary	10	9¾-10½
——	8	7¾ 8¼
—— Pref. Half-Shares	8	8¼-4
—— " "	5	4-4½
Charing Cross and Strand	5	11-12
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	9-10
—— 4½ per cent. Debentures	100	114-116
City of London, Ordinary	10	19-20
—— " 90,001-100,000	10	18-20
—— 6 per cent. Cumulative Pref.	10	15½-16½
—— 5 per cent. Debenture Stock	100	124-129
City and South London Railway, Consolidated Ordinary	100	73-74 xd
—— Ordinary	8	4¾-5¼
—— 4 per cent. Debenture Stock	100	133-135
—— 5 per cent. Pref. Shares	10	14½-15½ xd
—— " " '96	10	14-15
County of London and Brush Prov. Elec. Light Co., Ord.	10	12-13
—— " No. 30,001-40,000	10	12-13
—— 6 per cent. Cum. Pref.	10	14½-15½
Crompton and Co.	8	2¾ 3¼
—— 5 per cent. Debentures	—	98-101
Crystal Palace District, Ordinary 5 per cent. Stock	100	130 135
—— Preference 5 per cent. Stock	100	142-147
Edison and Swan United Ordinary	8	2¾-3¼
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	97-99
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5½-6¼
Electric Construction, Limited	2	2¾-3¼
—— 7 per cent. Cumulative Pref.	2	3-3½
—— 4 per cent. Perp. 1st Mort. Deb.	100	103-105
W. T. Henley's Telegraph Works, Ordinary	10	25-26
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	111-116
House-to-House Company, Ordinary	5	9-10
—— 7 per cent. Preference	5	9½-10½
Imperial Tramways, Limited	6	22½-23½
Inuia Rubber, Gutta Percha, and Telegraph Works	10	23-24
—— 4 per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	13-14
London Electric Supply, Ordinary	3	3¾-4
—— 6 per cent. Pref.	5	6¾-7
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	104-106
Metropolitan Electric Supply, Limited, Ord., No. 1-62,500	10	17½-18¾
—— " " No. 62,501-85,000	4	14-15
—— 4½ per cent. First Mortgage Debenture Stock	100	118-121
National Telephone, Ordinary	5	5¾-6¼
—— 6 per cent. Cum. First Pref.	10	14-16
—— 6 per cent. Cum. Second Pref.	10	14-16
—— 5 per cent. Non. Cum. Third Pref.	5	5¾-5¾
—— 3½ per cent. Deb. Stock, Red.	100	100-102
Notting Hill Electric Lighting Company, Limited	10	17½-18½
Oriental, Limited, 1879	1	1½-1¾
—— £5 Shares	5	7¼-7½
—— £4½ Shares, New	4½	6¾-6¾
Oriental Telephone and Electric Company	1	1-1¼
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6¾-7¼
Royal Electrical Company of Montreal	½	160-165
—— 4½ per cent. First Shares Mortgage Debentures	100	107-109
South London Electric Supply, Ordinary	3	3¼-3½
St. James's and Pall Mall, Limited, Ordinary	9	16-17
—— 7 per cent. Pref.	5	9-10 xd
Telegraph Construction and Maintenance	12	38-43
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	100	109-112 xd
Westminster Electric Supply, Ordinary	5	15-16

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NOTES.

Telephone Engineering.—We understand that the Council of the Institution of Electrical Engineers has appointed a committee to enquire into the future of electrical engineering in the domain of telephony in the United Kingdom.

The Electric Light at the Vatican.—The installation of electric light in the Vatican was inaugurated last Sunday, and consists of an installation of about 6,000 lamps. According to a Reuter's telegram, the Pope remarked that "people will no longer be able henceforth to reproach the Vatican with being the enemy of light."

Photographing Lightning.—At the last meeting of the Royal Photographic Society, Mr. H. Glew showed some interesting negatives and prints of lightning flashes. His results go to prove that the duration of lightning flashes has been miscalculated, and that really a series of sparks or electric discharges pass down a given path, and not a broad stream of light.

Alcohol and Electric Shocks.—Our contemporary the *Gas World* announces the stupendous fact that "there is a growing belief that alcoholic individuals are particularly susceptible to electric shocks." We wonder whether our contemporary considers that there is anything different in this from the propensity of alcoholic individuals to use the support they find nearest to them?

Electric Clocks.—We understand from an Irish paper that the North Counties Railway Company have just erected a magnificent two-dial electric clock on the tower of their York-road terminus at Belfast. This clock is worked entirely by electricity, by an arrangement which admits of synchronised clocks being driven at any part from the station. The value of this at a large railway terminus can be hardly overestimated.

Simple Wire Signalling.—The short article in our last issue under this head should have been credited to Mr. J. Colquhoun. The article is a continuation of a short letter which appeared in our correspondence column recently. At the time we questioned the statement that Hertzian waves were produced by Mr. Colquhoun's system, and even now we see nothing in his article to prove this, or to prove that signals can be transmitted in the way he says.

Vienna Tramways.—The Corporation have now received the necessary Government permission to commence the preparatory works for an extensive network of light railways, to be worked by electricity, in and around Vienna. The system of the Vienna Tramways Company, the transformation of which we noted some time ago, is included in this scheme, which consists of the construction of 69 new sections and the reconstruction of 30 old ones.

Calcium Carbide.—We are glad to see that the Board of Trade regulations as to the storing of calcium carbide in bulk are being rigidly enforced in most towns. In Walsall, for instance, a cycle company, which had been convicted for the storing of this commodity in bulk, has appealed to the Home Secretary against the conviction, but the action of the Corporation has been upheld. General Booth, of Salvation Army fame, has also been fined for the infringement of these regulations.

Society of Arts.—We regret to hear that, in consequence of the indisposition of Mr. Philip Dawson, the paper which was to have been read by that gentleman at the Society of Arts on Wednesday last on "Electric Traction and its Application to Railway Work" has had to be postponed. We trust that Mr. Dawson will soon recover, and that the paper may create as lively a discussion as those which have followed his communications to the Institution of Mechanical Engineers and elsewhere.

The Finsbury Conversazione.—At the recent conversazione in connection with the Technical College at Finsbury, the Robertson Lamp Company gave a complete and interesting display of the whole process of manufacturing an incandescent lamp. The exhibition commenced with the squirting of the cellulose, and the range of operations to the sealing and exhausting the bulbs were shown. The students of the college were much interested, and no doubt the young ladies employed by the company, and who are so adept at the operations, received every attention.

The Government Telephone Bill.—In the House of Commons on Monday last, Mr. Provand, of Glasgow, tried to ascertain what the Government proposed to do on the telephone question. The answer given by Mr. Hanbury is sufficiently broad as to give practically no information. It was to the effect that the Government intend to introduce a Bill based on the recommendations of the Select Committee. From this it is impossible to glean whether the first recommendation, of an active opposition by the Post Office, is to receive the support of the Government, or whether licenses will be granted to local authorities.

A Seehear.—Mr. W. Rollins, in his Röntgen-ray notes in the *Electrical Review* of New York, describes, amongst other things, the seehear, which is an arrangement for seeing and hearing your heart beat. He says that a nervous patient whose organs were sound would be sometimes comforted by being shown by his own eyes that all was well. The apparatus is a combination of a fluorescent screen with the usual stethoscope; but from what we know of a nervous patient the test would be likely to stop his heart altogether. Without doubt the arrangement for making a patient see his own heart moving is ingenious, and this is about the best that can be said of the device.

Electric Power in Italy.—Baron F. de Renzis di Montanaro, the Italian Ambassador, presided at a dinner of the Italian Chamber of Commerce last Wednesday, and in a speech referred to the commercial importance of his country. Thus in matters maritime, not only did Italy make all her own ships, but she turned out work for others. His Excellency admitted that the industries of Italy lacked the powerful aid of ample coalfields, but he prophesied that electricity would come to her aid, and that possibly she must look for her mechanical reorganisation and emancipation to the utilisation of the million horse-power contained in the waterfalls that course down the slopes of the Apennines.

The Telegraphists' School of Science.—The Postmaster-General (the Duke of Norfolk) presented the prizes gained in connection with this school at the annual conversazione held at St. Martin's Town Hall on Monday last. Mr. A. Brooker, the chief instructor of the school, presided. It was announced during the evening that, in consequence of the building in which the school was held being required for other purposes, instruction would in future be given at the Northampton Institute. At the conclusion of the distribution of prizes a testimonial was presented to Mr. Slingo, the late instructor of the school, in recognition of the valuable services he had rendered to the students.

County Council Tramways.—We are glad to see that in one respect at least the London County Council is adopting the right course with reference to the management of its tramways. Thus, in the agenda of the meeting held last Tuesday, a proposal was made that Prof. A. B. W. Kennedy should be asked to give a full report to the

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Council on the question of electric traction. For this purpose Prof. Kennedy is asked to inspect all the recent developments in tramway work on the Continent, and a fee of 500 guineas, together with 100 guineas for expenses, is to cover the cost of his report. We trust that after receiving the report, no great interval will be allowed to elapse before its recommendations are put into effect.

The Volta Centenary.—The Zürich correspondent of the *Times* writes to the effect that the organisation of the memorial exhibition, to be opened at Como on May 14, and towards the cost of the buildings for which the town has voted a handsome sum of money, is proceeding rapidly. The exhibits will be almost entirely electrical. It will be remembered that Como was the birthplace of Volta, who also died there in 1827. The exhibition buildings will face Lake Como, on which a number of electric launches and boats will ply. It may be also recalled that Volta's electric pile was first described in England in a letter to Sir J. Banks, then president of the Royal Society. This letter is dated March 1, 1800, and was read before the society on June 26 the same year.

The Battersea Quarrel.—The Vestry of St. Mary, Battersea, has not given up the attempt to obtain redress from the County of London and Brush Provincial Electric Lighting Company for the arbitrary way in which they opened certain streets in the district without permission. The Finance and Law Committee of the Vestry now recommend a notice being served on the company, in accordance with the provisions of Section 109 of the Metropolis Management Act, 1855, requiring them within 24 hours to remove the offending mains and to reinstate the footways. This, of course, the company will refuse to do, and we presume that more money will be expended in law costs. We are afraid, from the recent decision given against the Vestry, that this will be incurred to no purpose.

Electric Tramways in America.—The *Street Railway Journal* has, in its February number, a useful table of tramway statistics for the United States and Canada for the year ending Dec. 31, 1898. Thus we see that at that date there were 15,672 miles of electric lines in use, an increase of almost 2,000 miles on the previous year. The number of motorcars had increased during the same time from 29,659 to 36,429. It is interesting to note under the columns of "cable tramways," also included in the tables, that there is a decrease in the mileage from 539 in 1897 to 460 miles in 1898. The horse tramways show even a larger percentage decrease. At the end of 1898 the total amount in capital stock and funded debts of the various tramway undertakings in the States had reached the enormous total of £406,000,000.

The Baker-street and Waterloo Railway.—At a special general meeting of the company held last week the chairman explained the scope of their Bill, which is now before Parliament. He pointed out that thier line would be the only railway which connected Waterloo and the tramway systems south of the Thames with Charing Cross, Piccadilly-circus, Oxford-circus, Baker-street, and the Great Central terminus. Although these connections would enable them to change passengers with eight different railway systems, they proposed to extend by obtaining parliamentary consent to lines to Paddington and Euston. In this way the great railway termini of London would be linked together. When the Bill was passed they proposed to change the name of the company to the Waterloo, Paddington, and Euston Railway Company.

Royal Colonial Institute.—The annual meeting of this institute was held on the 16th inst., when a report showing its flourishing condition was read. It was announced that the dinner would take place on April 9, and that the Earl of Aberdeen would preside. The Chairman, in moving the adoption of the report, referred to the all-British Pacific cable, and said that although such a cable would be probably constructed in time, at present he thought the proposal to lay a second cable *vid* Gibraltar to the Cape and Diego Garcia was more likely to find favour. A subsequent speaker proposed a resolution expressing the sympathy of the institute with the Right Hon. Cecil Rhodes in his great Imperial work, and also stating that they thought Mr. Rhodes should receive every encouragement from the Government in carrying out both the telegraph and railway communication through Africa.

Gas v. Electricity.—The editor of the *Gas World* has been seriously upset by Mr. Swinburne's paper on the Nernst lamp. He had carefully determined the fact that gas at 7s. 6d. per 1,000 cubic feet is equivalent to electricity at 1½d. per Board of Trade unit. Now that Mr. Swinburne has spoken, the inefficiency of the ordinary incandescent lamp makes the editor raise the price of gas to 8s. 6d. The Nernst lamp, however, upsets the calculation, and the unwelcome news is borne in upon the editor that gas must be sold as low as 3s. 9d. or 4s. to compete with electricity at 1½d. The only remaining solution is stated as follows: "Even then, energy at 1½d. has yet to be found as a commercial commodity, if we may apply the term to a phenomenon so little understood." Why the editor of our contemporary should write so much on a subject which he can neither understand nor write grammatically upon is incomprehensible.

Another Niagara Gorge Scheme.—A prominent Philadelphian engineer, Mr. John Birkinbine, has prepared a scheme for utilising some of the power now running to waste in the Niagara Gorge. On this gentleman's estimate, the expenditure of some £500,000 will render 35,000 e.h.p. available. The scheme consists in under-cutting one side of the gorge and making a canal, through which a certain proportion of water can be carried. In this way, with a canal 5,300ft. long and 100ft. wide, a total fall of 45ft. will be available at the power-house. This will be situated at the outlet to the well-known whirlpool. The financiers who are at the back of the engineer have entered into arrangements with the railway company using that side of the gorge, by which any alterations in tracks will be met by the power company free of cost. When this power has been developed, only 5 per cent. of the water will be diverted from its present channels.

Telegraph Rates in Australia.—We regret to note that the proposal to reduce the inter-colonial telegraph rates in Australia is likely to fall to the ground, because the South Australian colonies will not agree to it. It seems that Mr. Duffy, the Postmaster-General of Victoria, was the moving spirit in the proposal, which was to the effect that the rates between Adelaide and Melbourne should be reduced to 1s. 6d. for the first 10 words, and that a charge should be made of 1½d. for every additional word. The other postmasters concerned considered that the change would mean a loss of over £2,000 per annum to each colony. It is always difficult in these matters to correctly estimate what the effect of reduction in price will be, but we are sure the colonies would gain by cheapening telegraphic communication, even should the annual deficit spoken of be actually incurred. In our opinion an increase of messages would soon wipe out any such deficiency.

New Electric Condenser.—Mr. C. S. Bradley, of Avon, New York, has lately invented a somewhat new type of electric condenser, consisting of two conducting separate wires wound in alternate layers upon a bobbin. One of the wires is wrapped with thread having a com-

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paratively low specific inductive capacity, the several convolutions of which are separated from one another so as to leave open spaces between them. The other wire is bare. From the illustrations we have seen of this condenser it does not appear to us to be constructed in a way which will use the materials to the best advantage. Thus, while the distance between the two wires is small where they touch, the distance in other places is very much greater. For this reason the volumes of the materials used to provide a given capacity in the condenser is much greater than if flat sheets were used. It seems to us that in this case no great improvement over present practice has been made.

Underground Wires at Washington.—We referred a few months back to the disgraceful state of the electric lighting distribution systems in Washington, U.S.A. At the time we had before us a report from one of the electric lighting companies of that city, speaking highly of a system of distribution for arc lighting in which overhead wires at 6,000 volts were used. We now see, from the columns of the *Electrical Review* of New York, that a Bill has been introduced before Congress providing for the discontinuance of all electric light wires within the fire limits within one year, the penalty to be a fine of 50dol. per day. We gather from our contemporary that the object of the Bill is really to discontinue all overhead electric light wires, and one of the electric companies is objecting to this on the ground that if underground conduits are provided all companies will have equal facilities. Surely there is nothing in this objection to stop the passing of the Bill.

Polyphase Machinery.—A special course of instruction on the design of polyphase machinery is to be given next month at the City and Guilds Technical College, Leonard-street, Finsbury, commencing on the 6th prox. Six evenings will be devoted to the course, and instruction in the form of lectures and personal help will be provided. Three hours each evening are to be devoted to the students, and the class is to be kept strictly limited in numbers. Mr. A. C. Eborall, who was formerly with Messrs. Brown, Boveri, and Co., of Baden, will take charge of the course, and be assisted by Mr. W. B. Woodhouse, who is the instructor in mechanical drawing at Finsbury. Mr. Eborall will explain the principle and methods of working out the design of generators, transformers, and induction motors for use on single-phase and polyphase circuits. The fee for the course will be three guineas, which is the highest fee we have heard of for any special courses at Finsbury. We are sure, however, that in view of the limited numbers, those who do attend will receive quite their money's worth.

Aluminium as a Conductor.—The present high price of copper, which now stands at considerably more than 50 per cent. above its value this time last year, is giving a chance for other metals to encroach on its domain as a conduit for electric currents. Of these other conductors, aluminium has at present the most hopeful prospect. Thus, while it is practically three and a half times lighter than copper, the pure metal has a specific conductivity of about 63 per cent. of that of copper. On this basis the American manufacturers of aluminium estimate that for electrical conductors of equal conductivity aluminium at 1s. 2½d. per pound is cheaper than copper at 7d. As far as we know, however, aluminium at present has only been used for overhead conductors. An insulated strand of aluminium will have to compare favourably with the ordinary copper insulated cables, and in this respect more insulation will be required for the aluminium. Still, if the present high price of copper keeps up, and aluminium decreases in cost, as it should do, there will be keen rivalry between the two metals for use as electric conductors.

English Electric Tramways.—After the craze for American machinery for electric traction in England, it is refreshing to find that other countries are beginning at last to look upon the English electric tramways as worthy of inspection. In this respect we are assured that, although American machinery and cars have been used on a great many of our English lines, the careful engineering of the lines makes these well worthy of being considered standards of design. As an indication of what is thought of the Leeds tramway in Copenhagen, we notice from the *Birmingham Daily Post* that the municipal authorities of the Danish capital have sent a somewhat novel request to the Corporation of Leeds. It is to dispatch at once to Copenhagen one of its electric cars just in the state in which it is being run. The Corporation of Leeds, however, think the sample is rather too big for prompt dispatch, and, from what we ourselves know, the whole of the electric cars at Leeds happen to be wanted for the present service. The reply which was telegraphed to the enquiry was as follows: "Could not possibly send you car to look at."

A Telephone Message Counter.—We notice a paragraph in the columns of our contemporary, *L'Electricien*, to the effect that Mr. R. Van Kerckhove has designed an arrangement for recording the number of telephone messages passed through trunk lines from Brussels, and also for counting the same, and ensuring that just charges are enforced. Unfortunately, in the columns of our contemporary only the outside of the apparatus is described. We are told that the instrument can be manufactured at a very moderate price, and that it partly solves the perpetual motion problem. On the outside there is a dial with the figures 1 to 5. The needle, when the conversation commences, stands at No. 5, and gradually moves back, indicating how many minutes the speaker still has at his command without extra charge. After 4½ minutes' conversation a stroke on a bell warns the user of the telephone that the time is almost up. Any further conversation after the five minutes has to be paid for, for which purpose the apparatus is reset. There is also provided a device by which, during the busiest portions of a day, a change can be made from the five minutes' to a three minutes' conversation. We trust that the inventor will place some of his instruments on show on this side of the Channel.

The Institution.—Prior to Mr. Miles Walker proceeding with his paper on "Electric Traction by Surface Contacts" at the Institution of Electrical Engineers last week, Prof. Silvanus P. Thompson, who presided, made one or two interesting announcements. One of these was that the Council had that evening reappointed its former committee, with instructions to carry into practical effect the resolution passed on the 9th inst. pressing on supply companies, municipal engineers, and fire offices the desirability of adopting such rules as will secure uniformity in regard to wiring. A second matter of interest was that after many months and almost years of consideration, the Council had adopted a seal and form of diploma for the Institution. The diplomas are to be obtained free of charge by all members and associate members who apply for them. They will be printed on a kind of Japanese vellum paper, but the Council have also decided to provide a number of diplomas on vellum of a more expensive kind, and for each of these a charge of one guinea will be made. Any profit resulting from such purchases is to go to the building fund. We think it might be applied with better advantage to the benevolent fund. The printing of the diplomas, however, will

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take time, and nothing will be done as far as their distribution is concerned until the President, whose health, we are pleased to state, has very much improved, shall have returned from abroad.

Steam-Engine Economy.—Prof. W. F. Durand contributes to this month's number of the *American Electrician* another interesting *résumé* on the question of the possible improvement in the economy of the steam-engine. He shows how important the question of cylinder condensation is when considering the economy of the steam-engine, and how the splitting up of the expansion into a series of changes tends to keep down cylinder condensation. He also considers the other methods of preventing the same, such as superheating and jacketing. Prof. Durand's conclusion of the whole matter is summed up as follows: The one thing needed above all others is to reduce cylinder condensation. The transfer of heat to the condenser by means of the walls with dry or superheated steam is comparatively small in amount. The great loss in the steam-engine cycle comes from the exaggeration of this effect due to the presence of moist steam in the cylinder and a layer of condensed water on the inner surfaces. To this end the use of highly superheated steam is the most effective, but is attended with serious mechanical difficulties. These may in time be overcome. At present they prevent the general use of this means. More moderately superheated steam may be successfully used with good effect, especially in the successive cylinders of a multiple-expansion engine. In such case it may be satisfactorily provided by means of reheaters between the cylinders, or more especially just before the low-pressure cylinder, where it is the most needed. The most promising combination at present seems to be the multiple-expansion engine, probably not beyond triple, with its naturally decreased loss by condensation, combined with suitable means for moderately superheating the steam between the various cylinders, or particularly before entering the low-pressure cylinder, where the most serious loss is likely to occur.

Underground Pumping Notes.—The following abstract of an illustrated article by Mr. Lasche in the *Elektrotechnisher Anzeiger* is taken from Mr. Carl Hering's digest in the *Electrical World*. The article is a description of an 800-h.p. pumping plant, the large motor and pump for which are located 1,500ft. underground. The generator is a three-phase machine of the inductor type, generating 2,000 volts, connected by the triangle system, delivering, with a motor load, 650 kw. The frequency is 25. In spite of the high voltage the armature windings consist of bars insulated with artificial mica. In order to make repairs in these bars the stationary part is so mounted that its supports may be removed, so that it rests on the revolving part, and by turning this through a half revolution the lower part, which is ordinarily in a pit, can be brought uppermost. (It does not seem clear why the apparently simpler method of making the pit accessible was not used.) The exciter of the dynamo is driven by a separate machine, because it is required by the method of starting used, in which the dynamo must be fully excited at the start. The installation in the underground pumping chamber is extremely simple, as it contains neither switches nor measuring instruments; the use of short-circuited armatures also enables the apparatus at the generating station to be very simple. The motor has an output of 750 kw., and runs at a speed of 180 revolutions, the armature being also wound with bars, it being of the short-circuited type. Owing to the slow speed required by the pumps, the power is transmitted from the motor by means of ropes. The builders have, however, made a change in the design of several similar underground stations, in which the motor is made the flywheel of the pumps, operating the latter through cranks. Such a combined motor and pump is illustrated for a speed of 200 and a power of 120 h.p. The method of starting the motor of the above-mentioned plant is not described, but presumably the dynamo and motor are electrically connected while at rest, the motor therefore starting with the dynamo, the latter being fully excited at the start.

Calorimetry.—Mr. Charles V. Kerr has a communication in the December number of the *Journal* of Western Society of Engineers of America, on "Berthier's Method of Coal Calorimetry." He explains that the method was due to a French mineralogist, Pierre Berthier, and that it was published by him in 1833. It consists of mixing, say, one part by weight of the coal to be tested with at least 20 parts, but not more than 40, of litharge. Charcoal, coke, or coal may be readily pulverised, but in the case of wood, the sawdust produced by a fine saw or rasp must be employed. The mixture is put into a close-grained, conical clay crucible, and covered with 20 or 30 times its weight of pure litharge. The crucible, which should not be more than half full, is covered, and then heated gradually until the litharge is melted and evolution of gas has ceased. At first the mixture softens, and froths. When the fusion is complete, the crucible should be heated more strongly for about 10 minutes, so that the reduced lead may thoroughly subside and collect into one button at the bottom. Care must be taken to prevent the reduction of any of the litharge by the gases of the furnace. The crucible, while hot, should be taken out of the fire and left to cool; when cold it is broken, and the button of lead detached, cleaned, and weighed. The accuracy of the result should be tested by repetition. The author in his paper gives a number of useful points to be observed in carrying out this method, and also a series of results that he obtained. In each case he tried some three or four experiments with the same kind of coal, and the results did not appear to vary much more than 1 per cent. from the average value obtained in the series for each specimen of coal. He adds that he had intended comparing the results with those obtained by the oxygen calorimeter, but that he found the forms of instrument available gave such wide and varying results that the comparison was not satisfactory. He concludes by giving a few figures as to the cost of calorimeter tests by the Berthier method, and finds that five determinations of a fuel can be made at a total cost for materials of about 1s. 4d., provided that a suitable furnace is available.

Central-Station Design.—The paper read by Mr. B. J. Arnold before the North-Western Electrical Association at Milwaukee last month was on the trend of central-station design. In it Mr. Arnold reviews the general progress of central-station design, and the methods which have been found to be most suitable in practice. Arguing on Darwin's law of the survival of the fittest, which is equally applicable in engineering as in natural history, the author considers that by observing the design of recent stations an idea of the most economic procedure can be obtained. As an example of this he instances the disappearance of belts and pulleys, as far as new stations are concerned. The other points of accepted practice for electric central-station work emphasised by the author are the following: the use of water-tube boilers capable of carrying high steam pressures; the use of mechanical stokers; the use of steel chimneys. It must be remembered that in this respect the author is referring to American designs, and that he favours the steel chimney on the ground of much less cost. On the question of single steam-pipes, we do not think the American practice is reflected in England. The author says that although some years back it was the

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practice to duplicate all steam-pipes, he does not now believe in such practice. He also states that very few engineers in America are putting in duplicate steam-pipes in their new works. In favour of the cheaper single range of pipes, the author also instances the smaller losses from radiation thereby obtained. The use of large compound condensing engines is another point brought forward. In these, both economy in first cost and running can be obtained by using the large engines, which he agrees should be directly coupled to the dynamos. The two points remaining in the paper to which we should have liked to refer at further length are the use of mechanical draught and of cooling devices for condensing water. In the first instance Mr. Arnold passes judgment in favour of induced draught over forced draught. With respect to cooling towers, he claims a saving of at least 15 per cent. by the use of these, and also that the water being used over again, only a small amount is required from the water supply to make up that lost in evaporation. Mr. Arnold's paper is much more replete than these few notes can possibly indicate, and is worthy of careful reading.

Niagara-Buffalo Transmission Line.—We have noticed in a recent number of the *Electrical World* of New York an excellent description of the transmission and distribution system equipped by the Niagara Falls Power Company for sending power to Buffalo. The pressure at which the power is transmitted is at present 11,000 volts, though this will be raised to 22,000 volts as the load increases in Buffalo. All parts of the overhead lines are designed to withstand this high pressure. The wires between Buffalo and Niagara consist at present of six bare stranded cables of 350,000 circular mils each, placed on a six-pin cross-arm, making two three-phase circuits, one on either side of the poles. These are transposed at five points by carrying the inside wire over to the outside on extra cross-arms on two poles. The transposition poles are the same for both circuits. As soon as the wires get to the outskirts of Buffalo the power is taken by the local company, which distributes, transforms, and delivers it to the various consumers in the town. At present the incoming line is still carried overhead for three miles within the town boundaries to a site by the Erie Canal. A certain portion of this line will be soon equipped with underground wires. From this cable terminus underground wires are used for redistribution, which are divided into two general classes—first, those which will be used with the full high-tension current at 11,000 or 22,000 volts; and secondly lower-tension wires used for 2,200 volts. Of the first class, there are at present some 80,000ft. laid of triple-concentric cable running in duplicate to three transformer stations. From these transformer stations about 23,000ft. of triple-concentric 220-volt cable have been laid. All these cables are drawn into stoneware ducts. We are surprised to see, however, that the insulation used is indiarubber for the extra high tension, while paper insulation is used for the 2,200-volt cables. The arrangements at the sub-stations with the various transformers, regulating boosters, are fully described and illustrated in our contemporary's issue for June 21. We notice that the transformers which in some stations are as large as 850 kw. are oil-insulated. The oil which fills in the transformer cases is kept cool by means of water circulating through three coil pipes within the transformer case. The transformers of the above-mentioned capacity weigh about 19,000lb. when completely filled with oil. The switchboard arrangement seems well designed, and we notice that the extra high-tension switches have exceptionally large brakes. Sheets of insulation between the various switches prevent arcs being made between one switch and the next.

Municipal Trading.—In the House of Commons on Tuesday last, on the order for the second reading of the Bootle Corporation Bill, Sir J. Lubbock made an excellent speech, which was reported as follows in the *Times*: "Sir J. Lubbock said he was very reluctant to object to the second reading of any Bill promoted by a municipality, especially when it was what was known as an omnibus Bill, but he did so in this instance at the request of a large number of chambers of commerce throughout the country, who were alarmed at the tendency of municipalities to engage more and more deeply in commercial undertakings. They firmly believed that sooner or later their transactions would result in loss to the ratepayers. The Attorney-General, as the result of his great experience, told them at the Society of Arts a few nights ago that 'whatever might be said as to the profit made out of undertakings such as gas or tramways worked by corporations, his belief was that the burden on the ordinary ratepayer was less where no such risks were undertaken." But he did not object to these provisions mainly because he believed the corporations would lose money. There were four other and even stronger reasons. In the first place, they inevitably checked private enterprise. In the second, if they once allowed municipalities to trade in order to make money, where were they to stop? The time which ought to be devoted to the real business of municipalities would be frittered away on trading and manufacturing details. In the third, they would raise very difficult labour questions. Town councillors would have to regulate the wages of their electors. Just think of the tendency to set the wages against the votes. They were putting our municipal governors into a difficult if not an impossible position. Was this an imaginary danger? Look at New York. The defenders of Tammany denied that there was actual corruption. But they supported candidates who would support them; who would multiply posts and appoint their nominees. Must not this have a tendency to deter honest men from coming forward as candidates? Last, but not least, if our municipalities were to become gigantic trading monopolies they necessarily endangered purity in our municipal life. They were now at the parting of the ways. They began by allowing municipalities to purchase tramways, but not to work them. Then they took the next downward step, and allowed one or two to do so under certain circumstances. But that was within the municipal boundaries; now they were asked to do away with all limits. They were told that they must allow this privilege to Bootle, because it had been conceded in the case of Manchester. They had unfortunately allowed Manchester to invest in a canal. Was that to be a precedent? It was because he believed municipalities would lose money; because they would be diverted from their true and most important functions; because they would be dragged into labour struggles in which it was most important that they should not become involved; finally, because it would be dangerous to the honour, dignity, and character of municipal life, that he asked the House to withhold this dangerous privilege. He understood, however, that the Chairman of Committees proposed to cut out of these Bills the clause giving manufacturing powers, and that he approved the suggestion of the Chamber of Commerce that a committee should be appointed to consider the whole question of municipal trading. Under these circumstances he would not oppose the second reading, reserving, of course, the right to move an instruction or instructions as regarded particular clauses."

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THE PRACTICAL TESTING OF ELECTRICITY METERS FOR CENTRAL STATIONS.

BY C. A. L. PRUSMANN, A.M.I.E.E., ASSISTANT ELECTRICAL ENGINEER, BRADFORD.

(*Continued from page 167.*)

Connections and Terminals (continued).—Assuming, now, we have our cells charged, we will trace out the two circuits for testing ampere-hour and watt-hour meters. In the first place, it must be clearly understood that in nearly all cases there are two distinct tests required, each necessitating quite a different arrangement, and the object of each being also of a totally different nature. On nearly all meters, the tests carried out relating to the "accuracy" of the meter are made by means of what is known as a "short-time test." This is done by counting the number of revolutions made by the spindle of the meter in a given time, and the percentage of error is worked out. On this circuit, of course, it is of the utmost importance that only the most accurate instruments and the most suitable adjusting resistances, etc., are brought into requisition. We will therefore consider somewhat more in detail what is required on this circuit. The battery is connected to two multiple switches, as shown in figure. This illustration shows the switches connected to the cells used on the town supply; but, of course, it will be understood that in the case of separate cells being employed the same connections hold good. These multiple switches must be capable of carrying current up to from 100 to 200 amperes if necessary, but the main circuit is not supposed to be opened by either of these multiple switches. As shown in the diagram, another suitable switch is interposed for breaking the circuit when required. A useful type of multiple switch is such as is often applied on charge and discharge circuits, on small batteries of accumulators installed for private house installations. The number of contacts on these switches will vary in different test-rooms; the more numerous the contacts the larger the number of voltages it is possible to obtain. From these switches two leads are carried to fuses, suitable for carrying fuses for some considerable magnitude of current, though it is not necessary that the "break" should be exceptionally long, as the voltage at which the fuses blow is never very high, and although the current may be large, the amount of energy broken is comparatively small. Fig. 12 shows the type of fuses used

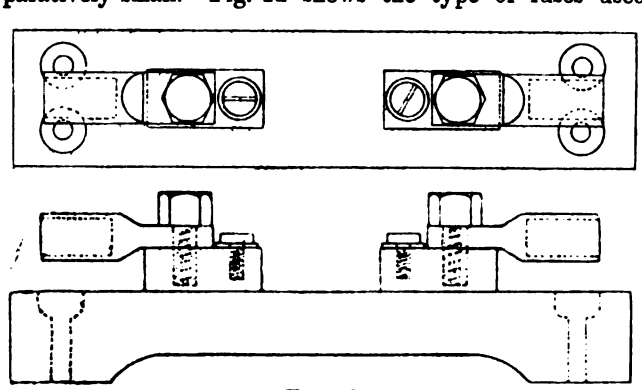

FIG. 12.

in Bradford. These fuses consist of two brass blocks, each carrying a large set screw for clamping the sweating socket holding the cable, and a smaller set screw and washer, under which the fuse itself is clamped. The brass blocks themselves are secured to the porcelain base by means of four screws screwed into the block from the underneath side of the porcelain, the heads of the screws being countersunk into the porcelain. To prevent the blocks from moving, a metal pin is let into them, which pin also passes into the porcelain base. The method of fastening these brass blocks is not shown in Fig. 12. The distance between the brass blocks is 1½in. The fuse itself is of the strip pattern, consisting of a thin strip of suitable fuse metal. It is advisable to have stamped on each fuse the current at which the fuse melts, or, if preferred, the safe carrying capacity of the fuse in amperes. The figure shows the fuse block in plan and elevation. These fuses are enclosed in suitable cases fitted with glass fronts. From these two fuses the leads are carried, one to the switch referred to above, for breaking the circuit, and thence to a suitable connecting bar, the other lead being carried direct to an ammeter, and thence to a connecting bar. We have now arrived at that point in our circuit to which are connected in series adjusting resistances, standard instruments, and meters to be tested. Before going on to consider this portion of the circuit, let us refer to Fig. 13, and see what results are able to be obtained in the way of different voltages at the connecting bars, C B and C B_1, by means of the multiple switches. Assuming 26 cells are connected to the multiple switches, of six contacts each, it will be seen that by so arranging the points of contact on the two switches a very large number of different voltages are obtainable at the connecting bars. By way of

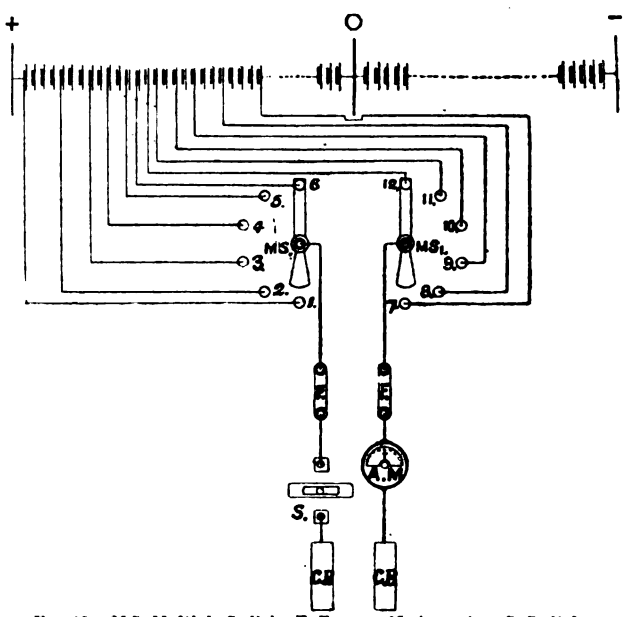

FIG. 13.—M S, Multiple Switch; F, Fuse; A M, Ammeter; S, Switch; C B, Connecting Bar.

illustration we will take these cases with the contacts of the multiple switches connected to the cells at points as given in the diagram. With the switches on the following points of contact, the voltages at C B and C B_1 are as follows:

Contacts.	Voltage.	Contacts.	Voltage.
6—12	4	3—9	24
6—11	6	4—8	26
5—11	8	6—7	28
6—10	10	5—7	30
5—10	12	4—7	34
6—9	14	2—8	36
4—10	16	3—7	38
6—8	20	2—7	44
5—8	22	1—7	52

It will further be noticed that voltages identical with some of the above can be obtained by having the switches on different contacts to those given. For instance, contacts 6 and 7 give 28 volts, contacts 1 and 12 also give 28 volts. It is, therefore, possible to obtain current from different portions of the battery, and thus by switching on to a different set to prevent certain cells becoming too much discharged. It is an excellent plan to have a card fixed near these multiple switches on which is tabulated the different contacts required for giving certain voltages, the contacts themselves also being numbered. By this means chances of error of switching in the wrong number of cells are greatly minimised. Of course, where the town cells are utilised, it becomes impossible to connect the cells in parallel, but if a separate battery is employed the connections might easily be arranged to enable this to be done. This necessity would only arise if large currents are required at a low voltage, and in the case of the separate battery having a low ampere rate of discharge or where damage would result to the cells under this discharge. It is obvious in the case of the town battery that the cells would always

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be of sufficient size to enable all discharges required for the purposes of meter testing to be taken from them, and, therefore, no occasion really arises for anything but the arrangement similar to that shown in the diagram. Whenever a test is carried out the voltage of the circuit should be no more than is required to force the necessary current through the meters under test, the measuring instruments, the connections, etc., with a sufficiency to allow for any necessary adjustment to be carried out on the resistances. This state of affairs is the cheapest as regards energy required, the safest as regards possible damage to meters, instruments, etc., and all round the most satisfactory.

INSTITUTION OF ELECTRICAL ENGINEERS.

Electric Traction by Surface Contacts.

BY MILES WALKER, ASSOCIATE.

We cannot put forward any surface-contact system as a practical substitute for the overhead wire in electric traction unless we can answer in the affirmative the following three questions: (1) Is it possible to lay surface contacts in a roadway so that they do not cause any obstruction to traffic? (2) Is the method of picking up current from studs by means of a skate feasible under practical working conditions? (3) Can the studs be made perfectly safe? If affirmative answers to these three questions can be established, the future of surface contacts for town traction is a great one. If the answer to any question is unsatisfactory, there may be grave objections to this system of conveying electrical power to a moving car.

Nothing but a long trial can give us conclusive answers, but an Institution like that of the Electrical Engineers can form a very fair judgment upon the probabilities of a scheme on being supplied with experimental data, and it can, moreover, give a diversity of criticism and suggestion which will be of the highest value to a scheme in its infancy. It is to obtain that judgment and to profit by that criticism and variety of suggestion that I have brought forward the details and experimental data of a surface-contact system, upon which Mr. C. E. Holland and I have been at work under the direction of Prof. Silvanus Thompson.

To arrive at an answer to the question as to the obstruction in the roadway we must find by what amount the studs ought to project, and also what amount of inequality is ordinarily found and is admissible in a roadway.

During the last few months I have been making observations of roadways in city streets and along tramway tracks, and I have been surprised to find how great the depth of inequalities in pavement really are when we come to measure them. Hollows ½in. or even ¾in. deep are hardly noticeable if of 2ft. or 3ft. in extent. Hollows 1in. in depth, and with gently sloping sides extending 4ft. or 5ft. from the centre, are of very common occurrence in roads which a casual observer would call good. The track between tramrails is generally to be found much more uniform as to levels than the other parts of the road, but even here sudden changes of ½in. or ¾in. in the level of the crowning are so common that we never notice them. It is difficult for the eye to detect slight changes of slope in a groundwork of rough granite setts.

In order to give an idea of the sort of inequalities which commonly occur unnoticed in roadways, I have made a drawing (Fig. 1) to scale of the section of a fair average piece of well-worn roadway in the Holloway-road. The section is taken parallel to the rails and midway between them. The straight line gives the level of the rail. The upper line gives the inequality of the paving-stone surface. The average hollow that one meets with is about ½in. deep. In places the stones have sunk until they are nearly level with the rails, while the original crowning between rails seems to have been about 1⅛in. Of course, it looks very much worse in section than it does in the street. For comparison with this piece of paving I have given a section (Fig. 2), drawn to the same scale, of our experimental line at Willesden Junction. This, of course, represents a piece of track just newly laid and without the inequalities which are sure to come with time and traffic, but one can see at a glance that if we impress the inequalities of Fig. 1 upon those of Fig. 2, we do not get anything which is substantially worse than either. In order to show the sort of hollows that one meets with in roads which are in bad condition, I have given a section (Fig. 3) of a hollow in a rather bad piece of roadway. I do not know that the thoroughfare from which this was taken (and which contains many hundreds of similar hollows) bears at all a bad name. People seem to put up with them very quietly. Figs. 4 and 5 show sections of roadway at right angles to the rails, one with a surface contact and the other without.

Now, the projection of the stud shown in Fig. 2, innocent though it may seem in comparison with ordinary paving-stone inequalities, is amply sufficient to give the required clearance to the skate. Its top is on the average 1⅛in. above the level of the rail, and the clearance between the

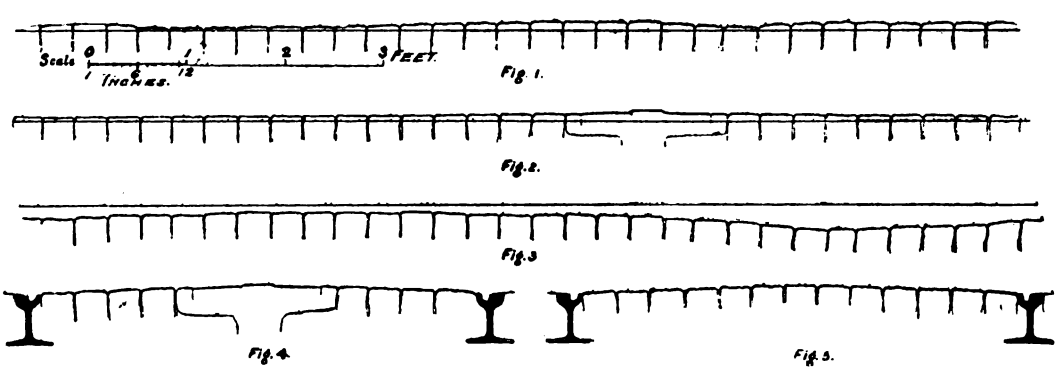

Fig. 1.

Fig. 2.

Fig. 3

Fig. 4.

Fig. 5.

skate and the crowning of the pavement between two studs is ¾in. This is sufficient to clear all but very deep mud. The effects of mud and water are considered at length below. If a paving stone happened to project some way above the others it would do no harm until it projected above the level of the stud, and a rare occurrence of that kind could be very easily dealt with.

This brings us to our second question as to the feasibility of picking up current from studs. It should be noticed in the first place that a row of studs is a very much better thing than a sectional rail. A stud is much easier to insulate than a rail. The leakage from a rail in wet weather would be 20 times as great as from a stud. A rail is much more difficult to renew, and though it gives greater facility upon sharp curves, its advantage in this respect loses weight as soon as we show that the studs can operate on the sharpest curves met with in practice.

When studs are used it is, of course, necessary to carry below the car a long metal skate which will maintain its contact with one stud while it passes on to the next. And the question naturally arises, Can a skate be made to run smoothly over a row of studs? That is a question upon which we had considerable doubt until we tried it. The answer (so far as an answer can be obtained from an experimental line) is that it can be made to run at the highest speed smoothly—in fact, almost noiselessly. We have tried the effect of various obstacles on the line. Anything big, like a brick or a tin canister, is simply knocked out of the way without even causing a spark. Stones standing about an inch high generally suffer the same fate. Sometimes, however, if a stone is wedged carefully into a hollow in the road the skate will glide over it and be prevented from

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touching the stud. The effect of this is that the car is deprived of power from that stud, but running on by its impetus contact is again established with the main. This is an accident of no moment, and would, in fact, very seldom occur in a paved street. A shovelful of gravel thrown upon and round the stud has the effect of causing considerable sparking, but does no great harm. Gravel upon the track will cause sparking in any electric traction system in which the rails are used for a return.

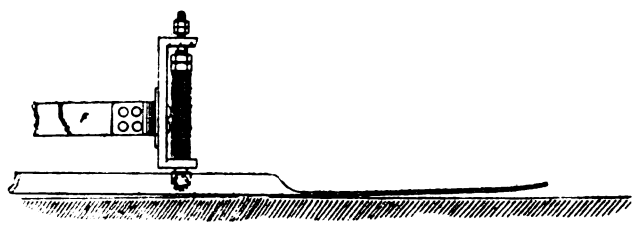

FIG. 6.

One method of supporting the skate (in the case of a four-wheeled car) is shown in Fig. 6. A frame (part of which is shown in the figure and marked F) is supported on bearings running on the axles of the car. To this is bolted a pair of stout brackets of the shape seen in the figure. A vertical pin, 1¼in. in diameter, with a thickened base pivoted to the skate, slides freely in each bracket, and carries two pairs of lock nuts. The lower pair press upon a spring, and can be adjusted to take any required fraction of the weight of the skate, while the upper pair act as a back-stop and prevent the skate from falling below a certain fixed limit. In practice the back-stop should be adjusted so that it allows the skate to fall as low as the lowest stud on the line (say about 1in. above the level of the rail), while the spring is adjusted so that when running on an average

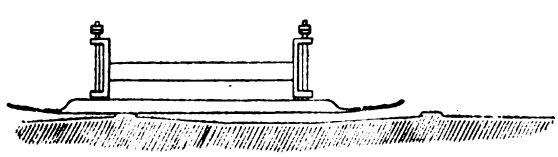

FIG. 7.—Vertical Scale Exaggerated, Showing How Skate Rests on Stud.

stud the pressure is about 10lb. The spring, being a long one and much compressed, changes its forces very little with a lift of ¼in. or ½in. The little friction that occurs on the pin is just sufficient to deaden any tendency to dance when running at a high speed. The skate is composed of a U-shaped steel girder 4⅛in. by 2½in., and is 18ft. long.

The side webs of this girder are cut off for a length of 3ft. at each end of the skate, so as to give the point a certain amount of springiness. The springy portions are then bent up at a very gentle slope (about 1 in 100), and the tips are still further curved upwards. By supporting the skate on springs at two points about 4ft. from its ends a very useful pitching motion is given to it as it slides over the studs. This is shown in Figs. 7 and 8, in which the vertical scale is exaggerated so as to make a small drawing sufficiently clear.

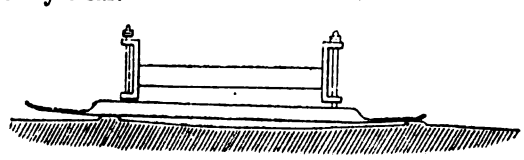

FIG. 8.—Vertical Scale Exaggerated, Showing the Dipping Action of Skate.

The greater part of the weight of the skate being borne by the springs, so long as a stud is under the central part, the ends are kept well above the ground. But as the stud gets nearer and nearer the hind end, more and more weight is thrown upon the front end, until just before the skate reaches the next stud, the front end is down upon its back-stop, as seen in Fig. 8. This stop is about 4ft. from the tip, and the slight tilt of the skate throws the tip a little lower than it otherwise would do and at the same time presents the striking surface at an exceedingly small angle (about 0° 30′) to the horizontal. Thus the contact with the studs can be made almost silently even at the highest speeds. The tip of the skate, which is ordinarily well above the ground, dips down to accommodate itself to a worn stud just at the point where it is required. Having once touched the stud and excited the magnet under it, the attraction of the magnet helps to stop any jumping. The ends of the skate being very springy accommodate themselves very well to studs differing considerably in height. In practice it will be possible, by setting the boxes directly upon ties between the rails, to ensure that the studs do not in the ordinary course vary by more than ¼in.

The method by which one stud is made alive before the car leaves the stud behind will be considered in the next section, but while considering the skate it is important to note what amount of overlap must be allowed to it. In designing an experimental line we wanted to be on the safe side, so we allowed a 3½ft. overlap, knowing that the switches took about one-tenth of a second to close. Thus the skate was made 18ft. long with 14½ft. between the studs. This overlap is more than sufficient. We have run at a measured speed of 16 miles an hour without experiencing trouble from the non-closing of switches, and could probably go quicker but for the inconveniences of our short track. Now, as the Board of Trade regulations limit the speed at which cars in towns may run far below this, we might have a much shorter overlap or a longer distance between the studs. The Board of Trade regulation for Dublin runs as follows: "The speed at which the carriages shall be driven or propelled along the tramway shall not exceed the rate of eight miles an hour, and the speed at which the carriages shall pass through facing points, whether fixed or movable, shall not exceed the rate of four miles per hour."

Further, in the regulations relating to the motor carriage it is provided: "It shall be fitted with a governor which cannot be tampered with by the driver, and which shall operate so as to cut off all electric current from the motors whenever the speed exceeds 10 miles an hour."

While it is possible to go at the speed of 15 to 20 miles an hour with a moderate overlap, we can by shortening the overlap positively prevent the car from going at a speed greater than a certain fixed limit. We find that we can increase the length of skate to 22ft. for a 25ft. car and have 18ft. 6in. between the studs. Lines on which bogie cars are employed would allow of still greater length of skate and as much as 30ft. between the studs. In wet weather a certain amount of leakage occurs from the stud which is for the time supplying current to the car, and it is important to enquire how much this leakage is. It is easily ascertained by actual measurement with street mud and water placed around the stud and skate. The following data were obtained by experiment. The pressure on the line was 500 volts.

PARTICULARS OF LEAKAGE FROM STUDS.

Condition of Road.	Current leaking, in amperes.
Track covered with very wet mud and water ½in. to ¾in. deep so as to make the very worst street condition. The skate resting on two studs at 500 volts above earth. The mud between the studs touching the skate at intervals along its length. Total leakage from the two studs	3·9
The same after standing five minutes	4·5
After one stroke of a brush so as to reduce the depth of mud and water to ½in.	2·3
One stud with short skate resting on it. Wet mud about ½in. deep	1 2
The same with mud deeper. Very bad road conditions	2·5
The same with thin mud and water as it would be on an ordinary wet day	0·4
The same dry	Practically none.

It must be remembered that the sloping asphalte round the studs tends to become cleaned in very wet weather. After a very heavy shower, the bulk of the mud having been removed, the leakage will be very little indeed. It is probable that the average leakage in wet weather will be about half an ampere per car; while under exceptionally bad road conditions it may approach five amperes. By carrying a brush in front of some of the cars to sweep away the deepest mud, it can be kept at about one ampere even under the worst conditions. Taking only five fine days to one wet one, the average leakage will be under a quarter of an ampere per car, or about 2 per cent. of the total power of the station. It is difficult to say what effect this will have upon the coal bill, but it is certain it cannot increase

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it by 2 per cent. Of course, on a dry year like the one we have just had, the average leakage would be almost negligible.

Ease in going round curves and over crossings is a matter of great importance in any system of electric traction in towns. When a long skate is used on a simple four-wheeled car it is necessary to put the studs nearer together on a sharp curve, because the ends of the skate do not keep to the centre of the track. On a 34ft. radius curve it is desirable to have studs every 8ft. This, of course, adds to the cost of construction, but as the greater part of a tramway company's rails are straight or nearly straight it is not a serious matter. The length of the skate is really limited by the radius of the sharpest curve on the line. If a line has many 34ft. radius curves, a suitable length for the skate is about 18ft. for a four-wheeled car.

It is a great advantage in a surface-contact system to have only one row of studs in the centre of the track. It is also an advantage to have each stud self-dependent—that is to say, capable of being exerted without interconnections from other studs. In systems having two rows of studs it must be very difficult to keep the right skate on the right stud when going round a curve, unless the skates are quite short and the studs very near together in each row. At crossings the difficulties would become greater. We have found that by employing a single row of studs in the centre of the track (where full advantage can be taken of the crowning of the paving stones) there is no difficulty in going round sharp curves and over crossings.

In electric traction systems it is not usual to provide a means of bringing the car off the rails and taking it round an obstruction on the line. If it is thought desirable to do this, it can be done very easily on a surface-contact system by carrying with the cars properly protected flexibles which can in an emergency be attached to the studs and to the rail.

We now come to the most important question—the question of public safety. The automatic switches must be designed so that they can only be closed when a car is over the stud, and the provision for guarding against the accident of a stud being left alive in the street must be absolutely without a flaw if the surface-contact system is to be permitted for a moment in England.

It is exceedingly difficult to form an estimate of the safety of any particular device. Things that we are accustomed to use every day without injury to ourselves we come to regard as harmless, often not so much because they have no element of danger in them, as because in common experience accident does not happen. Who, seeing for the first time a railway train steaming at 60 miles an hour, would care to trust himself on board it? The more he might know of the laws of motion, the attraction of gravitation, and the strength of materials, the less would he be inclined to listen to arguments to prove that it could not come off the rails. The reason that we dare go railway journeys is not because we are satisfied with the proof; it is because in common experience trains do not run off the rails. Upon the introduction of anything to which we are unaccustomed, anything that contains a conceivable element of danger, we are at once afraid, and it is exceedingly difficult for anyone to satisfy us that it is perfectly safe. It is so with surface contacts. The more we know about mechanism, the less we feel inclined to trust in the safety of a device which is proved to be safe by unanswerable arguments. There is only one way of bringing conviction to the mind of the timid, and that is to simplify the issue upon which safety depends until it becomes identical with something with which we are perfectly familiar and in which we have perfect confidence. It is in this way that we have tried to bring home the safety of surface contacts.

Take something that we are sure about. Can a magnet attract the air? It cannot. If we are sufficiently sure of that, it will do for a principle upon which to base a safety switch. But we want something more than a principle, we want a moving part to make a switch. Then let us take one of the simplest and surest of all moving things, a heavy cylinder sliding in a very loose vertical tube. Is it possible for it to remain suspended in the tube when the only force upon it is gravity? If it is impossible, then that cylinder will do for our moving part. The problem now is to make a switch whose safety depends, and depends only, upon a magnet not attracting air, and a cylinder which will not stick. If we can do so without introducing other issues of a more complicated character and with which we are less familiar, then we have a switch upon which we can rely. If we take an iron plunger with expanded ends, like that numbered 2 in Fig. 9, and surround it by a solenoid of wire carrying a current, it is possible to choose the size of the heads so that the tendency of the plunger to assume a central position is balanced by the attraction of the solenoid on the iron heads. With properly chosen heads the solenoid exerts no force whatever on the plunger. Gravity being the only force upon it, it will, of course, take up the position No. 2. If, now, a piece of iron is placed over it, as shown in No. 3, the plunger may be raised by the attraction between the two. In case a very heavy plunger is used it is possible to support part of its weight by merely increasing the size of the lower head by a small amount. Thus we have a simple piece of mechanism whose movement is entirely dependent upon the presence of a mass of iron in its neighbourhood, and which cannot be moved by the solenoid itself, even though the magnetising current carries the iron up to the saturation limit. This has been converted into the operating part of the switch, in the manner described below. Now, though the force of attraction is sufficient to lift a fairly heavy plunger and operate a switch, it is desirable to have something more than this. We want a switch which will, notwithstanding its massive moving parts, close in an exceedingly short space of time. We want a very great acceleration upon the moving parts during the first

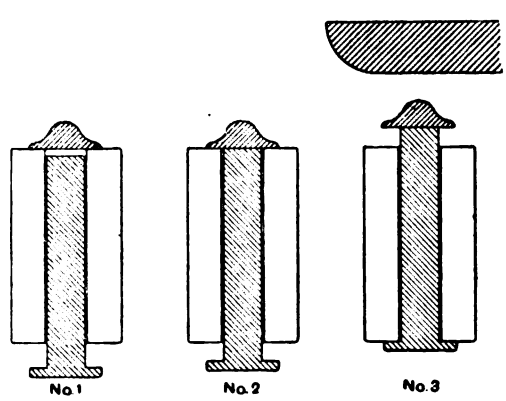

FIG. 9.

part of their motion. This is easily obtained by merely separating the upper head from the plunger by a short air-gap, as shown in position No. 1 of Fig. 9, and arranging matters so that the mass of iron comes over the switch before current is put through the magnetising coil. As soon as current passes, the attraction upon the head is so great that the plunger gets up a high velocity before the two come together, with the result that the switch operates as though it had been hit with a hammer. A very simple device, a mere film of oil acting as a cushion, can be employed to prevent the switch from being injured by the concussion. The connection of this operating part to the contact points of the switch has been the subject of some very varied experiments. If we are to preserve our original simple issue, we must not hamper this plunger with any gear at all. The safety of street passengers must be made dependent upon nothing else than the falling of the plunger when the mass of iron is removed. The attachment of any gear at once introduces the risk of friction whose amount may be a variable quantity. Fig. 10 shows the construction of one of our safety switches. The switch is in the closed position. The plunger, P, is the same in design as that shown in Fig. 9. It is surrounded by a very loose tube, which is enlarged at its lower end, T, so as to enclose the expanded end of the plunger, which is free to slide in the tube, the clearance being as great as we like. The tube, T, can itself slide in an outer tube, and is attached by insulating brushes to the yoke-piece, Y, which, when the switch is closed, makes electrical connection between two brushes, C and C_2.

As the whole switch is immersed in oil a considerable suction exists between the plunger, P, and the tube, T, not-

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withstanding the large clearance, so that when the plunger falls it carries the yoke, Y, with it and opens the switch. Before describing the details of this switch it will be best to look at the general method of operating the switches in succession. Figs. 11 and 12 are diagrams of the electrical connections. Switch No. 1 of Fig. 11 is closed and current is flowing from the feeder main, F F, through the fuse, *f*, through the yoke piece from C_1 to C_2 and to the stud, S, thence by means of the skate, K, it passes to the motor and then to the frame of the car truck. In this particular method of making the connections the plunger is magnetised by means of a shunt coil connected between the stud and earth. The comparative advantages of shunt and series coils in switches of this kind was discussed in our British Association paper, and I need not go into that matter again. It is sufficient to describe here the method which we have found to be simplest and most satisfactory. It will be seen that in the diagram the yoke between C_1 and C_2 is drawn as a piece separate from the plunger, but it is to be understood that in the ordinary course they rise and fall together

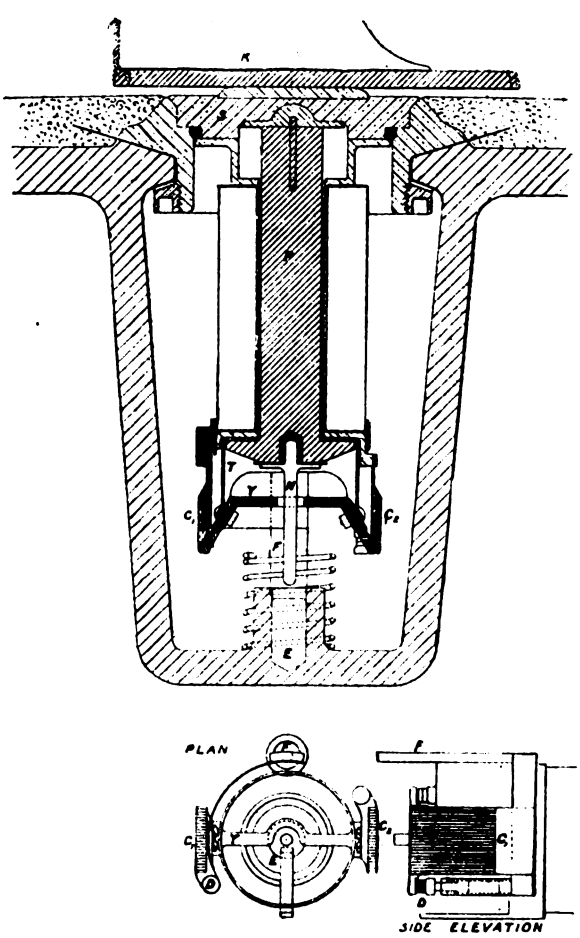

Fig. 10.

as mentioned above. Thus in No. 1, Fig. 11, the plunger is up and the yoke is up; in No. 2 they are both down. Fig. 12 shows the car in the act of passing from one stud to the next. As soon as the skate, K, touches the stud of No. 2, current passes from it round the shunt coil, magnetising the plunger, which rises and is held up by its attraction upon the iron skate, K. A moment later the skate, K, leaves switch No. 1, and as the plunger has no longer anything which it can attract, it falls and opens the switch. The forces required to open the switch are very small, and the 3lb. weight thrown upon the yoke piece upon the removal of the iron of the skate gives a very ample factor of safety. But the safety of street passengers does not depend upon the opening of the switch in this way. If for any reason whatever the yoke piece did stick up (a thing which it practically never will do), the plunger will slide down the tube, T, and make connection between the yoke piece and the earth in the manner shown in Fig. 13. This will connect the main to earth through the fuse, *f*. The fuse will of course be blown immediately, and the switch entirely cut off from the main.

The switch shown in Fig. 10 can now be described in greater detail. In the first place, it is contained in a round cast-iron box, the lid of which is of gunmetal, and forms the stud. The lid is fixed into a gunmetal ring, which is insulated from the cast-iron box by means of micanite. The whole is designed to bear a weight of 15 tons, and to take a heavy blow having a considerable horizontal component, such as would be received from a heavy wagon jogging on to it. The space round about the stud is filled in with asphalte up to the level of the road, but the micanite is designed to insulate the stud sufficiently by itself even if the asphalte were broken away and the space filled up with water. In still later designs we are insulating the studs by supporting them entirely upon a block of granite. The stud is faced with a plate of hard phosphor-bronze to take the wear, and this plate can be replaced when worn down.

One very important matter in connection with surface contacts is the water-tighting of the switch-boxes. Our method is to keep the opening of the switch-box as small as possible, and to provide a very solid lid screwed down hard against a rubber washer placed in a suitable recess. This

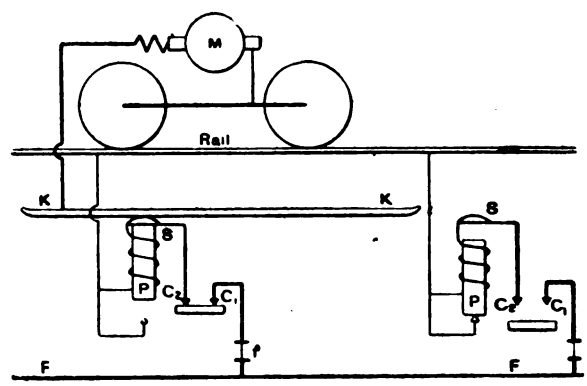

Fig. 11.

gives a very perfect joint. The lid of the switch-box is the stud itself. The switch is attached to the underside of the stud and comes away with it as a single piece. To renew a switch, all that is necessary is to take out the three screws which hold it down, withdraw it by a holder made for the purpose, and drop in a new switch and stud, and screw the whole down. The operation can be performed in less than

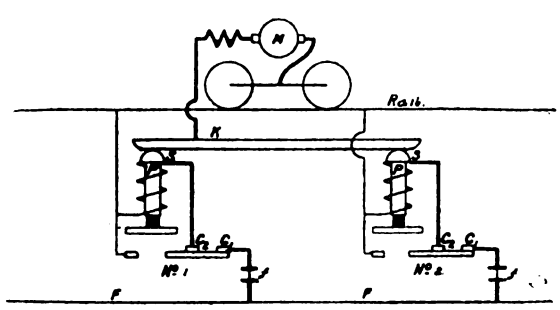

Fig. 12.

two minutes. On the form of the switch contacts we have experimented a good deal. We have found that a particular form of mercury contact is very satisfactory, but there is a prejudice against mercury contacts, and so I show here a brush contact which answers its purpose admirably. The precautions to be adopted to keep a metal contact in good condition permanently are as follows. In the first place provision must be made to absolutely prevent sparking upon the contact surface. Secondly, a certain amount of friction must be introduced between the surfaces to keep them bright. The surfaces should be arranged to touch on as many points as possible, and yet there should be a substantial bulk of metal in the vicinity of the touching surfaces. A material should be employed which has good elastic properties, and in the operation of opening and closing all strains upon it must be far below the elastic limit. The cross-section of the material must, of course, be amply sufficient to carry the required current, and all causes of warming must be eliminated. If these precautions are adopted, a switch contact can be made to operate thousands of millions of times without injury. The switch has, of course, never to break the main current going to

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the car. It cannot open until the skate has been removed. It has, however, to break the current leaking from the stud and also the current taken by the magnetising coil, which is nearly half an ampere. To take the spark caused by this current we provide a contact between two arc carbons, D (in parallel with the main contacts), which does not break until the main contact has opened ¼in. This ensures the small spark always occurring on the carbon points. The switch being immersed in oil, this small spark is not pulled out any perceptible distance, and by providing a 2½in. break the switch is enabled to break currents of 10 times the amount if it were necessary to do so.

The method of earthing the switch in the event of the yoke piece, Y, failing to open is seen at once from Fig. 10. The rod, N, is of copper, and has a collar on its upper end which will come in contact with the yoke piece, Y, whenever P moves down relatively to T. If Y and T should for any cause stick and keep the switch closed after the car has gone past, N in falling will connect the earthed mercury-cup, E, with the yoke, Y, and blow the cut-out. The mercury-cup, E, is merely a hole drilled in the cast-iron switch-box. The box is permanently earthed by being connected to the rails by a stout conductor. It is found that a mercury-cup of this kind remains unchanged for years, but, still, it is well to put a check upon its efficiency as a safeguard. This is done in the following way: It will be seen from the diagram of connections that one end of the shunt coil is connected to earth. The method of making the earth connection is to bring down a stiff conductor from the switch and make it dip into the upper portion of the mercury-cup, E. So long as that cup remains efficient as a connection to earth the switch will operate, but if for any reason (as for instance the box being cracked and the mercury spilt) the connection to earth is broken, then the shunt coil becomes inoperative and the switch cannot be closed at all. If, therefore, the switch will close at all, we are sure that the mercury-cup, E, is full. In this way the risk of accident is reduced to the one risk of the plunger sticking in its tube.

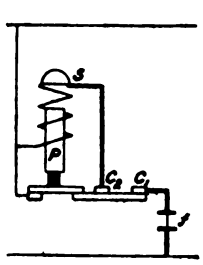

FIG. 13.

It is therefore necessary to consider somewhat carefully what risk there is in the plunger sticking up after the car has passed. It will be noted that there are absolutely no side forces upon the plunger to cause friction against the inside of the tube. The clearance is so great that even the introduction of grit does not have any effect. As a matter of fact, under the worst conditions the force due to friction is less than ¼oz. When the plunger and tube are polished and working in oil as in practice, we may safely take the force of friction as less than 0·01 of a pound. Now, we can make the downward force upon the plunger when the iron skate is removed almost what we please; how great we shall make it is merely a question of economy in copper. We consider that a factor of safety of 200 is more than sufficient. We have adjusted the sizes of the iron heads of the plunger so that the downward force after the removal of the skate is 2½lb. This, of course, becomes less as the plunger falls, but it still has a considerable value after the plunger has fallen ⅝in. and earths the switch. Thus we see that the chance of the plunger sticking is absolutely nil.

There is one other risk to guard against, and that is the breaking down of the insulation between the main and the stud. This is most effectually done by surrounding the switch by a sheath of metal which is permanently earthed and supporting all parts connected to the main on the earthed sheath, so that if their insulation breaks down there is an arc to earth and the fuse is blown.

Although the passage of the car from stud to stud is a continuous process, each switch being actuated by current derived from the last switch, it is necessary to have on the car some means of making a stud alive if by any means connection with the main should be lost. For this purpose we carry on the car a small accumulator battery capable of yielding a current sufficient to work a switch at a pressure of 500 volts. Its capacity need only be small, so it can be very solidly and cheaply constructed, and as it can be charged direct from the line it is always ready for use. In practice we find that it is very convenient in use. The ordinary car controller can be adapted with an additional contact on it, so that when the handle is swung round to a certain position the accumulator is connected to the skate. By this means the driver can in an instant pick up again if through any obstruction the skate loses contact with the main. It is a distinct advantage in a surface-contact system for the current which operates the switches to have a high pressure behind it because it is able to overcome little obstacles, such as mud and paper on the studs. For this reason switches requiring 500 volts pressure to operate them are preferable to switches operated by a low-voltage battery carried on the car.

Throughout the whole of our work on surface contacts we have, of course, been aware that they could never be as simple in operation as the overhead wire, and that where the overhead wire is permissible it is to be preferred on account of its cheapness, if for nothing else. We have merely directed our efforts to see how far surface contacts could be perfected. We believe that future experience will show that the studs can be laid so as to cause no obstruction to traffic; that the method of picking up current from studs in the road is much more feasible than it at first sight appears, and that the safety can be made as great as in any other system of electric traction.

One thing that augurs well for surface contacts is the ease with which they can be worked in conjunction with the trolley wire. It will be possible to run a car from one system to the other without any more delay than is required to hitch the trolley on to its line. Throughout the experimental work of the last two years we have had the assistance of Mr. C. E. Holland, and some of the most valuable suggestions have been due to him. Had it not been for his continual efforts, the experimental line at Willesden could not have been made such a great success.

DISCUSSION.

Prof. Silvanus P. Thompson, who presided, intimated that Mr. Walker's paper was open for discussion.

Prof. Carus-Wilson said he thought he should only be expressing the feeling of all present in congratulating the author and those who had been associated with him on the successful issue of the ingenious application of the principles that had been brought before them to the very important problem of surface contact. He hesitated to express any criticism on this interesting contrivance, because, as everyone was aware, it was at present in an experimental state. But he understood that the author submitted his paper with a view to getting an expression of opinion on the subject, so that it would be taken for granted that any criticisms would not be directed with any other feeling than that of goodwill and appreciation of the work which had been already done. At the same time, it seemed to him that the author had not made out as good a case as he might have done for some of the characteristics of his system. One of the most disagreeable features of surface contacts was that the leakage current was liable to close the circuit, and keep the contact rail or section alive. But anyone who had studied the system they were then considering would see that the leakage current could not make any one of these studs alive. The diagram on p. 14 of the paper made it quite apparent that the leakage current was unable to have any effect whatever in this direction, and he thought the author was to be congratulated on this as a valuable feature of his device. As to the question of safety, which, of course, was one of the most important considerations, it would be rash to say that it was possible to devise an electro-mechanical contrivance that would possess more elements of safety than that which had been brought before their notice. The demonstration of the author as to the practical impossibility of the plunger remaining up when the car had left the section or stud, seemed to him (Prof. Carus-Wilson) to be quite conclusive, and on this head Mr. Walker and those associated with him were to be congratulated on the remarkable success, so far as one could gather, of their efforts. But he thought there were other elements also besides safety which had to be borne in mind, some of which had been dealt with by the author. It was possible to sacrifice too much even to safety. Two points to which he wanted to allude particularly were those of accessibility and reliability. As to the former, he thought that any electro-mechanical contrivance should be easily accessible for purposes of inspection and repair, and without interference with the

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traffic. It was a rather serious element in this system that the studs had to be opened when the traffic was not passing, and the author stated that it took about two minutes to open and examine each one. If they reckoned up this time, they would find it took about twelve hours to examine all the studs in one mile of line. He thought this a point which was against the system. Then, as to reliability, it seemed to him that the only conditions in which the skate would not act would be when it was covered with ice. But in this country the point was not very important. As to the question of mercury contacts, he was sorry the author had given these up. The paper read at the British Association laid great stress upon mercury contacts, which he believed were good. As to the question of sparking, provision should be made to prevent absolutely sparking upon the contact surface. It seemed to him that the success of any system of surface contact depended upon the sparking at the surface contacts being got rid of completely. Prof. Carus-Wilson then proceeded to further explain this point by the aid of diagrams he drew on the blackboard. The problem was that a conductor passed over the studs, and a current had to be collected from each in turn without any spark in the switch. If they could not get rid of the sparking at these points, he agreed with the author in thinking there was a very serious defect. Mr. Walker had said that "the switch has, of course, never to break the main current going to the car." Now, he (Prof. Carus-Wilson) did not want to dispute that statement, but it did not seem at all obvious that the current would be broken at the stud before it was broken at the switch. Having added other observations, and explained more fully by means of diagram, the speaker concluded by remarking that he would not say that what he predicted actually did take place—he simply pointed out the possibility.

Mr. S. Sharp said that, of several contact systems which had come under his notice, the present one struck him as being by far the best, and he congratulated the author on the results he had laid before them. With regard to the last point touched upon by Prof. Carus-Wilson, he understood that the plunger at the back stud could not fall until the skate had quite broken contact with the stud, for until then the current was still actually passing through the shunt and holding up the plunger. Having seen what he had at Willesden some time ago and examined the working of the switches and the seeming ease with which they were removed and renewed, he had come to the conclusion that the system which Mr. Walker had introduced to their notice that night was one of the most easy and admirable methods of surface contact which had so far been made public. With this system all danger of the stud being kept alive was obviated, the break was hardly ever likely to fail, and there were no springs to get out of order. What he had seen of the experimental line appeared to be convincing, and he believed when the system came to be used for everyday work and everyday traffic it would be found to be well able to hold its own. He again congratulated Mr. Walker on what he (Mr. Sharp) thought some day must be a great success, and concluded by remarking that he held very strong sentiments against towns being disfigured by span wires, especially where these were multiplied to guide the trolley wires round corners.

Prof. Ayrton remarked that, as Mr. Walker had indicated, in addition to the well-known trolley and conduit system, there were two systems of electric traction to which reference was made—the subdivided conductor, and, lastly, what had been called the surface-contact system—studs, which were stationary, with which contact was made by a piece of metal, now called a skate, carried by a car. The subdivided conductor and the surface-contact system, although not called by that name, formed the subject of a well-known patent of 18 years ago. It did not attract much notice at the time, though it must be admitted that it started the idea, and after 18 years all that could be done at the present day was to make the methods which were disclosed in it successful, although that perhaps was saying a good deal. It was, therefore, a question of detail, and not of fundamental principle, which they had to consider. Having referred to Prof. Thompson's system when brought before the British Association last September, he remarked that the first thing which struck him was that it was not so perfect as he (Prof. Thompson) had hoped. What first impressed him (Prof. Ayrton) was that if dirt or paper or ice was lying on the top of this piece of metal, the skate failed to make contact, and the contact box became then absolutely dead. It was impossible for the car to move, and it was also impossible, of course, for any other car to pass the one that was devoid of current. Also, if in the generating station the main fuse blew, and the main circuit was interrupted even for an instant, in the same automatic way the whole line became dead, as it was absolutely impossible for any car to regain current even when the central station sent it out. To overcome that difficulty, they were told subsequently that there could be carried on each car a battery of 500 volts. This got over the difficulty, but it introduced, to his mind, a distinct disadvantage to the system, in that it was not one which was completely automatic. If from dirt or ice or paper the skate failed to make contact, the contact would have to be made alive by the car using its battery of accumulators. There were various defects in the mechanical part of the contact box described last autumn. That night they were shown a contact box which differed in many points from the one dealt with in the previous paper. For example, the way in which the contact-maker was moved was materially altered in the arrangement put before them now. But why should a system which was so perfect and so good a few months ago be to-day so entirely changed? The leakage, too, seemed a rather serious matter, and he proceeded to criticise the figures tabulated on p 8 of the paper. In conclusion, he said he would not like the London County Council or any other large body of men to adopt a system under the impression that every detail was guaranteed a success, when it was really only at the beginning of its experimental stage, and then for people to say that, after all, the old Ayrton and Perry contact system was a failure.

Mr. A. J. Lawson, having passed some criticisms on the paper, protested against the sentimental rubbish regarding overhead disfigurements of the streets of London referred to by Mr. Sharp.

Mr. Eustace Thomas remarked that the contact system was very pretty indeed, but the question was whether it could be worked out with any amount of practical success. He alluded to the long distances which separated the studs, but this was only a detail, and might be easily changed. He also referred to leakage, to the method of switching, the precautions to prevent watering, and to the plunger. On the last-named point, he said he could not help thinking that the yoke might stick to the lower portion of the coil in the same way as the plunger was supposed to stick to the yoke. In that case they would have trouble through fuses frequently going, and this, of course, would make it difficult to keep the line in comfortable operation. One difficulty was the fact that they would be working with a shunt coil, and it was necessary after every contact of the stud that the current in the coil should be broken. The insulation would require very great attention to prevent damage from this cause. The whole thing really came to this—that it was a very pretty principle, but one which had to be proved by practical use. As presented to the Institution, many objections were evident; it remained to be seen whether the difficulties of this particular contact system were insuperable.

Mr. Cozens-Hardy remarked that the author had shown considerable ingenuity in avoiding the usual trouble caused by leakage currents, but it seemed to him there were one or two conditions under which the magnet might hold up the plunger. With regard to the amount of leakage, this would depend to a very large extent on the behaviour of the horses. The vestries took care of the solid form, but they could not remove the liquid. The consequence was that the leakage was liable to go on for some considerable time. From a 2ft. rail in granite road he had measured a leakage current of over 20 amperes when horse urine was poured over the track. Having referred to the wearing of the studs, he said the insulation of rail at turn-outs was a matter for which no practical plan had been suggested.

Mr. G. C. Sillar thought the amount of leakage had been overestimated. It was in the practical application of the principle of the surface contact that success or otherwise could be determined.

Prof. R. H. Smith asked if it was not a fact that the studs in Paris were nearly 1in. above the ground. [It was pointed out that they stood only ½in. out.] Prof. Smith did not think that ordinary studs could last six months, and on that line he did not think there were any sharp curves.

Mr. E Tremlett Carter could testify to the rapidity with which the studs could be removed, because he was able to see the experimental line at Willesden, and on timing the removal of one of them he found it was a matter of a very few seconds. But if the stud happened to be under slush or water, the removal, after looking at the latest pattern of box, would admit of water finding its way in unless it was quite filled up with oil, and even then mud and so on would get in. Still, he thought this was the most beautiful form of contact system which had yet been devised, and having, as he had already said, seen it tried at Willesden, he thought it ought to have a fair test on a short system of public highway.

The **Chairman** took that opportunity of explaining very briefly that he was deeply interested in this particular matter, but had left to Mr. Walker the entire responsibility of preparing the paper, and also of replying. Referring to what he called all the "dreadful" things which were to happen to such a system, he said it had fallen to his lot to spend time and money in trying to find out whether such dreadful things really did occur, and those present had heard the result from Mr. Walker.

Mr. Walker then replied. He had, he said, a complete answer to all the objections, some of which were raised on account of a want of fuller knowledge of the system. Having disposed of Prof. Carus-Wilson's objection as to the time at which the switch would open, he, amid some laughter, thanked Prof. Ayrton for his criticism, for it was a question of which he (the professor) knew a great deal. Being first in the matter of surface contact, Prof. Ayrton was so much before his time This, however, was his misfortune. He (the professor) need not think that he was at all ungenerous in criticising the author and his colleagues, for they really all gained by his criticisms. The desirability of carrying a small accumulator for the purpose of picking up was certainly mentioned at the British Association meeting. The voltage of the accumulator was not mentioned, because it was not known how far the voltage could be reduced. A 500-volt accumulator would certainly be a drawback. Some recent types of switches would pick up at 100 volts, and there was not much objection to a 100-volt accumulator. A large battery was commonly carried for the purpose of lighting. Besides, there were well-known methods of transforming the voltage. A good many prejudices had to be removed. For instance, mercury contacts were things about which people had enormous prejudices; therefore, in order to show that the mercury contact was not at all an essential of the system, he showed a switch that had no mercury contacts, and yet was thoroughly reliable. He, for the moment, was prepared to leave a debatable question behind. Nevertheless, every switch at Willesden had mercury contacts, and he might also point out, with reference to change in design, that these early designs were still working on the best part of the line at Willesden. It was wrong to assert that the switch had failed in the experimental stage merely because variations had been introduced. It might just as well be said that the dynamo was not good because

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improvements had been made. The case cited of a 10-ampere leakage from a 2ft. rail was a corroboration of his figures. The leakage depended on perimeter, so that his tests pointed to an 8-ampere leak on the 2ft. rail or 10 amperes with the very bad conditions described. A 2 per cent. loss of power was an exceedingly small item, especially when it was compared with the loss of power arising from the carrying of accumulators on a car. With regard to the question of curves, it was not necessary to have a wide skate. By placing the studs nearer together on curves, all conditions were satisfied. A number of good points were raised by Mr. Thomas With reference to the distance dividing the studs, their object all along had been to get as wide a distance as possible, and they were quite satisfied that 15ft. was not excessive. It was hoped to increase this to about 25ft. With respect to the removal of mud from the way over which the car had to pass, this could be done by the car carrying in front of it a brush which could be temporarily depressed. The question as to whether it was better to have each switch in a separate box or group the switches in boxes was still open to discussion. Dealing with another point raised, he pointed out that it was impossible for water to get into the boxes. The method of water-tighting was exactly the same as the indiarubber ring in lemonade bottles, and the lid a solid casting of small diameter. The possibility of the yoke sticking was one which did not arise, because the formation of the brass cup into which the yoke fell was not at all the same as the way in which the iron plunger fitted. There was no great rise of voltage upon the breaking of the shunt circuit, because the mutual induction with the solid brass bobbin, upon which the shunt was wound, nearly wiped out the self-induction of the winding. As to the wearing of the studs, he did not know how long they would wear. If, however, they wore six months, he would be very well satisfied. With regard to mud getting into the boxes, this could be easily guarded against.

The usual votes of thanks brought the proceedings to a close, the **Chairman** in the meantime having announced that the next meeting would be held on March 2, when a paper would be read on "Wireless Telegraphy."

At the meeting of the Institution on Thursday, Feb. 16, the following were the candidates balloted for:

Associate Members.—A. H. V. Baughan, 8-10, London-street, Reading; E. W. Denton, Corporation Electric Supply Station, Huddersfield; A. E. Farrow, Electric Light Works, Windsor; S. J. Watson, 55, Heywood-street, Bury.

Associates.—E. K. Abbott, 98, Oakley-street, Chelsea; G. R. Blackburn, Cliffe Lodge, Baildon, Yorks; M. Bush, 11, Redcliffe-street, South Kensington, S.W.; E. Coates. Thornton's Woollen Mills, St. Petersburg; R. Humphries, Electric Power Station, Ballsbridge, Dublin.

Students.—K. W. Fiddian, 24, Florena road, Ealing, W.; C. W. Hacking, The Gables, Nightingale-lane, Clapham Common.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

143. Can street arc lamps, carried by trolley poles, be satisfactorily worked from the tramway distributors or from the trolley wire, using the rails as return? Give any examples you know of, and the number of lamps in series.—B.

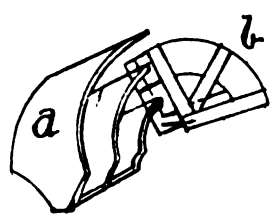
144. What difficulties might arise from drawing electric light cables into disused gas-mains?—J. A. S.

ANSWERS.

Question No. 138.—An electrostatic voltmeter takes no current when connected to a continuous-current system, but takes a current when connected to an alternating-current supply. Why is this?

Best Answer to No. 138 (*awarded* 10*s.*).—The simplest way to consider this is to look upon an electrostatic voltmeter as a condenser, the vanes of the voltmeter acting as the coatings and the air-space between the vanes as the dielectric, and the above effect as condenser effect; an explanation is then simple, capacity, like inductance, having no effect upon continuous current except at starting and stopping, but with an alternating current its effect is continuous. For instance, the sketch below is a diagram of the working part of a voltmeter of the Ayrton and Mather type. (*a*) is connected to the positive main of a continuous-current system; (*b*) to the negative. When the current is started (*a*) becomes positively charged, and acts inductively across the air-space on (*b*), creating a deficit or negative electrification there and repelling electricity to the negative main. This influenced charge reacts on (*a*), and so making room for more, the capacity of (*a*) being thus slightly increased. Upon the current being switched off, there is another momentary current from (*b*) to (*a*), but this is the only condenser effect continuous current has upon these voltmeters.

Now, with an alternating current things are different. During the first alternation—*i.e.*, while the E.M.F. is in one direction—it pumps electricity, so to speak, from (*b*) to (*a*); (*a*) is consequently +ly charged and (*b*) −ly charged.



Influence takes place across the air-space, causing a rush of electricity from (*a*) to (*b*) the same as in continuous currents, but owing to the capacity of a voltmeter being small, this momentary current is also small. During the second alternation—*i.e.*, when the reversal of the alternator E.M.F. occurs—electricity is pumped from (*a*) to (*b*), so that (*b*) becomes +ly charged and (*a*) −ly charged. Another momentary rush of electricity takes place across the air-space, and so on with each reversal of the alternator E.M.F. The larger the capacity of the voltmeter and the higher the E.M.F. the greater will be the current passed, but with ordinary voltages and voltmeters it is almost negligible.—P. T. K.

Answer to No. 138 (*awarded* 5*s.*).—It is due to the electrostatic capacity of the voltmeter. If we put in series with an electrostatic voltmeter a mirror galvanometer, and then connect it to the terminals of a dynamo, at the moment of connection there will be a deflection of the spot of light, and it will then settle down to zero again. If we disconnect from the dynamo, and put the galvanometer across the terminals of the voltmeter, there will be an equal throw in the reverse direction. It is well known that these throws are due to the capacity of the voltmeter, and are proportional to the capacity and the applied potential difference conjointly. When the voltmeter is connected to a source of alternating-current supply, then there will be instantaneous rushes of electricity back and forwards to it every time the potential difference changes sign, thus making an alternating current in the voltmeter leads. The magnitude of this current is given by the formula

$$C = 2\pi n K V \times 10^{-6},$$

where C is the current in amperes, n the frequency, K the capacity of the voltmeter in microfarads, and V the potential difference in volts.

In the *Proceedings* of the Royal Society, June 2, 1892, Lord Kelvin describes a method of measuring the capacity of an electrostatic voltmeter. A Kelvin multicellular voltmeter has a capacity of about one ten-thousandth of a microfarad. At 100 volts alternating it therefore takes a current of $2\pi 80 \times 10^{-4} \times 10^{-6}$ amperes if the frequency is 80. This works out to nearly one-twentieth of a microampere. Mr. A. Campbell, B.A., has measured the capacity of an Ayrton and Mather electrostatic voltmeter for various positions of the needle, and finds that it varies between 8×10^{-6} microfarads and 12×10^{-6} microfarads.—J. C. R.

Question No. 139.—Describe fully some form of independent jet condenser, giving details as to the steam it will condense and the quantity of condensing water required.

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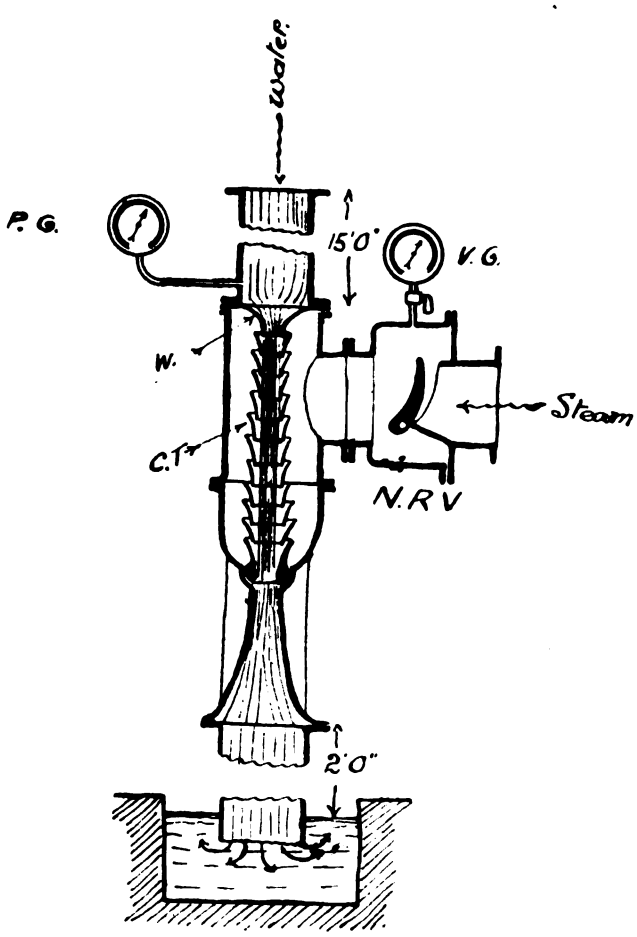
Best Answer to No. 139 (*awarded* 10*s.*).—The ejector type of jet condenser is now coming into general use, especially in the case of electric lighting units, for which it has some advantage over the ordinary jet condenser, as it requires no air-pump, the evacuation of the water vapour and air being effected by the lateral induction of the condensing jet itself. The construction of the apparatus is shown diagrammatically in the sketch. The condensing water enters the apparatus at the water-nozzle, W, under a head of 15ft. Here the potential energy of the jet is transformed into kinetic energy by the convergence of the nozzle and passes down the condensing tube, C T, at a high velocity, thus creating a vacuum in the apparatus itself, and all air-spaces, such as exhaust pipes, etc., in the manner well understood. The condensing tube consists either of a series of concentric nozzles, or, as in the case of one well-known make, a continuous tube with a series of rings of holes drilled in it. The steam rushes through the nozzles or holes and impinges on the surface of the cylindrical jet, thus becoming condensed, the water and condensed steam discharging through a diverging nozzle into the sump. A non-return valve, N R V, is placed in the exhaust pipe to prevent water siphoning back into the engine cylinders should the head on the condenser fall at any time and allow the atmospheric pressure to force the water back through the apparatus.



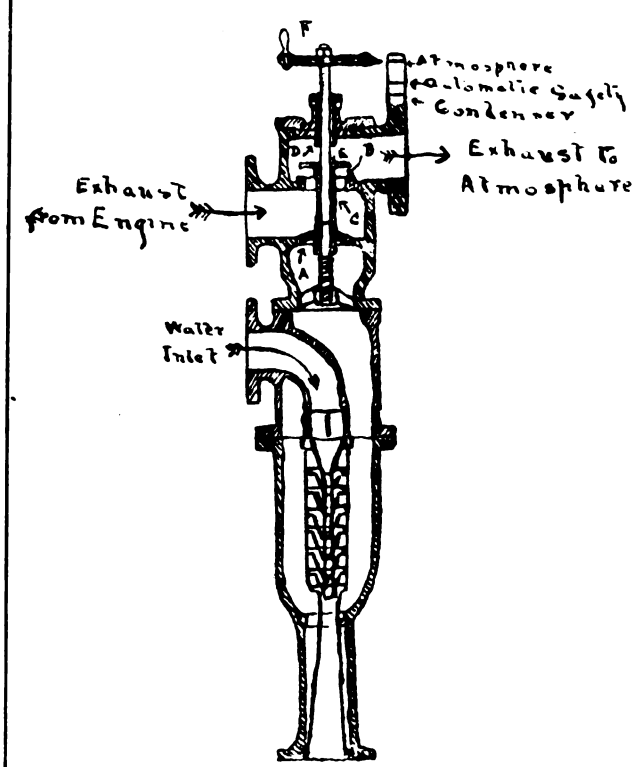
Water is usually supplied to the condenser from an overhead tank placed 15ft. above, and of such capacity as to ensure a constant supply to the condenser should the pump at times run a little below its proper speed. Where this arrangement is adopted, the risk of water getting to the engine cylinders is practically nil. An alternative method is to pump direct into the condenser, and where this is adopted a pressure gauge, P G, should be fixed at the inlet to the condenser, as shown, in order to reveal any fluctuation in the pressure of the water supplied to the condenser.

The usual proportion of condensing water to steam is 25 : 1, or 2½ gallons of water per pound of steam, and with this proportion a steady vacuum of 24in. Hg. can be obtained, the vacuum rising as the load decreases.

For electric light units where the period of top load lasts for a comparatively short time of the engine's run, it is not advisable to adopt a condenser of this type to give the highest vacuum with the engine developing its maximum, as regulation on the water supply is not possible. The usual practice is to adopt an apparatus which will give 24in. at top load, the average vacuum being 26in. Hg. The advantages of this type of condenser over the ordinary air-pump condenser are: low first cost, absence of moving parts with consequent certainty of action, small space taken up, thus enabling separate condensers to be applied to each engine, and obviating the use of long exhaust pipes with complicated draining arrangements, and complete avoidance of troublesome air-pumps, thus saving on the repairs bill. With this type of apparatus it is possible to use dirty and gritty water, as the condensing jet does not come in contact with the sides of the water-nozzle or condensing tube.

The power required for giving the necessary head for the ejector condenser is less than that absorbed in the working of the ordinary air-pump, which has a low efficiency owing to the fact that it has to discharge both water and air against the atmospheric pressure. This represents a greater head than is necessary for any except the very largest sizes of ejector condensers, and the pumps for these are raising solid water. Centrifugal pumps direct coupled to electrical motors are largely used, and carry the great advantage of simplicity and non-liability to wear and tear as compared with the air-pumps of ordinary jet condensers.—H. H. HARRISON.

Answer to No. 139 (*awarded* 5*s.*).—A jet condenser that is absolutely independent of the engine to which it may be applied, even to such an extent that a vacuum of 26in. can be obtained in the exhaust passages, and in the end of cylinder in connection therewith, while the engine is at



rest and before any steam has been admitted at the steam stop-valve of engine, providing the supply of water to jet is plentiful, is one of the ejector type. The ejector condenser is used for stationary engines and steam-pumps, and it dispenses with an air-pump. The action of this condenser is such that on opening the injection cock a flow of cold water from some external source is allowed to flow through a succession of cast-iron nozzles to the discharge, around and against which nozzles the exhaust steam impinges on its way to the condenser, and becomes condensed and produces a vacuum within the condenser. The water enters with a velocity due to the difference of pressure between the external atmosphere and the degree of vacuum maintained in the condenser, plus the velocity due to the head of the injection water. The water jet rushes through the combining nozzles of the ejector and discharge tube, and issues into the atmosphere in a continuous stream,

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carrying with it any air that may be mixed with the exhaust steam, the principle of the ejector being similar to that of an injector. The ejector condenser is very efficient and rapid in its action, the vacuum being produced within four or five seconds from the time of opening the injection cock.

The sketch shown is one of an improved ejector condenser, manufactured by Messrs. T. Ledward and Co., and fitted with their new automatic three-way valve: A is piston valve loose on valve spindle; B, ordinary valve seat; C, collar pinned on to valve spindle and acting as a stop to valves, A and E; F, handwheel with pointer for raising and lowering valve spindle for various conditions of working. On starting the engine the valve spindle is raised by means of the handwheel until the pointer is in the position marked atmosphere. This places the stops on the valve spindle in such a position that valve E is held full open, and the valve A closed, and allows the exhaust steam to pass into the atmosphere. When engine is running at the right speed required, the vacuum may be put on and steam allowed to go into the condenser. This is done by turning the handwheel down, until the valve E is held closed, while the valve A is held full open. As soon as the vacuum is on, with steam flowing into the condenser, the handwheel is turned up until the pointer rests at "automatic safety." In this position each valve is free to be opened or closed, but as long as there is a vacuum in the condenser the valve E is closed by atmospheric pressure, and the valve A is kept open by the steam flowing in. Should anything occur to obstruct the water from leaving the condenser through the discharge, the valve A instantly closes, and the exhaust steam finds its way out through valve E to atmosphere; the closing of the valve A effectually preventing any rush of water from condenser into the exhaust passages and engine cylinder, and the consequent engine breakdown. The water supply to an ejector condenser should be delivered under a head of 15ft. to work satisfactorily. The quantity of water required is from 70 to 100 gallons per indicated horse-power per hour, according to the steam consumption of the engine.

A very good way of employing these condensers for electric lighting stations, is to have a centrifugal pump direct-coupled to an electric motor, lifting the water into a tank high enough to give the required head, and of ample proportions to admit of the flow of water being maintained for some time, should it become necessary to stop the centrifugal pump for any reason whatever.—J. J. SMITH.

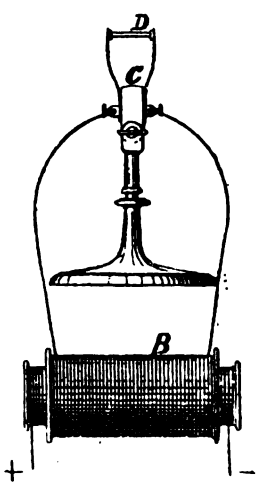
PAUL JABLOCHKOFF—PATENT LAMP, 1877.

At this time it may be interesting to recall some of the work of Jablochkoff. In his patent No. 1,996 for the year 1877 he describes a lamp which touches somewhat on the field more successfully explored recently by Nernst. The following extracts from the specification show the direction in which Jablochkoff was working and the views he had on the subject:

"According to my present improvements, instead of the electric light being produced by the action of the electric spark upon the conducting points themselves, it is the result of the action of such spark upon refractory bodies placed between the conductors, such bodies being either raised to a sufficient temperature to become luminous while subject to a slow combustion, or being subject to a rapid combustion. Thus if a thin slab of a refractory body such as kaolin be interposed between the two conductors, whether of charcoal or of metal, the current operates in two different ways, according as the current is one of quantity or one of intensity, but the result will always be a suitable light produced by the action of the current upon the kaolin.

"In the case of a quantity current the kaolin melts and disappears, producing a flame as in the electric lamp previously described by me, while in the case of a tension current the passage of the spark through the slab of kaolin has the following effect: The substance becomes of greater conducting power at all points where it is touched by the spark, and at the end of a few seconds the current passes readily where it could not pass before, the spark appearing to form as it were a path for the current by rendering conductors the points of the insulating body which it touches, while at the same time the said body becomes incandescent along the entire path of the current, emitting a fine uniform light. . . .

"In putting the lamp in action the current of the induction coil is caused in the first instance to pass through a kind of conducting match placed on the surface of the refractory slab. A spark being established along the line of this match, the heating and incandescence of the particles of kaolin along the same line is established, and the kaolin begins to consume away slowly while producing a brilliant light."



The illustration given is a reproduction of Fig. 1 of the patent specification D showing the slab of kaolin.

FORTHCOMING EVENTS.

FRIDAY, FEB. 24.

Royal Institution—At 9 p.m., Prof. Oliver Lodge, D.Sc., LL.D., F.R.S., on "Coherers."

Institution of Civil Engineers.—At 8 p.m., students' meeting. "The Loss of Heat from Buildings," by Mr. R. Gordon Mackay, student.

Electro-Harmonic Society.—At St. James's Hall Restaurant, at 8 p.m. Ladies' night concert.

SATURDAY, FEB. 25.

Royal Institution—At 3 p.m., Lord Rayleigh, M.A., D.C.L., F.R.S., on "The Mechanical Properties of Bodies." Third lecture of series of six.

MONDAY, FEB. 27.

Society of Arts.—At 8 p.m., Cantor Lecture, Mr. Archibald Sharp on "Cycle Construction and Design." Second lecture of course of four.

TUESDAY, FEB. 28.

Institution of Civil Engineers.—At 8 p.m., "Improvements in Dioptric Apparatus for Lighthouses," by Messrs. W. T. Douglas, M.I.C.E., and J. A. Purvis, B.Sc.

Liverpool Self-Propelled Traffic Association.—At Royal Institution Liverpool, at 8 p.m., "Some New Features in Motor Vehicle Design," by Mr. Thos. Parker, jun., M.I.E.E.

Municipal Officers' Association.—In the Guildhall, Cheapside, E.C., at 8 p.m., annual general meeting; the London Government Bill will be discussed.

WEDNESDAY, MARCH 1.

Glasgow Philosophical Society.—Lecture by Mr. A. A. Campbell Swinton on "Electric Discharges *in vacuo* and the Rontgen Rays."

Institution of Electrical Engineers.—At 7.30 p.m., students' meeting, "Direct and Alternate Current Distribution," by Mr. H. H. Williams.

THURSDAY, MARCH 2.

Institution of Electrical Engineers.—At 8 p.m., "Wireless Telegraphy," by Mr. G. Marconi, M.I.E.E.

Institution of Civil Engineers—At 2.30 p.m., students' visit to the works of Messrs. Maudslay, Sons, and Field, Westminster Bridge-road.

FRIDAY, MARCH 3.

Institution of Junior Engineers.—At Westminster Palace Hotel, at 8 p.m., "Carbon-Consuming Batteries and their Possibilities," by Mr. W. R. Cooper, B.Sc.

SATURDAY, MARCH 4.

Royal Institution.—At 3 p.m., "The Mechanical Properties of Bodies," by Lord Rayleigh, M.A., D.C.L., F.R.S. Fourth lecture of series of six.

Institution of Electrical Engineers.—Students' visit to Messrs. Easton, Anderson, and Goolden's Works at Erith (train leaves Charing Cross at 10 a.m.).

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed*

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PRIOR WORK IN THE FIELD OF NERNST.

It is best to swear by one authority at a time, especially when you can choose your authority in order to suit your own ends. That is what the ancient Greeks did, and no doubt the still older Egyptians and Assyrians. That is what our "gas" contemporaries do now. It is well they should, because it shows the "drift of their desire." Mr. Swinburne's paper on the Nernst lamp, at the Society of Arts, forms a text to the liking of the cynical critics, but they fail to see that the reader of the paper was somewhat cynical himself. Again, Mr. Mordey's remark about prior claimants in this field serves for jocular reproduction; but it so happens that Mr. Mordey's remark was somewhat wide of the mark, and that Nernst has undoubtedly been at work in a field that was not altogether unexplored. To go no further back than to the period when Jablochkoff was working we find one experimentalist, at any rate, attempting to find a substitute for carbon, and so far succeeding as to patent his results. It is rather hard upon the workers, whose initial experiments, although they in a sense failed, really laid the germs of success, that they should be classed among the many impostors who claim to have done something in their own back garden. Jablochkoff and Gramme surely may claim a niche in the temple which contains those whose work heralded the electric era. There are two things singularly pertaining to the views of the old workers in this lamp of Nernst. In the first place, it has a rod instead of a filament. Many of the earlier attempts at incandescent lamps utilised carbon rods. The rod was subsequently reduced in sectional area and became a filament. This is not a true definition of a filament, but it will serve. Many attempts were made to find a substitute for carbon. Just examine what Jablochkoff did. We shall quote from his specification, No. 1,996, of the year 1877. Of course, his method of stating things is very different to the method of Mr. Swinburne, but then the latter has the experience of nearly a quarter of a century since Jablochkoff's patent to assist him. The patent of 1877 first explains how the light had been obtained previously between carbon points—in fact, in the well-known Jablochkoff candles, with kaolin separating the carbon rods—and goes on to state that in the new form "it is the result of the action of such spark (spark is used as the analogue of current) upon refractory bodies placed between the conductors." Mr. Swinburne explained how Nernst, taking an insulating material, raised it in temperature and rendered it conducting—just the explanation given by Jablochkoff. Further, Nernst has to raise the temperature of his material either by means of a match, lamp, or automatic arrangement in which platinum plays its part. This is what Jablochkoff says: "In putting the lamp in action, the current . . . is caused in the first instance to pass through a kind of conducting match placed on the surface of the refractory slab." The lamp, like the Nernst, was claimed to be suited either for continuous or alternate currents. It is just possible for ardent cynics to say that there is no similarity in the two

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arrangements because Jablochkoff's turned out to be impracticable, but we claim that, on the very lines of Nernst, Jablochkoff may not have achieved success, but at any rate he tried to deserve it. So much for the work of one of those who cannot write to the newspapers to claim credit which is his due. We are not among those who took seriously Mr. Swinburne's diatribe about existing incandescent lamps. There is no likelihood just at present of the Nernst or any other lamp doing much damage to the manufacturers of incandescent lamps. It has taken over twenty years to obtain Nernst's improvement on Jablochkoff, and Mr. Swinburne was pleasantly satirical at the dearth of improvement in the incandescent lamp, and its inefficiency. If, however, we care to look at all inventions as bad because they have not within a quarter of a century improved off the face of the earth, why it would necessitate a big book to record their number. The telephone is a modern electrical introduction, yet we fancy, as a receiving instrument, it stands pretty much where it did when it left the hands of Bell. The Nernst lamp, we take it, is due, not to any discovery of Nernst that an insulator raised in temperature becomes a conductor, because that was well known before, but to recent discoveries having placed in the hands of Nernst an insulating material which can be raised to the very high temperature at which light rays form a much larger proportion of the total emitted vibrations than in the case of incandesced carbon or kaolin. Also this material, when raised to the high temperature required for conduction and illumination, disintegrates far less rapidly—if it disintegrates at all—than the kaolin of Jablochkoff.

THE NEW ENGINEERS TO THE POST OFFICE.

In consequence of the retirement of Mr. W. H. Preece, Mr. J. Hookey has been appointed engineer-in-chief to the Post Office. Mr. Hookey's past career has in every way fitted him for the high position he now holds, and we wish him every success in the enlarged responsibility he has now taken up. The following brief *résumé* of his career will be of interest at the present time. Mr. Hookey was born at Bristol on Dec. 30, 1839, and was educated at Bath. In 1854 he entered the engineer's office of the Bristol and Exeter Railway. At this time the Electric Telegraph Company was erecting its lines to the West of England. Being much interested in this work, Mr. Hookey was induced in 1855 to join that company's service, and he rapidly rose to be assistant superintendent and engineering inspector for the whole of the company's lines in the West Midlands. In 1863 he was transferred to headquarters, and acted under the late Mr. Cromwell F. Varley, who was succeeded by Mr. Richard Culley. On the transfer of the whole of the telegraphs in the United Kingdom to the State in 1870, Mr. Hookey was appointed senior officer. The next move was in 1882, when he was made the principal technical officer. The excellence of the work done by him in these two capacities was further recognised on the death of the late Mr. Edward Graves, when Mr. Hookey was appointed assistant engineer-in-chief.

The other appointment which has been made in consequence of Mr. Preece's retirement is the elevation of Mr. J. Gavey to the post of assistant engineer-in-chief and electrician. Mr. Gavey commenced his professional career by entering the service of the Electric and International Telegraph Company in the year 1860. He was then drafted to the Southern District, which was under the control of Mr. W. H. Preece, the now retiring engineer-in-chief of the Post Office. On the acquisition of the telegraphs by the State in 1870 Mr. Gavey was appointed superintendent for the Post Office of the South-Eastern sub-division of the Department. In 1872 he was placed in charge of the Great Western sub-division, which has its headquarters in Bristol. His next move was in 1878, when he was appointed superintendent engineer of the South Wales District, which has its headquarters at Cardiff. In 1892, Mr. Gavey was transferred to the head office in London, being made the chief technical officer at the General Post Office, and in 1897 he was appointed second assistant engineer-in-chief.

MR J. GAVEY, CHIEF ASSISTANT ENGINEER AND ELECTRICIAN TO THE POST OFFICE.

Mr. Gavey has taken an active part in many societies, but his best effort was undoubtedly the well-prepared paper on "The Telephone Trunk Line System in Great Britain" read before the Institution of Electrical Engineers in 1896.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

KILDUCHEVSKY TRANSMITTER.

SIR,—In its issue of the 17th inst., the *Electrical Review* states, under the above heading, that Mr. A. R. Bennett found that with this transmitter "conversation of any description could be carried on without effort through an artificial cable equal to 200 miles of real cable, with a resistance of 594·48 ohms, a capacity of 59·73 microfarads, and a K R of 35,508."

I should be glad if you would allow me to say that this statement is absolutely untrue.

With regard to the same journal's leading article on the subject, in which is deprecated the use of artificial cables for telephone testing, because of the back inductance of resistance bobbins, one is constrained to wonder how it comes about that (as is apparently the case), the editors of the *Electrical Review* have never heard of artificial cables in which the resistance is distributed otherwise than in bobbins.—Yours, etc, A. R. BENNETT.

44, Manor Park-road, Harlesden, London, N.W.,
Feb. 20, 1899.

REVIEWS.

Telegraphy. By W. H. PREECE, C.B., F.R.S, Pres.Inst.C.E., etc., and J. SIEVEWRIGHT, M A, K C.M G. Fifteenth edition. Thoroughly revised. Longmans, Green, and Co. Price 6s.

There is little to be said about a book that has reached a fifteenth edition. It has clearly proved its merits, but in this particular case the new edition has been revised and brought up to date. The necessity of revision means that telegraphy is not such a stand-still thing as it is often supposed to be. Methods and apparatus have grown obsolete, and are replaced. These things are notified in the book. Altogether the information is practical, and

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indicates that ordinary telegraphy will not just yet be superseded by any of the newer developments, such as telephony or space telegraphy.

Money Weights and Measures of all Nations. By W. A. Browne, M.A., LL.D. Eighth edition. Stanford. Price 2s. 6d.

To the commercial man this book is a necessity, and it would save them a good deal if travellers made themselves acquainted with the coinage of the countries through which they passed. Changes are frequently taking place, hence the value of such a work depends largely upon its being accurate to date. Mr. Browne has carefully corrected this edition, so that it is an accurate statement of the present position of weights and measures throughout the world. We have tested the book so far as regards the countries with which we are familiar, and found it reliable. Hence we may assume that it is equally so throughout.

HASTINGS ELECTRIC LIGHTING.

We are glad to note that the Corporation of Hastings having secured the works of the Hastings and St. Leonards-on-Sea Electric Lighting Company, are not wasting any time before expanding the undertaking. The following two reports have recently been considered by the committee. The first of these, prepared by Mr. L. Andrews, the borough electrical engineer, reads as follows:

Gentlemen,—In accordance with your instructions I have carefully considered the question of extensions to plant, mains, and buildings immediately necessary, and now beg to submit the following report thereon:

Steam Generators.—The maximum demand upon the generating plant at the Earl-street works during this winter has been 12 per cent. in excess of the normal output of the present plant, consequently, as we have already applications on hand for about 1,000 additional lights, we are practically bound to make some extensions to this portion of the plant before next winter. The space at the Earl-street works is very limited, therefore it is not advisable to put in any more 100-kw. sets of plant. By using direct-coupled plant it is possible to get two 200-kw. sets in practically the same space as is at present occupied by each of our 100-kw. sets. In order to prevent interruptions to the supply, it is always advisable to have one set of plant as a stand-by, equal in output to the largest running set in the station, so that two 200-kw. sets should be put in at the same time. I presume you will advertise for tenders for the supply of the above plant. I should recommend, however (provided the price is not excessive), that a combined direct-driven plant, consisting of a Belliss engine coupled to a Brush alternator, be used. The Belliss engines are, I believe, giving universal satisfaction in all stations at which they are used. They are very economical in coal, oil consumption, and attendance, and being of simple and durable construction, the cost of repairs and maintenance is not liable to be excessive. I recommend the continued use of Brush alternators, because they are likely to run in parallel better with our existing machines than any other type of generator. Added to that, we have used the Brush Company's generators for several years, during which they given us very little trouble, and I believe these alternators are acknowledged to be the most excellent regulators at present on the market—that is to say, a sudden increase or decrease of load does not appreciably affect the steadiness of the lights supplied. I estimate the cost of two 200-kw. Belliss-Brush steam generators, erected complete with foundations, steam and exhaust pipes, and necessary extensions to switchboard, will be about £6,500.

Exciting Plant.—Our present plant consists of one 18-kw. Crompton dynamo, direct coupled to a Chandler engine, and one 6·5-kw. Victoria dynamo, belt driven from one of the alternator engines—as a stand-by. As about 10 kw. are required to excite our present plant and an additional 7 kw. will be required to excite the two 200-kw. sets, it is obvious that the above-mentioned stand-by will be practically useless for this purpose. I propose, therefore, to put in a secondary battery, capable of supplying 150 amperes at 120 volts for three hours, as a stand-by to the Crompton exciting plant. This will cost, erected complete, £350. To accommodate the plant referred to above, it will be necessary to extend the present generating station on to the adjoining site—viz., the 'bus company's old premises. This will entail pulling down the walls dividing the two buildings marked A B on the enclosed plan, rebuilding the old 'bus stable wall facing Earl-street, strengthening the wall of the adjoining premises, and continuing the wall at the back of No. 4 boiler and covering in with an iron frame skylight roof. Whilst this extension to the building is being carried out it is desirable that the existing wooden floors over the present generating station should be taken out. These floors are a source of great danger from fire and of general inconvenience; they prevent the use of an overhead travelling crane, they collect dirt, and make the engine-room very hot. We have already on two or three occasions had very narrow escapes from fire. I recommend, therefore, that the floors, etc., over the engine-room be replaced by an iron frame roof as suggested for the extended portion of the building, and that the present wooden floors over the boilers should be replaced by concrete floors, supported between iron girders, similar to the existing coal floor, as shown on the enclosed sectional elevation. These new floors would require fitting-up as offices, stores, and workshops. The cost of extensions to buildings, etc., referred to above will probably be about £5,500, making a total, with the £6,500 for plant and £350 for a secondary battery, of £12,350. These extensions, with an additional £1,000 for another boiler, not immediately needed, will more than double the present maximum output of our station, and will also enable us to work with far greater economy.

Mains and Transformers.—At the present time current is being supplied to consumers in Hastings upon what is known as the house transformer system. This system for pioneering work was practically the only possible method of economically distributing current in such scattered districts as Hastings and St. Leonards, but the demand has increased to such an extent that the disadvantages of the system now more than outweigh its advantages. In the first place, about 40 per cent. of the total current generated at the works is wasted in the numerous small transformers used, and in the second practically all the faults we have had on our cables, causing interruptions to the supply, have occurred on the small cables used for connecting these transformers on to the high-tension mains. As it is quite certain therefore that the system will have to be changed over sooner or later, it is very desirable that this should be done as soon as possible, since the longer the change is delayed the more it will cost, and all the money expended in connecting consumers on to the existing system will be practically wasted. I recommend, therefore, that all the existing transformers which are scattered over our present area of supply should be grouped together in suitably equipped sub-stations at the points indicated by red squares on the enclosed map. Low-tension distributors, consisting of armoured and lead-covered cable laid straight in the ground, or in troughs filled with bitumen, should be laid in all the streets at present supplied, and these should be put in large enough to meet any probable future demand. The present declared pressure of 100 volts at consumers' premises should be changed to 200 volts. This change has already been effected in a large number of stations in this country, and is being considered at the majority of the others. I estimate the cost of the extension referred to above, including cost of mains, labour for laying ditto, building and equipping sub-stations, new 200-volt lamps, and new meters where necessary, to be about £6,080. This expenditure will enable us to economically distribute current to at least three times as many lamps as we are able to supply from our existing system of distribution.

High-Tension Feeders.—The high-tension feeders—particularly our No. 3 circuit, which is feeding the transformers at St. Leonards—are also practically fully loaded. Instead of drawing in a larger cable in place of the existing one, I recommend that a second cable should be drawn in of the same size as the existing one. This will serve as a duplicate supply in case of failure, and if it is connected up to the sub-stations in the manner suggested in my recent Institute of Electrical Engineers' paper on "The Prevention of Interruptions to Electricity Supply" (see pp. 16 to 20), it will be possible to prevent the failure of any high-tension feeder interrupting the supply to any section of lights. The estimated cost of duplicating the high-tension feeders, as suggested above, is £884. This expenditure will, of course, double the output of our present high-tension feeders as well as increase the reliability of the supply.

Extensions to New Districts.—In addition to the extensions referred to above it will be necessary in a few weeks to run a main to the new music hall on the Marine-parade. I recommend that this should be supplied from a sub-station at the music hall, that the sub-station should be fed by duplicate high-tension feeders, and that secondary distributors should be laid in at the same time from Castle-street to the bottom of High-street for the purpose of supplying other consumers on the Marine-parade or in George-street. I estimate that the cost of this extension, including high-tension and low-tension mains, building, and equipping sub-station, etc., will be about £920. About a dozen applications for current have also been received from residents in the Blacklands district. To supply these, I recommend that a properly equipped sub-station should be built in the neighbourhood of Christ Church, Blacklands, that this should be fed by a $^{19}/_{16}$ high-tension lead-covered cable drawn in Doulton conduits, and that a $^{37}/_{14}$ low-tension armoured cable should be laid in at the same time between this point and the Earl-street works for the purpose of supplying intervening con-

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sumers. The cost of this extension, I estimate, will be about £1,950.

The following is a summary of the estimates quoted above:

Engines and alternators, etc.	£6 500
Secondary batteries	350
Extensions to buildings	5 500
Changing over to sub-station system of mains	6,080
Duplicate high-tension feeders	884
Extension of mains to new music hall	920
Extension of mains to Christ Church, Blacklands	1,950
	£22,184

The above sum does not include the cost of connecting on new consumers on to the existing mains. That will, of course, depend entirely upon the demand.

Free Wiring, etc.—It is advisable that some steps should be taken to stimulate the demand for electricity in this town, as a greatly increased consumption would undoubtedly reduce the cost of production per unit considerably. I have had some correspondence with the National Free Wiring Company, and have ascertained from them that they are prepared to instal electric light wires, fittings, etc., into consumers' premises at a rental of 1d. per unit of current consumed. They are willing either to compete with the present local wiring contractors or to employ them as their local agents. I think the introduction of a scheme for free wiring would undoubtedly greatly increase the demand for current. The maximum price of 8d. per unit at present charged for current is undoubtedly prohibitive. I am confident that a maximum price of 7d. per unit, plus 5s. per quarter meter rent, with an optional charge of 4d. per unit plus 1s. per quarter per 8-c.p. lamp demanded, would pay much better in the end. It is very desirable that applications for electric light services should, as far as possible, be received before the main supplying their street is laid in. In the first place the main would be earning revenue as soon as it was connected to the works, and in the second much of the cost and inconvenience of repeatedly opening a road would be avoided. I propose, therefore, that a reduction of 50 per cent. on their first quarterly account should be offered to consumers who apply for a service before the main opposite their premises is laid.

(Signed) L. ANDREWS,
Borough Electrical Engineer.

This report was submitted to Prof. A. B. W. Kennedy by the Corporation, and he has reported as follows on the same:

Gentlemen,—In accordance with your wish, I have carefully examined Mr. Andrews's report on extensions. I have also had the advantage of conferring with Mr. Andrews on the whole matter. I have pleasure in making the following remarks on this:

Steam Generators.—I quite agree with Mr. Andrews that it is desirable to have in reserve a unit equal to the largest unit actually at work, so that it is often good policy to order two duplicate sets at the same time, but at present, and for the ensuing year, it would, I believe, be sufficient to order only one large set, reserving the second for a later order. This would of course reduce the immediate expenditure very much. I believe that the Belliss-Brush generators proposed by Mr. Andrews will be satisfactory.

Exciting Plant.—I think this proposal of Mr. Andrews is a proper one.

Building Extensions.—I reported to the Hastings Company long ago to the effect that it was most desirable to take away the wooden floor immediately above the engine-room, practically on the grounds now stated by Mr. Andrews. As considerable extensions and alterations have to be made to the buildings in any case, I think it will be very advisable to carry out this change along with the rest.

Mains and Transformers.—I quite agree with Mr. Andrews that it is desirable to substitute transformer sub-stations for isolated transformers. As, however, the expense of doing this will be very considerable, I would suggest that at present the change should only be carried out in connection with extensions to the mains, or in whatever places it may be urgently required. The change of system could proceed step by step so that its cost would be distributed over a considerable period. I make this suggestion as I made the suggestion about the second large unit in the station, and because I recognise that it is very desirable for you during the present year to increase your capital expenditure as little as possible. I have no doubt, however, that the expenditure mentioned by Mr. Andrews should be incurred presently as work grows.

High-Tension Feeder.—As I understand that the present No. 3 feeder is practically fully loaded, some such addition as is here mentioned must no doubt be carried out. It is better to draw in a second cable, as proposed by Mr. Andrews, than to take out the old one and replace it by a larger one.

Extensions to New Districts.—The desirability of making these extensions seems to me a matter of general policy rather than of engineering. I may say only that in every place where I have hitherto had to do with work of this kind it has been found that extensions of mains were always followed by a more than proportionately increased output. Any persons within your borough can demand that you shall carry your mains to their premises and supply them with light, but if they are more than 60 yards from your existing mains you may demand that their application should be accompanied by a three years' guarantee that they will use an amount of current whose value is 20 per cent. of the whole sum which you have to expend specially upon the mains which supply them. Although I have known this guarantee to be given in many cases, I have never known it to be called on, for the consumption has always been very much more than the minimum guarantee.

Free Wiring.—It will be necessary to examine very carefully, for reasons which I have explained to Mr. Andrews, the formal agreement proposed in connection with this matter.

Price of Current.—I do not feel that I can advise you specifically as to the reduction of price which is mentioned by Mr. Andrews. I would only like to say that everywhere, without exception, I have found in those boroughs with which I have had to do that reduction of price was the one method of increasing output, and the only certain method of doing this. Whatever you may do tentatively just at present, I trust that before long you may be able to make a very large and substantial reduction in your price so as to bring yourselves more in line with other places having the same output, after allowing, of course, for the difference in price of coal. I can quite understand that you may hesitate to make any very large reduction of price at present as you have only just taken the scheme over, but I really feel no doubt whatever that the reduction of price will be followed by such a great increase of output as will amply justify it. ALEX. B. W. KENNEDY.

These two reports were adopted by the committee and presented to the Corporation last week. In the committee's report, presented at the same time, the total cost of obtaining the electric lighting undertaking is put down at £62,095. This is some £4,000 in excess of what was sanctioned by the Local Government Board for the purchase of the undertaking, but the excess is due to reasons which can be easily explained.

The Public Lighting Committee have appointed a sub-committee, consisting of the following gentlemen, to undertake the management of the electrical department: Alderman Hutchings, and Councillors Coussens, Shoesmith, Tree, and W. Cruttenden, and the chairman of the Public Lighting Committee (Councillor Dr. Allfrey). This sub-committee recommend that the electrical department shall be kept financially distinct from the General Lighting Committee; that the electrical engineer shall act quite independently of the borough engineer, except when any alterations or extensions of the buildings are reqired; that the electrical department shall have its own separate stores, and, as far as possible, carry out its own repairs; that the undertaking shall be carried out as if it were a private trading concern, with separate office, books, and accounts; and that it shall treat other committees of the Council as if they were private consumers.

The staff recommended by the committee to the Corporation are the following: as electrical engineer, Mr. L. Andrews; as assistant engineer, Mr. C. W. Kennaway; as mains superintendent, Mr. E. S. Haslam; and as accountant and collector, Mr. F. E. Burton.

The committee recommended that Prof. Kennedy should be retained by the Corporation as their consulting engineer, with an annual retaining fee and a fixed fee for every day his services are required. On the engineer's reports the committee recommend an immediate expenditure of some £32,768, and that application shall be made to the Local Government Board for sanction to borrow that amount, repayment being spread over a period of at least 30 years.

On the question of price to be charged for electrical energy, the committee advise that beyond a slight readjustment, it will not be expedient for the present to deviate from the scale of charges adopted by the company. This is as follows: incandescent lighting—6d. per unit for all current consumed and 1s. each per quarter for all 8-c.p. lamps or their equivalent burning at one time; arc lighting—6d. per unit for all current consumed and 30s. per quarter per lamp, no meter rents being charged for either incandescent or arc lighting. A few consumers, who use many lamps and little current, are charged 9d. per

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unit for the first 200 units and 8d. per unit for the remainder of current consumed, and 5s. per quarter meter rent. For places of worship the charge is 6d. per unit and 5s. per quarter meter rent.

The committee express the hope that they may shortly be in a position to reduce the price to 6d. per unit, but they think that until more plant has been laid down it will be unwise to stimulate a largely increased rate of consumption.

All these recommendations were carried unanimously at the last meeting of the Hastings Corporation, and we hope soon to congratulate the inhabitants of that town and neighbourhood on having their electrical energy supplied at as cheap a rate as most other towns in England.

LEGAL INTELLIGENCE.

SOUTHAMPTON TRAMWAYS ARBITRATION.

In the Queen's Bench Division, before Mr Justice Bruce and Mr. Justice Ridley, on Saturday last (Feb. 18), a case was stated by Sir Henry Oakley, the umpire appointed under the Southampton Corporation Tramways Act, 1897, and the Railways Clauses Consolidation Act, 1845, to decide certain disputes which had arisen between the Southampton Tramways Company and the Corporation of Southampton as to the price at which the Corporation should take over the undertaking of the tramways company, in accordance with the Act of 1897.

Mr. Asquith, Q.C., Mr. J. D. Fitzgerald, Q.C., Mr. G. M. Freeman, Q.C., and Mr. Alfred Lyttleton appeared for the tramways company; and Mr. Cripps, Q.C., and Mr. Haldane, Q.C., for the Corporation of Southampton.

The questions for the opinion of the Court were (1) whether in determining the price to be paid under the Act of 1897, the arbitrators and umpire should treat the undertaking of the company as defined by that Act as an undertaking which the company only enjoyed subject to the contingency of being compelled to part therewith under the terms of Section 43 of the Tramways Act, 1870, or (2) whether in determining the price to be paid as aforesaid the arbitrators and umpire should treat the undertaking as an undertaking which the company enjoyed free from all obligation to part therewith otherwise than under the terms of the Act of 1897 itself. If the first question was answered in the affirmative the umpire fixed the price to be paid at £51,505, and if the first question was answered in the negative and the second in the affirmative, the price fixed was £109,963. The provisions of Acts upon which the questions rest are referred to in the judgment.

Mr. Justice Bruce, who delivered the judgment of the Court, said Section 43 of the Tramways Act, 1870, enacted in substance that when the promoters of a tramway in any district are not the local authority, the local authority (in this case the Corporation of Southampton) if by resolution they so decide may within six months after the expiration of a period of 21 years from the time when such promoters were empowered to construct the tramway and within the expiration of every subsequent period of seven years by notice in writing require such promoters to sell, and thereupon such promoters shall sell to them their undertaking upon terms of paying the then value (exclusive of any allowance for past or future profits of the undertaking, or any compensation for compulsory sale, or other consideration whatsoever) of the tramway and all lands, plant, etc., of the promoters, such value to be determined by an engineer or other fit person nominated by the Board of Trade on the application of either party. And when any such sale has been made all the rights, powers, and authorities in respect to the undertaking sold shall be transferred to the authority to whom the same has been sold. If no application were made to Parliament under Section 48 of the Southampton Street Tramways Act, 1877, by the Corporation for powers to purchase the tramways within a period of 21 years, then the Corporation would have the right, within a period of six months after the expiration of 21 years, and within six months after the expiration of every subsequent period of seven years, by notice in writing, to require the promoters to sell upon the terms of paying them the then value of the tramway, that is, the value of the structure and plant, and nothing more. The third section of the 1897 Act provides: "the Corporation shall purchase and the company shall sell the undertaking of the company for such price and conditions as may be agreed on between them, or, as failing agreement, may be settled by arbitration under the provisions of the Lands Clauses Acts. The purchase shall be completed on or before June 30, 1898." Upon this section turns the question which we have to decide. On June 30, 1898, the undertaking became transferred to or vested in the Corporation, and, the Corporation and the company having failed to agree upon the price to be obtained, arbitrators and an umpire were duly appointed to determine the price. Mr. Cripps was right when he contended that the interest of the company in the undertaking was only a limited interest liable to be determined by the terms of Section 43 of the Act of 1870 at the end of 21 years, and after that at successive periods of seven years, and that the company are not entitled to be paid for a larger right in the undertaking than they in fact possessed. The company could not under the provisions of the Act of 1876 be deprived of their rights and privileges until the expiration of the period of 21 years therein mentioned. The Southampton Street Tramways Act of 1877 made it a condition that purchase should be effected by June 30, 1898. If the Corporation had waited till Aug. 11, 1898, they could have obtained the tramways by merely paying the structural value. But the Corporation chose to promote a Bill in Parliament, and Parliament made it a condition that the price to be paid by the Corporation should be determined under the Land Clauses Acts. The fact that the Corporation had the power under the Tramway Act of 1870, however, clearly affected the case, and it followed from what had been said that the first question should be answered in the affirmative and the second in the negative, and the award held good for £51,505.

Mr. Justice Ridley concurred.

STREET-LIGHTING CONTRACTS.

An important case between the Lord Mayor and Corporation of London and the City of London Electric Lighting Company was tried before Mr. Justice Kekewich last week. The question in dispute was the meaning of certain existing contracts for street-lighting. We think, on the whole, the decisions were in favour of the electric lighting company, although by these a large amount of latitude is left to the engineer of the Corporation as to the use of either arc or incandescent lamps for lighting the side streets of the City. His Lordship found that under the terms of the contract the Corporation were bound to light such streets electrically, and to pay for the electrical energy used in these lamps in proportion to the number of watts actually expended. In the event, however, of the Corporation desiring to use an arc lamp where an incandescent lamp has been previously fixed, the only charge to be made by the company for the change is that representing the difference between the costs of the two lamps.

COMPANIES' MEETINGS AND REPORTS.

NOTTING HILL ELECTRIC LIGHTING COMPANY, LIMITED.

Directors: Sir William Crookes, F.R.S. (chairman); Arthur Ellis Franklin, Esq.; Alexander Howden, Esq.; James Thomas Jervis, Esq.; Francis Radford, Esq. Engineer and manager: Geo. Schultz. Secretary: R. G. Rawkins.

Report of the directors (with abstract of accounts) to be submitted to the shareholders at the twelfth ordinary general meeting of the Company, to be held at the offices of the Company, 140, High-street, Notting Hill-gate, W., on Wednesday, March 1, at 5.30 p.m.:

The expenditure on capital account at the date of the last balance-sheet stood at £113.184. 5s. 4d., and during the past year a further sum of £14,819. 14s. has been expended; £9,248. 0s. 5d. on new mains and machinery, and £4,060. 16s. 7d. on the purchase of additional freehold property, bringing the total expenditure up to £128,003. 19s. 4d., being £2,093. 19s. 4d. in excess of the capital received. Further issues of first mortgage debentures amounting to £21,000 were made during the year at premiums aggregating, after deducting stamps and petty expenses, £1 308. 13s. 9d. The directors have dealt with these premiums as follows: £973. 16s. 7d. has been written off the balance of the expenditure not represented by visible assets, bringing this item down from £5,205. 5s. 4d., at which it originally stood, to £1,000, and the balance of £324. 17s. 2d. has been placed to the credit of renewal and reserve fund. The following table shows the progress of the Company:

1891	Lamps,	6,056	Loss	£554	18 6
1892	,,	9,438	Profit	112	6 1
1893	,,	12,153	,,	1,481	7 1
1894	,,	15,669	,,	2,101	17 8
1895	,,	20,307	,,	3,227	14 10
1896	,,	25,716	,,	4,736	9 8
1897	,,	33,000	,,	6,854	1 2
1898	,,	46,066	,,	7,251	13 7

The charge for coal shows an increase of over £200 owing to the effect of the strike in Wales, which necessitated the purchase of steam coal elsewhere at an enhanced price. The reduction in the charge for current had but a slight effect upon the revenue, and the policy of the directors in encouraging the higher voltage has been so far successful that already more than two-thirds of the consumers are supplied at 200 volts. When this conversion is completed the saving in the cost of distribution will be considerable. During the past year this Company, in conjunction with other metropolitan companies, was seriously threatened with competition, and the directors, besides joining in opposing Bills before the parliamentary committees, adopted a policy of strengthening the position of the Company in the district by extensions of mains, so that should Parliament grant a competing order they might be able to protect the interests of the shareholders. The buildings were extended by the purchase of the freehold house, 140, High-street, Notting Hill, so as to provide a frontage on the main thoroughfare, and thereby bring the Company and its officers into closer touch with the inhabitants of the district. The present central station being fully equipped, and in view of the increased demand for current, the directors were considering the advisability of extending their works on the north side of the station on the freehold land which was secured at the outset of the undertaking with this object. The Kensington and

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Knightsbridge Electric Lighting Company, Limited, were also desirous of increasing their works, and the two companies met and decided to establish a joint station at some convenient position where current could be produced at a minimum of cost, and a joint Bill promoted by the two companies with that object is now before Parliament. The Vestry of Kensington, on the other hand, anxious to have the streets and public buildings of the parish lighted by electricity, also deposited a Bill in Parliament asking for powers to erect works with that object. This Bill would have enabled them to enter into competition with the existing companies. After long negotiation the directors of the two companies succeeded in effecting an agreement with the Kensington Vestry, in accordance with which that body agreed to withdraw its Bill and petition in favour of the Kensington and Notting Hill Electric Lighting Bill, the two companies agreeing, each in its own area, to supply current for the purpose of street lighting, and for the use of the Vestry's buildings, on terms which are satisfactory to both parties. After the business to be transacted at the ordinary general meeting is completed an extraordinary general meeting will be held, to confirm the resolution passed by the shareholders on Feb. 2, approving of the Kensington and Notting Hill Electric Lighting Bill mentioned above. This agreement will be explained to the shareholders, and the directors are satisfied that the result will be to strengthen the present position and increase the future prosperity of the Company. Of the £7,251. 13s. 7d. profit, the directors have set aside £825. 2s. 10d. for depreciation and reserve fund, making together with the balance of premiums £1,160, and bringing the total amount up to £4,500. After paying the debenture interest, amounting to £685. 16s. 8d., and 6 per cent. on the preference shares, amounting to £1,738. 16s. 10d., there is a balance of £3 933. 18s 11d., out of which the directors recommend that a dividend at the rate of 6 per cent. per annum, less tax, be declared on the ordinary shares. An interim dividend at this rate was paid on June 30, and the balance when declared will be paid forthwith. The directors desire to place on record their appreciation of the services of the manager, secretary, and staff generally, more especially for the great assistance they have given to the directors during the delicate negotiations referred to above. The directors retiring in rotation are Sir William Crookes, F.R.S., and Mr. Alexander Howden, who, being eligible, offer themselves for re-election. The shareholders' auditors, Messrs. Fox, Sissons, and Co., retire, and, being eligible, offer themselves for re-election. The accounts will be audited in due course on behalf of the Board of Trade.

REVENUE ACCOUNT, YEAR ENDED DEC 31, 1898.

Dr.				£	s.	d.
Generation of Electricity.						
Coal and other fuel, including dues, carriage, etc.	£1,471	14	5			
Oil, waste, water, and engine-room stores	241	9	11			
Wages and gratuities at generating station	532	6	0			
Repairs and maintenance, as follows:						
Buildings	31	17	10			
Engines, boilers	240	2	0			
Dynamos	21	0	3			
Machinery, instruments, and tools	48	16	5			
Accumulators	490	7	2			
				3,077	14	0
Distribution of electricity—repairs, maintenance, and renewals of mains of all classes, including materials and laying the same				45	2	4
Rents, rates, and taxes, £473. 8s. 7d.; less taxes over reserved for in previous years, £251. 8s 1d.				222	0	6
Management Expenses.						
Directors' remuneration	1,100	0	0			
Trustees for debenture-holders' remuneration	105	0	0			
Salaries of engineer and manager, secretary, clerks, and messengers	1,092	10	9			
Stationery and printing	75	16	6			
General establishment charges	139	19	7			
Auditors of Company	31	10	0			
Auditor appointed by the Board of Trade under the provisions of the order	33	0	0			
				2,577	16	10
Special Charges.						
Insurances	123	18	10			
Law costs	119	10	7			
				243	9	5
Connecting installations, and sundry stores				153	17	2
				6,320	0	3
Balance carried to net revenue account				7,251	13	7
				£13,571	13	10

Cr.	£	s.	d.
Sale of current (455,871 units), less discounts and bad debts	12,238	14	8
Rental of meters and other apparatus on consumers' premises	486	6	6
Connecting installations, sale of stores, etc.	565	11	2
Rents receivable	253	11	0
Transfer fees, etc.	27	10	6
	£13,571	13	10

Dr. GENERAL BALANCE-SHEET, DEC. 31, 1898.	£	s.	d.
Capital account—amount received	126,000	0	0
Sundry tradesmen and others, due on contracts for fuel, stores, etc.	1,895	6	6
Sundry creditors	1,184	8	10
Depreciation, renewal, and reserve fund account	4,500	0	0
Net revenue account—balance at credit thereof, £5,672. 15s. 9d.; less dividend paid on ordinary preference shares, £1,738 16s. 10d.; ordinary shares, £1,935. 12s.—£3,674. 8s. 10d.	1,998	6	11
	£135,578	2	3

Cr.	£	s.	d.
Capital account—amount expended for works, including cost of provisional order	128,003	19	4
Sundry debtors for current supplied, etc.	5,113	4	6
Other debtors	82	13	3
Stores on hand: coal, £24. 9s. 11d.; general, £691. 19s. 6d.	716	9	5
Stock (movable plant and tools)	256	18	9
Cash at bankers, £404. 0s. 4d.; and in hand, 16s. 8d.	404	17	0
Preliminary expenses, compensation, etc., £1,973 16s. 7d.; less portion of premiums received on issue of first mortgage debentures, £973. 16s. 7d.	1,000	0	0
	£135,578	2	3

CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION, LIMITED.

Directors: William Francis Fladgate, Esq., Craig's-court, S.W. (chairman); G. H. Brougham Glasier, Esq., St. James's-street, S.W. (vice chairman); Stefano Gatti, Esq. (A. and S. Gatti), Strand, W.C. (managing director); John M. Gatti, Esq. (A. and S. Gatti), Strand, W.C.; Richard Chadwick, Esq., St. Martin's-lane, W.C Secretary: E. Wilmot Seale, Esq. Engineer-in-chief: W. H. Patchell, M.I.C.E., M.I.E.E., M.I.Mech.E.

Report of the directors (with abstract of accounts) to be presented to the ordinary general meeting of the Corporation to be held at the offices, 15, Maiden-lane, Covent Garden, W.C., on Monday, Feb. 27, at 12 noon:

In submitting the accounts for the year ended Dec. 31, 1898, the directors are pleased to report that the progress of the business has been very satisfactory. The Maiden-lane and Lambeth stations and the plant and machinery have been maintained in a high state of efficiency. A provisional order for parts of the Holborn and St. Giles's districts such as are south of High Holborn and New Oxford-street respectively has been granted to the Corporation. An application for a provisional order to supply electric energy within the City of London (supported by a very influential memorial of ratepayers and others) is under the consideration of the Board of Trade, and (if granted) application to Parliament will be made in due course to confirm the order. There has been connected up to the mains of the Corporation during the past year the equivalent of 26,694 additional 8-c.p. lamps, making with those previously connected up the equivalent of 134,236 8-c.p. lamps. Eighteen and a half miles have been added to the mains laid, including seven miles in the new districts of Holborn and St. Giles, making with those already laid 101¼ miles. The combined output in units from the stations of the Corporation has increased by about 20 per cent. for the year 1898 over 1897. The rapid extension of the business of the Corporation has necessitated a modification of the original plans of the station buildings at Lambeth; about 90ft. have already been added to the length of the engine-room and boiler house, and additional boiler, engine, and dynamo plant installed. The station will, however, have to be still further enlarged, and for this purpose it has become necessary to determine tenants' leases of parts of the properties at Lambeth not at present in the occupation of the Corporation. The directors have acquired upon lease for 999 years a site upon which they are building a sub-station (rapidly approaching completion); from this station it is intended to distribute electric energy to the Holborn and St. Giles's districts and to supplement the present supply in the northern parts of St. Martin's parish and the Strand district. It will be seen that the necessary outlay on building extensions, mains, and plant to cope with the present and prospective demand has been exceedingly heavy; to meet this outlay and provide for future requirements in the present areas of supply, the directors propose to increase the ordinary share capital of the Corporation by the issue of 20,000 shares of £5 each at a premium. The net earnings, as shown in the revenue account, have amounted to £21,377. 2s. 6d.; £4,600. 1s. 8d. has been paid in respect of interest on debentures and temporary loans up to Dec. 31, 1898; and £4,500 was distributed as interim dividend at the rate of 6 per cent. for the half-year ended June 30, 1898. A sum of £12,277. 0s. 10d. remains, which, added to the undivided profit of £3 014. 18s. 4d. from last year's account, makes £15,291. 19s. 2d., which the directors propose to deal with as follows: to provide for dividend on 4½ per cent. preference shares (apportioned to Dec. 31, 1898) £4 499. 17s. 9d.; to pay a dividend at the rate of £10 per cent. for the half-year ended Dec. 31, 1898, on the ordinary shares (making, with the interim dividend paid in August, 1898, £8 per cent. for the whole year), £7,500; and to carry forward £3,292. 1s. 5d. Mr. Stefano Gatti and Mr. R. Chadwick are the directors who retire by rotation, and, being eligible, offer themselves for re-election. The auditors, Messrs. O. R. Johnson and Son, also retire, and offer themselves for re-election.

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REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1898.

Dr.			£	s.	d.
Generation of Electricity.					
Coal or other fuel, including carriage, etc.	£13,354	3 8			
Oil, waste, water, and engine-room stores	1,201	17 10			
Proportion of salaries of engineers, superintendents, and officers	489	13 1			
Wages and gratuities at generating stations	4,562	14 0			
Repairs and maintenance as follows:			19,608	8	7
Buildings	165	8 10			
Engines, boilers, dynamos, motors, and other machinery, instruments, and tools	2 350	14 1			
Accumulators and accessories	110	1 10			
			2 626	4	9
			22,234	13	4
Distribution of Electricity.					
Proportion of salaries of engineers, superintendents, and officers	692	7 6			
Wages and gratuities to linesmen, fitters, labourers	148	19 6			
Repairs, testing, maintenance, and renewals of mains of all classes, including materials and laying the same	434	6 1			
Repairs, maintenance and renewals of motor-generators, meters, switches, fuses, and other apparatus on consumers' premises	538	14 8			
Wayleaves and licenses	490	13 0			
			2.305	0	9
Rents, rates, taxes, and insurances			2,657	2	11
Management Expenses.					
Directors' remuneration	1,050	0 0			
Salaries of secretary, accountants, clerks, and messengers	2 058	12 11			
Stationery and printing	223	17 0			
General establishment charges	417	14 9			
Auditors of Company	75	0 0			
Auditor appointed under the provisions of the order, year 1897	70	0 0			
			3,895	4	8
Law, Parliamentary, and Other Charges.					
Law expenses			177	7	11
Accident compensation claims			191	12	11
Depreciation in respect of leasehold premises, buildings, plant, machinery, etc.			7,000	0	0
			38,461	2	6
Rents, repairs, rates, and taxes in respect of the Company's house property not in its own occupation			134	6	8
Total expenditure			38 595	9	2
Balance carried to net revenue			21 377	2	6
			£59,972	11	8

Cr.	£	s.	d.
Sales of current, less rebates and allowances for bad debts	58 985	3	2
Rentals of meters and other apparatus on consumers' premises	776	18	1
Transfer fees	36	3	9
	59,798	5	0
Rents receivable in respect of the Company's house property not in its own occupation	174	6	8
	£59,972	11	8

GENERAL BALANCE SHEET, DEC. 31, 1898.

Liabilities.			£	s.	d.
Capital account—amount received			377,500	0	0
Sundry creditors for:					
Debenture interest due to Dec. 31, 1898	£1,691	13 4			
Preference dividend to Dec. 31, 1898	1,656	11 6			
Various credits	1,818	14 5			
Sundry tradesmen and others due on construction of plant and machinery, fuel, stores, etc, to Dec. 31, 1898	18 767	7 6			
			23,934	6	9
Net revenue account—balance at credit thereof	19,791	19 2			
Less preference dividend to Dec. 31, 1898	4,499	17 9			
	15,292	1 5			
Less interim dividend paid in August, 1898, on ordinary shares	4,500	0 0			
			10,792	1	5
Depreciation fund account	20,000	0 0			
Share premium account	9,609	3 2			
			29,609	3	2
			£441,835	11	4

Assets.	£	s.	d.
Capital account—amount expended for works	409,383	13	0
Premises not used by the Company	400	0	0
Stores on hand at Dec. 31, 1898: coal, £997. 1s. 11d.; oils, waste, etc., £62 13s. 6d.; general stores, cables, etc., £2,443. 12s. 8d.; stationery, £58 2s. 5d.	3,561	10	6
Sundry debtors for payments on account of contracts in course of completion	8,929	0	10
Sundry debtors for current supplied to Dec. 31, 1898, £17,209. 8s. 1d.; other debtors, £1,468. 10s. 4d.	18 677	18	5
Cash at bankers and in hand	883	8	7
	£441,835	11	4

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		3 985,481
Quantity sold ... { Public lamps ... 4,900 / Private consumers by meter... 3,241,331 }		3,246,231
Quantity used on works		709,865
Total quantity accounted for		3,956,096
Quantity not accounted for		29 385
Number of public lamps		13
Total maximum supply demanded (kilowatts)		2,176

CITY OF LONDON ELECTRIC LIGHTING COMPANY, LIMITED.

Directors: Sir David L. Salomons, Bart. (chairman); George Herring; Edward Lucas; Colonel B. H. Martindale C.B.; Frederick W. Reynolds Engineer: Frank Bailey. Manager and secretary: J. Cecil Bull.

Abstract of report of the directors to be presented to the shareholders at the ordinary general meeting of the Company to be held at Winchester House, Old Broad-street, E.C., on Wednesday, March 1, 1899, at 2.30 p.m.:

The expenditure on capital account during the year ended Dec. 31, 1898, amounted to £90 968. 6s. 1d. Details of this outlay are given in the capital account. The directors propose to make a further issue of the authorised ordinary shares in the course of this year, to provide for extensions of works and plant necessitated by the increasing demand for electric energy.

The total revenue for the year was				£175,607	15 8
From which must be deducted the following items:					
Expenses of generation and distribution	£48,448	16 1			
Rents, rates, taxes, general, and special charges	27,978	17 5			
Transfer to depreciation fund No. 1	17,000	0 0			
Transfer to reserve fund	3 075	9 0			
Amount written off suspense account	1,338	0 8			
			97,841	3	2
Leaving			77,766	12	6
To which must be added the balance brought forward from 1897			1,055	6	7
Making a total available revenue of			78,821	19	1
Of this sum the following amounts have been distributed:					
(a) Interest on debenture stock for year ended Dec. 31, 1898	19,333	6 8			
(b) Interim dividend on £400,000 6 per cent. preference shares, paid in July last on account of the distribution for the year	11,600	0 0			
(c) Interim dividend at the rate of 5 per cent. per annum on £500,000 ordinary shares, fully paid, and £100,000 ordinary shares (November issue, 1897), paid in July last on account of the distribution for the year	12.929	3 4			
			43,862	10	0
Leaving for further distribution			£34 959	9	1

The directors now recommend that the following dividends for the year ended Dec. 31, 1898, be declared, subject to the deduction of income tax, to members registered in the books of the Company on Feb. 15, 1899: preference shares—12s. per share, being a distribution for the year at the full rate of 6 per cent. Of this sum 6s. per share was paid on account in July last, and it is proposed that the balance of 6s. per share be paid on March 2, 1899; ordinary shares, Nos. 40,001 to 90,000—12s. per share, being a distribution at the rate of 6 per cent. for the year. Of this sum 5s. per share was paid on account in July last, and it is proposed that the balance of 7s. per share be paid on March 2 1899; ordinary shares, Nos. 90,001 to 100,000 (November, 1897, issue)—8s. 1d. per share, being a distribution at the rate of 6 per cent for the year, calculated from the due dates of the respective instalments, paid in respect of capital, to Dec. 31, 1898. Of this sum 1s. 9d. per share was paid on account in July last, and it is proposed that the balance of 6s. 4d. per share be paid on March 2, 1899. This will absorb £31,577. 15s. 7d., and leave a balance of £3,381. 13s. 6d. to be carried forward. It is proposed that the warrants for the respective dividends shall be posted on March 2,

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1899. The directors regret the decrease in the rate of dividend on the ordinary shares. It has been mainly caused by the reductions made in the charges to consumers; by the decreased consumption of current per lamp owing to the unusual brightness of the weather during 1898; by the increased cost of coal, and by the increased amount of capital which had to be issued in advance to provide plant and buildings for the steadily growing business of the Company, and which capital ranked for dividend in the past year. The statutory provision for depreciation and reserve funds in accordance with the City of London Electric Lighting Act, 1893 has been made, of which £20,075. 9s. has been set aside out of revenue. The City Corporation availed itself of its rights under the contracts to inspect the accounts of the Company up to Dec. 31, 1897, in order to satisfy themselves that the regulations with respect to the statutory depreciation and reserve funds had been complied with. In consequence of the decreased receipts owing to the reduced charges, etc., the generation and distribution expenses for the year, including repairs and renewals were 36·1 per cent. of the gross earnings, as compared with 31·3 per cent. in 1897, 34 per cent. in 1896, 36·87 for 1895, 46 for 1894, and 52·2 for 1893. The number of customers and equivalent of 8-c.p. lamps connected being at Dec. 31, 1898, 7,414 and 355,825 respectively. On Feb. 8, 1899, there were 379,314 8-c.p. lamps (equivalent) applied for, out of which 363,151 were connected. The income, as shown in the audited statements of accounts issued by the Company for the year ended Dec. 31, 1898, was as follows: gross revenue (after deducting allowances to consumers), £175,607. 15s. 8d.; net revenue available for depreciation, reserve fund, interest on debenture stock, and dividends, £97,842. 1s. 6d. The application for provisional orders made to the Board of Trade by the Charing Cross and Strand Electricity Supply Corporation, the Smithfield Markets Electric Supply Company, and the Metropolitan Electric Supply Company respectively, are being actively opposed by the directors. The applications and objections of the Company thereto are now under consideration by the Board of Trade. The directors deeply regret the loss of their esteemed colleague, the late Earl of Suffolk and Berkshire. They have appointed Mr. George Herring to fill the vacancy thus created. In accordance with the articles of association, two of the directors Colonel Ben Hay Martindale, C.B., and Mr. George Herring, now retire, and, being eligible, offer themselves for re-election. Messrs. W. H. Pannell and Co. retire, and, being eligible, offer themselves for re-election.

REVENUE ACCOUNT FOR YEAR ENDED DEC. 31, 1898.

Dr.	Public lighting. £ s. d.	Private lighting. £ s. d.
Generation of electricity—		
Coal and other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on works	2,745 7 3	24,399 17 0
Oil, waste, and engine-room stores	408 16 6	1,500 17 0
Water	197 16 5	1,635 5 0
Salaries of station engineers and assistants	627 17 0	2,092 12 0
Wages and gratuities at generating stations	1,275 9 6	6,058 12 4
Sundry expenditure	146 19 0	451 6 6
Total generating expenses	£5,402 5 8	£36,138 9 10
Distribution of electricity—		
Proportion of salaries of engineer's assistants	511 15 0	919 0 8
Attending mains and street boxes	210 7 11	1,398 6 5
Wages and gratuities to linesmen, fitters, and trimmers of lamps	1,356 1 11	278 18 11
Wages and gratuities to transformer men and sundry stores	—	1,364 10 11
Carbons and other materials for street and other lamps	694 14 2	126 1 8
Sundry expenditure	—	48 3 0
Total generation and distribution expenses	£8,175 4 8	£40,273 11 5
Rents, rates, and taxes—		
Rents payable	937 8 1	4 687 0 7
Rates, taxes, and lighting	1,407 2 8	7,035 13 5
Management expenses—		
Directors' remuneration, salaries of manager and secretary, accountant, clerks, collectors, etc.	1,263 18 9	6,319 13 11
Printing and stationery	144 19 8	724 18 7
General establishment charges	122 15 4	613 16 10
Meter reading	—	262 2 3
Auditors' fees	23 4 2	116 0 10
Trustees' fees	17 10 0	87 10 0
Legal charges	93 14 4	468 11 6
Special charges—		
Collection charges and various fines	153 1 7	715 2 8
Bad debts (estimate)	—	585 17 1
Official testing of meters	—	14 0 0
Insurances	139 15 0	1,257 15 2
Claims for accidents, etc.	—	50 9 6
Professional charges *re* buildings	—	115 12 0
Repairs to properties sublet	—	621 3 6
Total expenditure	£12,478 14 3	£63,948 19 3
Balance, being revenue for period carried to net revenue account	662 12 8	95,110 15 4
	£13,141 6 11	£159,059 14 7

Cr.	Public lighting. £ s. d.	Private lighting. £ s. d.
Sale of current	—	151,346 8 8
Revenue under contracts	12,927 15 9	—
Meter rentals	—	5,151 1 3
Rents receivable	178 8 10	2 141 6 7
Transfer fees	11 15 2	141 2 4
Testing fees and sundry receipts	23 7 2	279 15 9
Total income	£13,141 6 11	£159,059 14 7

The cost of repairs and renewals to buildings, machinery, mains, etc., amounting to £11 272. 15s. 11d., together with the statutory depreciation, has been provided for out of the depreciation reserve funds in accordance with the City of London Act, 1893

GENERAL BALANCE SHEET, DEC. 31, 1898.

Dr. Liabilities, etc.	£ s. d.	£ s. d.
Capital account—amount received		1,400,000 0 0
Sundry tradesmen and others, due on construction of plant machinery, fuel, stores, etc.		19 926 4 5
Sundry creditors on open accounts		2 317 11 3
Sundry deposits from consumers		350 18 0
Depreciation reserve funds—No. 1	£61 421 12 9	
Do. do. No. 2	43 625 3 10	
Reserve fund	13,999 15 11	
		119,046 12 6
Balance of premiums on issue of £400,000 debenture stock and dividends thereon	50,509 5 11	
Balance of premiums on issue of 10,000 ordinary shares (November, 1897), per last account, £1,537. 4s. 3d.; received during year, £52,825. 4s.	54,362 8 3	
	£104 871 14 2	
Less expenses relating relating to issue of ordinary shares, £122 16s. 2d.; transfer to depreciation reserve fund No. 1, £7,307; depreciation reserve fund No. 2, £20,000	27,429 16 2	
		77,441 18 0
Net revenue account—balance at credit thereof	59,488 12 5	
Less dividend paid on account on £400 000 preference shares (less tax), £11,600 and dividend paid on account on £500,000 ordinary shares, Nos. 40 001 to 90,000, and £100,000 ordinary shares, Nos. 90,001 to 100,000 (less tax) £12, 929. 3s. 4d.	24,529 3 4	
Balance available for distribution as proposed in report		34,959 9 1
		£1,654,042 13 3

Cr. Capital Expenditure and Assets.	£ s. d.
Capital expenditure	1,374 689 2 6
Stores at stations and elsewhere	22.753 2 1
Payments on account of contracts not completed	7,200 0 0
Sundry debtors for current supplied to September, 1898, £838. 9s. 4d.; December, 1898, £68 954 15s. 4d.	69,793 4 8
Other debtors and payments in advance	2,541 3 4
Suspense account, £5,722. 0s. 11d.; less written off out of revenue, £1,338. 0s. 8d.; legal charges, £123. 6s.—£1,461. 6s. 8d.	4,260 14 3
Cash at bankers	5,756 4 8
Cash on deposit and interest accrued thereon	25.276 14 3
Sundry deposits	3,923 0 8
Investments at cost and dividends accrued thereon: 2½ per cent. Greek guaranteed loan	18,000 0 0
Ditto, against depreciation and reserve funds—2¾ per cent. Consols, 2½ per cent. Metropolitan Stock, British railway, and other stocks, £98,073. 11s.; freehold and leasehold property, £22,596. 15s. 9d.; deduct profit on sale of Consols, £820. 19s. 11d.	119,849 6 10
	£1,654,042 13 3

PENNY-IN-THE-SLOT ELECTRIC SUPPLY SYNDICATE, LIMITED.

An extraordinary general meeting of this Company was held at the Registered Offices, Bartholomew Works, Lawford-road, Kentish Town, N.W., on Feb. 16, 1899, when resolutions affecting the distribution of the capital of the Company were carried, also a motion to the effect that the name of the Company be changed to "The Bastian Meter Company, Limited," and an agreement between the Electric Lighting Extension Syndicate, Limited, of the one part, and the Penny-in-the-Slot Electric Supply Syndicate, Limited, of the other part, for the purchase of the whole of their undertaking for the sum of £5,000, payable in fully-paid ordinary shares of this Company's authorised capital, the purchasers also

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undertaking to liquidate the amount of the cash liabilities of the Syndicate, was adopted The Penny-in-the Slot Syndicate already hold over 15,000 shares in the other syndicate.

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY, LIMITED.

The thirty-fifth ordinary general meeting of this Company was held at Cannon-street Hotel yesterday (Thursday), the Hon. H. Marsham in the chair.

In moving the adoption of the report, the **Chairman** said that the accounts showed, after provision for doubtful debts, a net profit of £82,322 for the past year. Adding £13,173 brought forward, and deducting £12,500 interim dividend paid in July, there remained a disposable balance of £62,895. 3s. 3d. The directors recommended the distribution of a dividend of 15s. a share, free of income tax, amounting to £37 500, making, with the interim dividend paid in July, a total payment of 10 per cent. for the year, and leaving £25,395. 3s. 3d. to be carried forward. General business had been more profitable during the past year than in 1897, the selling prices of goods having been advanced to meet the increase in the cost of the raw materials. The cable vessels had only been moderately employed. The efficiency of the Silvertown and Persan factories had been maintained by constant renewals and replacing of plant and machinery where improved methods of manufacture required it. The use of electricity for the transmission of power was being extended at the works. The Melbourne agency had been reinstated in its original quarters, the block which was burnt out having been reconstructed. The Chairman then moved the adoption of the report and accounts.

Mr. S. W. Silver seconded, and they were adopted.

WINDSOR ELECTRICAL INSTALLATION COMPANY, LIMITED.

Directors: M. Drury Lavin, Esq. (chairman); H. L. Prior, Esq. (deputy chairman); Tonman Mosley, Esq.; Edward Riley, Esq.; A. W. Shipley, Esq. (and managing director); A. A. Somerville, Esq.; Rev. R. H. Whitcombe. Engineer-in-charge: Mr. A. E. Farrow.

Report of the directors (with abstract of accounts) to be presented to the shareholders at the fourth ordinary general meeting to be held at the offices of the Company, Peascod-street, Windsor, on Wednesday, March 1, 1899, at 12.30 p.m.:

The directors, in presenting their report, are pleased to be able to state that the shareholders will find from the accompanying accounts for the year 1898 that the business of the Company is progressing satisfactorily. The number of lamps and motors installed on Dec. 31, 1897, was equivalent to 4,985 of 8 c.p. During the year 2,929 were added, bringing up the total to 7,914 on Dec. 31, 1898, of which total 540 represent the motor power. In the course of the year a new boiler has been added, and the mains have been extended to Park-street. The net profit for the year was: installation, £1,003. 6s. 8d.; lighting, £1,536. 6s. 1d.—total, £2,539. 12s. 9d., and to this must be added the balance brought forward from the previous year, making a total sum available for distribution of £2,830. 9s. 7d. The work of the installation department is chiefly obtained through the influence of the directors and their friends, and as this may fall off considerably at any time, it has been considered advisable to deal with the profits of this department separately, and the directors therefore have pleasure in recommending that a dividend at the rate of 3 per cent. be declared out of the profit of the lighting department, and a further 3 per cent. in the form of a bonus out of the profit on installation work, making 6 per cent. for the year. The directors also recommend that the sum of £793. 15s. 2d. be set aside out of the profits to a depreciation, renewal, and reserve fund, which will leave a balance of £687. 10s. 5d., and as no provision has been made in the accounts for directors' fees, the shareholders will be asked to vote them a sum for their services out of this balance, leaving the remainder to be carried forward. The remaining capital of £5,000 was issued during the year at a premium of 2s. 6d. per share, and the directors recommend that out of these premiums, amounting to £625, the whole of the preliminary expenses standing in the balance-sheet at £418. 15s. 2d. be written off, and that the balance of the share premiums be carried to the depreciation, renewal, and reserve fund, bringing that account up to £1,000. Shareholders will no doubt be gratified to learn that the mains have now been extended to Windsor Castle, and since the close of the year the number of lamps connected has already increased by 550 of 8 c.p. The directors have also decided to extend the mains into Victoria-street, William-street, and Oxford-road. This work is now in progress, and it is hoped that these mains will be an additional source of revenue to the Company. In order to meet the growing demand for electricity a new engine capable of supplying current to 6,300 lamps has been ordered, and it will be necessary during the present year to erect an additional boiler, and to replace the two small engines by two of a larger capacity. The present boiler-house being full, an additional one will be erected on the adjoining land. The total capital expenditure to the end of last year, including the stock of the installation department, was £26.409. 15s. 11d., but, as the total capital received was only £25,000, it is obvious that in view of this, and to cover the additions to mains and machinery as mentioned above, it is necessary that the Company's capital be increased. As you will gather from the notice annexed, the directors recommend that the capital be increased by £25,000 from £25,000 to £50,000 and they have no doubt the shareholders will be of the same opinion. The new shares will be issued in such quantities and at such premiums as the Board shall from time to time decide, and it is intended to offer them to the shareholders *pro rata* to their holding Current is being supplied at 7d. per unit, but on and after April 1 next it is the intention of the directors to reduce the charge to 6½d. per unit, which is equivalent in Windsor to a reduction of 3d. per 1,000ft. of gas, and the directors will consider the question of a further reduction when this is justified by increased consumption of current. The directors retiring in rotation are Messrs. H. L. Prior and E. Riley, who, being eligible, offer themselves for re-election.

Revenue Account, Year ended Dec. 31, 1898.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel, including dues, carriage, unloading storing, and all expenses of placing the same on the works	£830	6	5			
Oil, waste, water, and engine-room stores	136	17	3			
Wages and gratuities at generating station	179	5	8			
Repairs and maintenance as follows: buildings, £15. 19s. 6d.; engines and boiler, £78. 17s. 3d.; dynamos and accumulators. £24. 10s. 10d.; other machinery, £9. 14s. 10d.	129	2	5			
				1,275	11	9
Distribution of Electricity.						
Wages and gratuities to linesmen, fitters, labourers	14	6	11			
Repairs, maintenance, and renewals of mains, meters, switches, fuses, and other apparatus on consumers' premises	42	11	9			
				56	18	8
Rents, Rates, and Taxes.						
Rents payable	26	2	0			
Rates and taxes	87	17	2			
				113	19	2
Management Expenses.						
Proportion of salaries of managing director, chief engineers, accountant, clerks and messengers	270	5	2			
Stationery and printing	41	19	7			
General establishment charges	58	12	7			
				370	17	4
Law and parliamentary charges				5	0	8
Special Charges.						
Insurance, etc	20	18	2			
Proportion of fee to auditors of Company	10	10	0			
Fee to Board of Trade auditor	8	0	0			
				39	8	2
Total expenditure				1,861	15	9
Balance carried to net revenue				1,536	6	1
				£3,398	1	10

Cr.	£	s.	d.
Sale of current per meter (105,828 units) at 7d. per B.T.U., less discount and bad debts	2,819	3	8
Sale of current under contracts	128	0	0
	2,947	3	8
Rental of meters and other apparatus on consumers' premises	79	16	10
Rents receivable	127	0	6
Transfer fees	1	7	6
Pupil's premium	41	13	4
Sale of steam, etc.	201	0	0
	£3,398	1	10

General Balance-Sheet, Dec. 31, 1898.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	25,000	0	0
Sundry tradesmen and others due on construction of plant and machinery, fuel, stores, etc., to Dec. 31, 1898	3 217	9	5
Forfeited shares	1	7	6
Net revenue account—balance at credit thereof	2,830	9	7
Premiums on shares	625	0	0
	£31,674	6	6

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	25,414	5	2
Stores on hand at Dec. 31, 1898: coal, £33. 6s. 6d.; oils, waste, etc., £58. 5s. 3d.; general, £995. 10s. 9d.	1,087	2	6
Cells and other apparatus on loan	183	2	4
Preliminary expenses	418	15	2
Sundry debtors for current supplied to Dec. 31, 1898	1,396	6	2
Other debtors	2,395	0	3
Cash at bankers, £771. 17s. 10d.; and in hand, £7. 17s. 1d.	779	14	11
	£31,674	6	6

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KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING COMPANY.

The ordinary general meeting of this Company was held on Wednesday last at 1, Great George-street, Westminster, Mr. G. R. Ryder in the chair.

The **Chairman**, in moving the adoption of the report, said it was satisfactory that they had been able to declare a dividend of 10 per cent. in view of the generally unprofitable year which electric lighting companies had had. With regard to the figures in the accounts, there were some he should like to bring forward. During the year the number of houses and shops connected with the system had increased from 1,620 on Dec. 31, 1897, to 1,851 on Dec. 31, 1898, while the number of lamps calculated on the basis of 8 c.p. had increased from 137,953 to 156,158. With regard to the number of units sold, there were 2,081,074 in the year 1897 as against 1,898,062 in 1898. There was not much difficulty in accounting for the falling off. In 1897 the Jubilee celebrations used a very large amount, and also in the past year there were not so many nice fogs as in 1897. The cost of production in 1898 was £31,897, and in 1897 £29,270. This increase was owing to the great increase in the cost of coal. The rates also increased by about £450. Also in 1897 an interim dividend was paid at a rate of 4 per cent., while in 1898 5 per cent. was paid. There was also a difference in the payments by consumers. In 1897 they paid 5d. per unit, and in 1898 they paid slightly less. The cause of the reduction, which amounted to about ¼d. per unit, was the latest competition they experienced from firms large enough to generate their own electricity. Additional capital required by the Company during the year had been raised by the issue of £12,785 4 per cent. debenture stock, producing £13,807. 16s., and by the issue of 1,187 second preference shares, producing £7,122. The directors had transferred to the renewal account £5 117. 15s. 11d., making the total amount placed to that account £25,615. 9s. 9d. After providing for the above amount, and paying the dividends on the 6 per cent. first preference shares to June 30. 1898, on the 5 per cent. second preference shares to Sept. 30, 1898, and an interim dividend at the rate of 10 per cent. per annum on the ordinary shares for the first half of the year, the balance standing to the credit of the net revenue account for the year 1898 was £6,300. 10s. 11d. Of this £1,450 had been appropriated to the payment of the first preference dividend to the end of the year, and £400 had been set aside to meet the portion of the dividend on the second preference shares accrued to the same date, leaving £4,450. 10s. 11d., out of which they proposed to pay a further dividend on the ordinary shares at the rate of 10 per cent. per annum for the past half-year, making, with the interim dividend paid to June 30, 10 per cent. for the year. That left a balance of £825. 10s. 11d.

The report was seconded by **Sir F. Bramwell** and adopted.

An extraordinary general meeting was then held, at which the following resolution was adopted: "That the Bill which has been deposited in the Parliament Office, and in the Private Bill Office of the House of Commons, with a view to its introduction into Parliament in the approaching session, and of which the short title is 'Kensington and Notting Hill Electric Lighting,' of which Bill a copy has been laid before this meeting, be and the same is hereby approved."

LONDON ELECTRIC SUPPLY CORPORATION, LIMITED.

Directors: The Right Hon. Lord Wantage, V.C., K.C.B. (chairman); The Right Hon. the Earl of Crawford, K.T., F.R.S., LL.D.; Roger de Quincé Quincey, Esq.; R. Stewart Bain, Esq., C.A. (managing director). Engineer-in-chief: P. W. D'Alton, M.I.M.E., M.I.E.E. Resident engineer and electrician: G. W. Partridge, A.M.I.C.E. Secretary: H. C. Carter.

Report of the directors (with abstract of accounts) for the half-year ended Dec. 31, 1898, to be submitted to the shareholders at the ordinary general meeting to be held at the Cannon-street Hotel on Thursday, March 2, 1899, at 12 noon:

In accordance with the resolution passed at the extraordinary general meeting of the Corporation on June 7 last, the capital of the Corporation has been reduced by £222,000 by writing down the nominal amount of the ordinary shares from £5 to £3 each. This reduction duly received the sanction of the Court, and it has enabled the Board to write off £181,688. 16s. 2d. in the various works set forth in the capital account, and the whole of the preliminary expenses and debenture discount accounts. The capital account now stands at £736,521. 14s. 2d. The issue of £200,000 first mortgage debenture stock, which was largely over-subscribed, enabled the Board to pay off the whole of the debenture debt and loans as at June 30 last, and the undertaking passed again into your hands as from July 1 last. Stock Exchange quotations have been obtained for the ordinary and preference shares, and for the debenture stock. The Board is pleased to state that the satisfactory progress of the business of the Corporation up to March 31 last, as described at the meeting held on June 7 last, has continued during the year. The number of lights added during the year was 31,221, being an increase of 25 per cent., the total number of lights at Dec. 31 being 155,319, and the same ratio of increase has continued since the accounts were closed. The new 2,000-h.p. plant was finished in October, and has worked satisfactorily during the winter. New distributing mains have been laid from Newington-causeway to Greenwich, and also in the whole of the compulsory area in Bermondsey, and partly in Rotherhithe. The plant and machinery have worked satisfactorily during the year, and have been entirely maintained out of revenue. The prolonged strike in the South Wales coalfield added materially to the generating costs during the year. The profit on the workings for the half-year ending Dec. 31 is £13,535. 5s. 6d., to which has to be added interest on deposits, £291. 17s. 8d., making a total of £13 827. 3s. 2d. Out of this the interest on debentures to Dec. 31—viz, £3,344. 3s. 7d.—has been paid, leaving £10,482. 19s. 7d. now to be dealt with. The Board propose to deal with this amount as follows: by payment of a dividend at the rate of 6 per cent. per annum on the preference shares for the half-year ending Dec. 31, £7,207. 10s.; and to carry forward £3,275. 9s. 7d. The retiring director is the Right Hon. Lord Wantage, V.C., K.C.B., who is eligible for re-election.

REVENUE ACCOUNT, HALF-YEAR ENDED DEC. 31, 1898.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing same on the works	£9,686	10	6			
Oil, waste, water, and engine-room stores	1,278	2	11			
Salaries of engineers, superintendents, and officers	512	10	0			
Wages and allowances at generating station	2,888	14	2			
Repairs and maintenance as follows: buildings, £209. 3s. 6d.; engines and boilers, £1,558. 5s. 2d.; dynamos and exciters, £175. 0s. 3d.; other machinery and tools, £159. 19s. 6d.; transformers and accessories, £86. 14s. 4d.	2,189	2	9			
				16,555	0	4
Distribution of Electricity.						
Salaries of superintendents and officers	624	18	9			
Wages and allowances to linesmen, fitters, etc.	718	8	3			
Repairs, maintenance, renewals, and charges of mains of all classes, including materials, and laying same; also wayleaves	839	18	2			
Repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises	448	17	9			
Repairs to buildings	143	3	6			
				2,775	6	5
Rents, Rates, and Taxes.						
Rents payable	518	18	4			
Rates and taxes	937	15	3			
				1,456	13	7
Management Expenses.						
Directors' remuneration (£1,000—half relinquished)	500	0	0			
Salaries of manager, secretary, engineers, clerks, and messengers	1,593	8	11			
Salaries of canvassers and meter readers	238	3	1			
Stationery and printing	177	9	6			
General establishment charges	260	4	10			
				2,769	6	4
Law and Parliamentary Charges.						
Law expenses	91	18	4			
Board of Trade audit	42	10	0			
				134	8	4
Balance carried to net revenue account				13,535	5	6
				£37,226	0	6

Cr.	£	s.	d.
Sale of current per meter less discounts and allowances	34,252	12	1
Sale of current under contracts	814	4	2
Rental of meters, converters, and other apparatus on consumers' premises	1,516	9	5
Transfer fees	34	15	0
Sundry receipts, including students' fees, discounts, etc.	607	19	10
	£37,226	0	6

Dr. GENERAL BALANCE-SHEET, DEC. 31, 1898.	£	s.	d.
Capital account—amount received	773,250	0	0
Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, etc., to Dec. 31, 1898	11,105	16	7
Sundry creditors on open accounts	1,915	14	0
Net revenue account	10,482	19	7
	£796,754	10	2

Cr.	£	s.	d.
Capital account—amount expended for works	736,521	14	2
Cash at bankers and in hand	39 260	7	8
Sundry debtors for current	18,888	3	8
Other debtors	1,043	1	6
Running stores on hand, Dec. 31, 1898	1,041	3	2
	£796,754	10	2

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NATIONAL TELEPHONE COMPANY, LIMITED.

The ordinary general meeting of this Company was held last Friday at the Cannon-street Hotel, E.C.

Mr. James Staats Forbes, who presided, said that the income for the half-year showed an increase of £66,104, the working expenses an increase of £29,376, and the profit balance an increase of £28,430. The net result for the half-year, after deducting Post Office royalties amounting to £54 356, was a profit balance of £206,888, as compared with £178,457. Out of the balance of £172,037 the Board recommended the payment of a dividend at the rate of 6 per cent. per annum, less income tax, on the first and second preference shares, 5 per cent. per annum, less income tax, on the third preference shares, and 6 per cent. per annum, free of income tax, on the ordinary shares. That was the same dividend that they paid for several half-years. The Board proposed to transfer £50,000 to the reserve fund and to carry forward the balance of £8,287. The income accrued in respect of the business of the half-year was £573,707, which was an increase of £66,104. The next was the item of Post Office royalties. £54,356 for the half-year, and reduced the income to £519,350. That was to say that the Post Office took 10 per cent. of the gross receipts, an enormous incubus on the Company. The net income amounted to £519,350, from which they had to deduct £312,462 for working expenses, leaving the net result for the half-year at £206,888. The amount brought into the revenue account was a small one as compared with some of the previous half-years. They next came to the debenture and other interest, which had increased by £2,743. The preference and ordinary dividends would absorb £113,750, and they proposed to carry £50,000 to the reserve, and to carry forward £8,287. As to the capital account, they had no unissued capital at the present time. Of the £2,000,000 debenture stock they had succeeded during the half-year in placing £330,000. During the half-year they had spent £367,201 in the erection of 6,932 additional exchanges and private lines, and which was about the average of the past few years. A considerable prejudice had been created against the Company, but that had been created by people who were interested in doing so, and they had recently held a parliamentary enquiry, during which much stress was laid on the fact that the Company was exempt from the conditions as to the services and charges which in the case of railways, gas, and water companies were usually imposed by Parliament. He (the chairman) would, however, point out that the Company had lodged several Bills in Parliament so that they might have powers to enable them to carry on their work efficiently, but they had all been vetoed by the Government. The Board considered that the probable wants within the next four or five years would be covered by the sum of £1,000,000, according to the present rate of expenditure. The Chairman moved the adoption of the report, which was seconded by **Lord Harris,** and agreed to.

The **Chairman** then proposed a resolution to the effect that the borrowing powers of the Company should be three-fourths of the issued capital for the time being, that was to say, he said, that they would be able to borrow another £1,000,000.

This was seconded and agreed to.

The **Chairman** then moved resolutions approving certain Bills proposed to be introduced into Parliament. The Bills, if passed, would, he said, give the Company powers to enable it to efficiently carry on its business.

The resolutions were seconded and approved.

After the close of the ordinary business of the meeting the **Chairman** continued his remarks, and complained that the Post Office had not carried out its part of the bargain entered into with the Company when the trunk wires were taken over, and at the present time they were threatened with the practical withdrawal of the most valuable of the concessions made to them as part of the purchase considerations of the trunk wires. When taking over those lines they promised to co-operate with this Company, but instead they had impeded them. The Company were now threatened with competition, but they did not fear that on equal terms. There was no doubt that the object of this opposition was to knock down the value of the Company's stock when the time came to take over the business. The wise course would be for the Post Office to take over the business at once. In conclusion, he said that the opposition to the Company he considered unfair, and the cause of much inconvenience to the public.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY, LIMITED.

The annual report of the directors of this Company states that of the £50,000 additional capital authorised by the extraordinary general meetings in 1897 the first issue of £25,000 was taken up by the shareholders or their nominees in 1897 at 60 per cent. premium, enabling the reserve to be increased by £15,000. The second issue of £25,000 was taken up by the shareholders or their nominees in 1898 at 80 per cent. premium, enabling the reserve to be increased by £20,000. The accounts show that during the past year a net profit has been made of £33,394 18s. 7d. After payment of debenture interest and income tax, and making ample allowance for depreciation of buildings, plant, machinery, etc., there remains £27,823. 7s. 9d., making, with £14,789. 11s. 7d. brought forward from last year, a total of £42,612. 19s. 4d. available for distribution. The directors have transferred £7,500 to the reserve (in addition to the £20,000 above mentioned), and they recommend the payment of the following dividends—viz : on the preference shares, 7 per cent., including the interim dividend of 3½ per cent. paid on Sept. 1 last; on the ordinary shares at the rate of 12 per cent. per annum, including the interim dividend of 4 per cent., also paid on Sept. 1 last, and a bonus of 2 per cent. per annum. These payments will together amount to £28,084. 5s. 1d., leaving £14,528. 14s. 3d. to be carried forward. The dividend warrants will be posted on Feb. 28, 1899. Major-General George Hutchinson, C.B., C.S.I., and the Hon. Randolph Stewart retire by rotation in accordance with the provisions of the articles of association, and, being eligible, offer themselves for re-election. The auditors, Messrs. Ball, Baker, Deed, Cornish, and Co. retire, and, being eligible, offer themselves for re-election.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY.

The report of the directors states that the accounts for the past year show a net profit of £71,593, after charging the interest on the debentures. The directors propose to distribute a dividend of £1. 4s. per share, being at the rate of 10 per cent., and making, with the amount already paid, a total dividend for the year of £1. 16s. per share, or 15 per cent., free of income tax. The report states that the Company's works during the past year have been fully occupied in the manufacture of submarine telegraph cables and insulated land lines, and the steamships have been actively employed in the laying and repairing of cables. An important addition to their fleet was the steamship "Anglia," 6,514 tons, built during the past year—the largest telegraph steamer afloat. The Company's £150,000 5 per cent. debentures, which matured on Jan. 1, had been extended for a period of 10 years from that date at the rate of 4 per cent. per annum. The directors propose to establish a pension fund for the benefit of the staff.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Huddersfield.—The Electricity Committee of the Corporation invite tenders for complete switchboard. Tenders by 27th inst.

Southport.—The Corporation offer for sale two Browett and Lindley engines and Mather and Platt alternators. Tenders by March 21.

Huddersfield.—The Electricity Committee of the Corporation are prepared to receive tenders for mechanical coking stokers. Tenders by 27th inst.

Madrid.—The Public Works Department are inviting tenders for the building of an electric tramway in the city. Applications must be sent in by p.m. on April 14.

Ecclesall Bierlow.—The Guardians invite tenders for the supply and erection of an electric light plant at their workhouse, The Edge, Sheffield. Tenders by Feb. 27,

Greenock.—The Board of Police invite tenders for the supply and erection of the various plant (low-tension system) for their electricity works. Tenders by March 3, 1899.

Canterbury.—The Lighting Committee of the Corporation invite tenders for the supply and erection of various plant for the municipal electricity works. Tenders by March 14.

Gloucester.—The Electricity Supply Committee are prepared to receive tenders for the supply and erection of various plant at the municipal electricity works. Tenders by Feb. 28.

Edinburgh.—The Magistrates and Council invite tenders for works in connection with their electric lighting station in Macdonald-road, particulars of which appear elsewhere. Tenders by Feb. 27.

Oldham.—The Electric Light Committee invite tenders for two Lancashire steam boilers, 28ft. by 8ft. Specification can be seen at the office of Prof. Kennedy, 17, Victoria-street, Westminster. Tenders by Feb. 28.

Redditch.—The Urban District Council invite tenders for about 100 alternating-current meters. Particulars can be obtained (£2. 2s.) from Mr. J. A. McMullen, M.I.E.E., Hornchurch, Essex. Tenders by Feb. 27.

Wolverhampton.—Firms desirous of tendering for the supply of small electric launches for lake use are requested to write to Mr. G. W. Bradley, A.M.I.C.E., borough surveyor, from whom further information can be obtained.

Poplar.—The Guardians invite tenders for steam turbines and dynamos (direct coupled), electric motors, battery of accumulators, electric cables, wiring, and fittings, main switchboard, and distribution boards. Tenders by March 22.

London, N.—The Shoreditch Vestry are prepared to receive proposals and to contract with any person or persons for various articles and works, for particulars of which refer to our advertising columns. Tenders by 28th inst. at 6.30 p.m.

Piedrahita (Spain).—Tenders are asked for the electric lighting of the town. The estimated cost is 33,750 pesetas, and the deposit required is 3,375 pesetas. Tenders are to be addressed to the Syndaco of Piedrahita, province of Avila, by March 9, or the Ministerio de la Gobernacion, Madrid, by March 3.

Edinburgh.—The Council invite tenders for the following works in connection with their electric lighting station in Macdonald-road: Contract No. 7: Condensing plant, with water-cooling tower, feed-water tanks, and filters. Tenders by March 6.

Wolverhampton.—The Lighting Committee invite tenders for an extension of the electric lighting station, Commercial-road,

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Wolverhampton. Particulars may be obtained of Mr. J. W. Bradley, C.E., Town Hall, Wolverhampton. Tenders by Feb. 27.

Hereford.—Tenders are invited by the Town Council for erection and completion of the buildings in connection with the electricity station in Widemarsh-street. Specification can be obtained at the office of Mr. John Parker, A.M.I.C.E. Tenders by 5 p.m. on March 13.

Ipswich.—Messrs. Pain and Bayles, chemists, Cornhill, Ipswich, are prepared to receive tenders for their plant, consisting of Crossley's high-speed Otto gas-engine, indicating 4 h.p., combined with dynamo for supplying about 30 16-c.p. lamps. Tenders will be opened on March 4.

Weston-super-Mare.—The Urban District Council invite tenders for fixing telephonic communication between the fire brigade station and firemen's dwellings. Specifications, etc., may be seen at the office of Mr. Hugh Nettleton, surveyor, Town Hall, Weston-super-Mare. Tenders by 28th inst.

Pernambuco.—The Government of the State of Pernambuco invite tenders for the construction of an electric tramway to run between that city and Olinda, situated at about three miles distance. Tenders, duly sealed, must be addressed to the Secretaria da Industria, Pernambuco, and should be received there not later than March 18.

Kirkcaldy.—Offers are invited from persons willing to make a proper tramline (2ft. gauge) along the county highway road, from High-street, Thornton, to Thornton Junction Station, and to equip it with tramcars, and work the same. Tenders to be submitted to Mr. Alex. Beveridge, clerk to the Kirkcaldy District Council, 220, High-street, Kirkcaldy, by March 4.

Dublin.—The Great Northern Railway Company (Ireland) invite tenders for erection at Amiens-street, Dublin, of an electric power-house, 75ft. long by 23ft. wide, to be built of brick, with steel principal roof. Specification, etc., may be obtained at the office of the Company's Engineer-in-Chief, Amiens-street Terminus, Dublin. Tenders by 10 a.m. on March 13.

Cardiff.—Tenders are invited by the Corporation for the covering of sundry steam and feed-water pipes at the Corporation electricity works. Specification obtained at the office of the Electrical Engineer, Eldon-road, Cardiff. Sealed tenders, endorsed "Pipe Covering," to be delivered at the office of Mr. J. L. Wheatley, town clerk, Town Hall, by 9 a.m. on March 2.

Edinburgh.—Tenders are invited by the Corporation for installing the electric light at Tollcross tramway power station. Specification, forms of tender, and plans of the building can be obtained at the office of the Resident Electrical Engineer, 5, Dewar-place, Edinburgh, on deposit of £2. 2s., which will be returned on receipt of a bona fide tender. Tenders by March. 6.

Stockport.—The Gas and Electricity Committee invite tenders for supply of two 140-kw. shunt-wound dynamos. Specification, etc., may be obtained on application to Mr. S. Meunier, Portwood, Stockport, on payment of £2. 2s., which will be returned on the receipt of a bona fide tender. Drawings and full details to be submitted to Mr. S. Meunier on or before March 2. Tenders by March 9.

Linthwaite.—Tenders are invited by the Urban District Council for supply of granite setts, tramrails, fish-plates, sole-plates, bolts, tier rods, copper bonds, etc., necessary for the construction for 3½ miles of tramways. Particulars and quantities, etc., may be obtained from Messrs. Abbey and Hanson, C.E., 20, Ramsden-street, Huddersfield, to whom sealed tenders are to be sent by 4 p.m. on 28th inst.

Lewes.—The Corporation invite offers from responsible companies or persons willing to establish an electricity supply undertaking under and subject to the provisional order of 1898. Particulars may be obtained at the offices of Mr. F. J. Warden-Stevens, Connaught Mansions, 34, Victoria-street, Westminster, S.W., or at the office of the Clerk, Town Hall, Lewes, on deposit of £5. 5s. Tenders by March 24.

Brighton.—The Council are prepared to receive tenders for the purchase of the following materials: (lot 1) about 1½ tons of pure electrical copper (cable ends with insulation and lead burnt off); (2) about 17½ tons of old cast-iron firebars; (3) about 11 tons of second-hand straight and tee cable joint boxes, with screw filling plugs (similar to Siemens's pattern), and a few street disconnecting boxes. Tenders by March 6.

Bristol.—Tenders are invited by the Docks Committee of the Council for the erection of the Avonmouth Granary electric generating station. The building will cover a space measuring about 75ft. by 45ft., and is to be of brick with galvanised iron roof. Plans may be seen at the Engineer's Office Cumberland Basin, Bristol. Specifications, etc., may be obtained on payment of £1, which will be returned on receipt of a bona fide tender. Tenders by 10 a.m. on March 2.

Dundee.—The Gas Commissioners invite tenders for the supply and erection of the following plant at the electric station, Dudhope-crescent-road, Dundee: (Contract No. 12) four Lancashire boilers; (13) two 450-h.p. steam-engines and dynamos; (14) one 700-h.p. steam-engine and dynamo. Specifications, etc., may be obtained from Mr. Walter H. Tittensor, Dudhope-crescent-road, Dundee, on deposit of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders by March 15.

Belfast.—The Electric Committee are prepared to receive tenders for the supply and erection of the following: (Section C 12) switchboard extensions. Specifications and conditions of contract may be obtained on application to Mr. Victor A. H. McCowen, city electrical engineer, on payment of £1, 1s. per copy, which sum will be refunded on the return of the specification with a bona fide tender. Sealed tenders, endorsed "Tender for Switchboard Extension," must be sent to Sir Samuel Black, town clerk, by 12 a.m. on March 16.

London, W.—The Vestry of Hammersmith invite tenders for the supply and erection of the following machinery by May, 1900: Contract A, three water-tube boilers; B (1), two 1,000-h.p. slow speed engines, coupled direct to B (2), two 600 kw. alternators; C, underground feeders; D, cast-iron pipes. Specification, with general conditions and form of tender, can be obtained at the office of Mr. W. P. Cockburn, vestry clerk, Town Hall, Hammersmith, on and after 27th inst. upon payment of £2. 2s., which will be returned on receipt of a bona fide tender. Specifications and drawings may be seen, but not obtained, at the office of Mr. A. H. Preece, 39, Victoria-street, Westminster. Tenders must be delivered at the Town Hall, Hammersmith, by 5 p.m. on March 15.

Shanghai.—The Shanghai Municipal Council invite tenders for a concession for constructing and working about 23 miles of electric tramways on the trolley system in the streets of Shanghai. The special attention of tenderers is drawn to the fact that the tender (if any) recommended by the Council will require ratification by the ratepayers. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 being deposited with Messrs. Pook and Co., which sum will be retained by the Council, and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China (telegraphic address Dynamo, Shanghai; "ABC," fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Tramway Concession," must be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, and received by 12 noon on June 30.

Shanghai.—The following resolution in reference to the telephone system in Shanghai was passed at the last annual meeting of the ratepayers of the Foreign Settlements at Shanghai, north of the Yang-king-pang: "Resolution VIII.—That the Council be and is hereby authorised to enter into negotiations with the China and Japan Telephone Company or any other company, and in its discretion grant a franchise with a view to the community being supplied with an adequate and efficient telephone service at a fixed maximum charge." In accordance with the above resolution the Shanghai Municipal Council invite tenders for a concession for a period of 30 years for the exclusive right of establishing and working a telephone system in Shanghai. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 sterling being deposited with them, which sum will be retained and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China. Telegraphic address, Dynamo, Shanghai (ABC, fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Telephone Concession," to be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, by 12 noon on March 31.

RESULTS OF TENDERS.

Knowle.—The Hants County Council have accepted the tender of Mr. F. Shalders, of Southampton, for electric plant, £4,052, for the County Asylum's new buildings.

Wimbledon.—The following tenders have been accepted: Messrs. Cowan's, Limited, for additional switchboards, £212; and Messrs. Aston's for ironwork at the tipping platform, £464. 10s.

London.—The London County Council have accepted the tender of Messrs. McClure and Whitfield at £3,726. 5s., and Messrs. J. E. H. Andrew and Co., Limited, for supply of dynamos and gas-engines for the electric lighting on the Victoria-embankment.

Edinburgh.—Tenders have been accepted by the Corporation as follows for the steelwork of roofs required in the construction of the McDonald-road electric lighting station: Steelwork of roofs, Arrol's Bridge and Roof Company, Limited, Germiston Works, Glasgow, £2,823; iron and steel work—Redpath, Brown, and Company, Limited, St. Andrew's Steelworks, Edinburgh, £7,788.

Buxton.—The Council have received the following tenders for building work in connection with their electric light station in Buxton: J. Booth and Son, Denby-street, Cheetham, Manchester; C. H. Normanton, Manchester; J. Fidler, Eckington, Sheffield; Groome and Co., Limited, Bakewell; J. Parnell and Son, Rugby; A. and E. Oakes, Buxton; R. Ash, Buxton; H. Vickers, Nottingham (accepted).

Buxton.—The Urban District Council have received the following tenders for works in connection with their electric light station: (Contract No 6) feeders, mains, and arc light leads—Callender's Cable and Construction Company, Limited, 90, Cannon-street, London (accepted). Also tendered: W. T. Henley's Telegraph Works Company, Limited, 27, Martin's-lane, Cannon-street; British Insulated Wire Company, Limited, Prescot, Lancs.; Western Electric Company, North Woolwich, E.; Siemens Bros. and Co., Limited, 12, Queen Anne's-gate, Westminster; W. J. Glover and Co., St. Helens, Lancs.

Hastings.—The Council have accepted, in connection with the extension of the electric light works, the tender of G. E. Belliss and Co., Limited, of Ledsam-street, Birmingham, for the supply, delivery, and fixing of one of their quick-revolution enclosed tandem compound three-crank equal-angle standard patent

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last, which recommended the overhead system as the best method of equipping the Woodside route for electric traction. Provision has been made in the plans deposited in connection with the provisional order for the doubling of the section from Kittybrewster to Woodside to construct a 6ft. way between the two lines; and in this section it is proposed to erect centre poles in the 6ft. way, fitted with ornamental side brackets to carry the overhead conductors. The cost of the works and plant is estimated at £33 300. In the report referred to an estimate was submitted referring to the conversion of the Woodside section from horse haulage to electric traction. The capital expenditure of the horse haulage system is given at £38,590, that of electric traction at £57,600, while the estimated revenue and expenditure account of the former give an estimated deficiency of £549, and that of the latter an estimated surplus of £254.

English Industrials, Limited, Manchester.—We are informed that this Company has been appointed the sole representative for Ganz and Co., of Budapest. It is not intended to import manufactured plant into this country, but arrangements have been made by which the whole of the construction and the execution of orders for central-station and other contracts will be carried out in this country. Mr. G. E. Heyl Dia, of Manchester, has been retained for the present to act as consulting engineer to the Ganz department of the company until the English Ganz Construction Company takes over the whole of the business. The manufacture of Messrs. Ganz's plant will at present be carried out by Messrs. W. R. Renshaw and Co. in Stoke-on-Trent under an agreement with this firm, but as soon as the financial arrangements have been completed, Mr. James Swinburne, of London, will act as consulting engineer to the Ganz Company, who will also have the advice of the scientific and practical staff of Messrs Ganz and Co. in Budapest, especially of an authority on alternating current, Mr. Blàthy.

New Lubricator.—We have received from Messrs. Scott, McLachlan, and Co., of 25, Richmond-street, E.C., an illustrated description of Scott's patent lubricator for semi-solid lubrication, also particulars with reference to their mica grease, which is especially suitable for use with this lubricator. The idea of the lubricator is that of having a piston always pressing on the mass of solid lubricant, forcing it gradually through the restricted orifice into the bearings. This pressure is produced by means of a screw on the piston rod, on which is a nut. This nut is constrained to revolve by a spiral steel spring, which can be set up by hand or by a worm and wheel according to the size and position of the lubricator. In this way a few turns of the nut can make the piston traverse the full depth of the lubricator reservoir. By using a long steel spring of the clock spring type the number of revolutions required in the nut does not cause any great diminution in the pressure exerted on the face of the lubricant. The principle of these lubricators is good, and if the detail is equally well looked after they should be found very servicable in practice.

Whitechapel.—At the last meeting of the District Board the following proposal was on the agenda with reference to the report of the Electrical Committee: "To consider the suggestions made by a letter from the London County Council on the proposal of the Board to borrow the sum of £60,500 in order to carry out that portion of the work of erecting an electric lighting installation in this district as contemplated by the report of Mr. Wright, the electrical engineer, and to renew such application upon the terms following—namely, 'That such loan be upon the instalment system and not upon the annuity system, as at first proposed by this Board, repayable in 42 years with interest at the rate of 3 per cent. per annum, provided that not less than £10,000 be taken up at one time, and upon the understanding that if any works fail to be renewed during the currency of the mean period, the cost of renewal shall constitute a maintenance charge and shall not be made the subject of a fresh loan, and that the repayment shall commence at the expiration of three years from the quarter-day anterior to the date of the advance of the first portion of the loan; and that the resolution passed by this Board at their meeting held on Jan. 16 last be varied accordingly.'" The report was, however, referred back for further consideration.

Paddington and Telephone Company's Bills.—On Tuesday at the Paddington Vestry the Legal Committee submitted a report stating that the National Telephone Company's Bills did not appear to affect any specific parts of the parish of Paddington, but they affected the rights of the Vestry as a road authority in common with other local authorities, and they also affected the rights of private owners of property. The committee therefore recommended that the Bills be referred to the sub-committee, with power to oppose the Bills on behalf of the Vestry, either alone or in conjunction with other local authorities, and to give such instructions and incur such expenses for the purpose of conducting such opposition as they may be advised, reporting from time to time to the joint committee consisting of the Works and Legal Committees. Letters were read from the Vestries of St. Martin's-in-the-Fields and of St. Luke's to the effect that they had requested the London County Council and the City Corporation to oppose the passing into law of the Bills, and asking the co-operation of the Vestry in the matter. The Vestry solicitor wrote wishing to know whether the Vestry would oppose the Bills, because notice of their intention to do so would have to be given by the 25th inst. The Vestry decided to adopt the Legal Committee's recommendation, and the solicitor to give the necessary notice to oppose.

Southampton.—The report of the Isolation Hospital Sub-Committee of the Health Committee, which has been adopted by the Town Council, states that the cheapest and best method of providing the electric current for lighting the isolation hospital would be to take a supply from the Corporation electric works by means of a cable from their existing mains in Shirley-road, and that the architect had obtained an estimate from the electrical engineer of the cost of laying the cable at £290. The estimated cost of wiring and fittings for the provision of 392 lights, as shown on the plan submitted, would be £650. The committee resolved to recommend that the Electric Lighting Committee be requested to lay a cable to the entrance of the hospital grounds, and that Messrs. Walton, J.P., and Lauder confer with the Electric Lighting Committee upon the subject of the cost of the proposed cable, and report. They also resolved to recommend the Health Committee to advertise for tenders for the wiring, fitting, lamps, and apparatus within the grounds and buildings of the hospital, in accordance with the plans submitted by the architect. The architect submitted a list of the necessary apparatus and fittings to be provided in connection with the above, and the sub-committee resolved to recommend the Health Committee to advertise for tenders for the necessary apparatus and fittings in accordance with the plans and specifications of the architect.

Paddington and Trunk Mains.—On Tuesday, at the Paddington Vestry, the Electric Lighting Committee submitted a report, in which they recommended, "That inasmuch as counsel is of opinion that the application of the Metropolitan Electric Supply Company to lay down trunk mains through Paddington should be resisted on the grounds that it would greatly complicate the question of purchase should the Vestry hereafter decide upon acquiring the works of the Paddington undertaking, the Vestry do not grant such application, and that the committee be empowered to instruct the solicitor to oppose the same, and, if necessary, to employ an expert to advise them in the matter." Colonel Barchard, the chairman of the Electric Lighting Committee, in moving the adoption of the report, said that the electric light company desired to lay down five large cables through their streets, and that the committee, seeing that these cables were to pass through their streets for the purpose of supplying other parishes with electricity, did not think it advisable to allow. Not long since, at Belfast, an explosion was caused and great damage done. If they allowed these mains to be put down, there was another matter which would be of great importance to them should the Vestry hereafter decide to purchase the undertaking of the company so far as it related to Paddington, because the question of these mains would lead, no doubt, to a bone of contention in regard to the price to be paid for the purchase. After discussion the committee's recommendation was unanimously agreed to.

Opposed Bills.—The Teignmouth Council have decided to petition against the National Telephone Company's Bills. A town meeting at Coventry has confirmed the City Corporation's action in opposing the Leicestershire and Warwickshire Electric Supply Company's Bill. The Ham District Council have asked Mr. T. Skewes-Cox, M.P., to oppose that section of the Electric Power Bill which provides for special powers for private companies. The Loughborough Town Council will oppose the National Telephone Company's Bills 1 and 2, and the National Telephone Company's Telegraph Act (1892) Amendment Bill. The Grimsby Town Council have sealed a petition in opposition to the Great Grimsby Street Tramways (Extensions) Bill. The Poplar District Board of Works have petitioned Parliament against the National Telephone Company's Bills, and have requested the London County Council to oppose such measures during their passage through Parliament. The Luton Town Council have asked Mr. Ashton to oppose the Leicestershire and Warwickshire Company's Bill. The Leamington Town Council will oppose the General Power Distributing Company's Bill. The Hastings Council will oppose the Bexhill and St. Leonards Tramroads Bill. The Stone Urban District Council will oppose the various proposed measures relating to electric light supply. The Mansfield Town Council will oppose the General Power Distributing Company's Bill. The Kenilworth Urban District Council will oppose the Leicestershire and Warwickshire Electric Supply Company's Bill. At a conference of authorities in Lancashire and Cheshire, held in the Memorial Hall, Manchester, on Tuesday, to consider the advisability of allowing the Lancashire Electric Power Bill, 1899, to pass in its present form, a committee was appointed to take the necessary steps to oppose the Bill. The Rawtenstall Town Council has asked their member to oppose the National Telephone Company's Bills. The Keighley Town Council will petition against the General Power Distributing Company, the Lancashire Electric Power, South Lancashire and Cheshire Electricity, Leicestershire and Warwickshire Electric Supply, Midland Electric Power P.O, Telegraph Act, 1892 (Amendment) Bills. The Perth Water Commission will oppose the Highland Water-Power Bill.

London County Council.—The Council on Tuesday agreed to lend the St. Pancras Vestry £12,000 for electric lighting purposes, the Islington Vestry £14,285 for similar purposes, and the Poplar overseers £2,500 for alterations and additions to the town hall. The Highways Committee's report on the National Telephone Company's overhead wires in Islington (which was referred back) recommended that the Council sanction the continuance for 12 months from Dec. 6, 1898, of the wires specified in the list submitted from the metropolitan superintendent of the National Telephone Company, as having been erected in the parish of Islington with a longer span than the 115 yards allowed by the Council's by-law No. 5 under the London Overhead Wires Act, 1891, but less than 150 yards in span; and that the Council also sanction the continuance for six months of the wires specified in the said list with spans of 150 yards or more; such sanction being, however, subject to the condition that the company

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before the expiration of the period named in each case, or of such other period as the Council may hereafter allow, and on such conditions as the Council may lay down, place all or any of the said wires underground, or provide within such specified period intermediate supports for such of the wires included in the list as may not have been placed underground; the Vestry of Islington be informed of this decision; and that the Vestry be at the same time informed that the Council appreciates the action taken by the Vestry for the enforcement of the by-laws, and that the object of the Council in giving its consent on the conditions above stated is to prevent inconvenience being caused to the public by the closing of the exchange with which the wires referred to in the application of the company are connected. The following notices under Electric Lighting Acts and Orders were approved under the usual conditions from the House-to-House Electric Light Supply Company; Blackheath and Greenwich District Electric Light Company (two); County of London and Brush Provincial Electric Lighting Company, under the Camberwell Order; Charing Cross and Strand Electricity Supply Corporation, 1896, (1) under the St. Martin's Order, 1889 (2) under the Strand District Order, 1896; the Vestry of St. Pancras. A notice was received from the Whitechapel District Board, under the Whitechapel District Order, 1892. The Vestry is the undertaker under the order, and the Council has no power of approval or disapproval of the works.

Hastings.—The Town Council have resolved that the scheme of the Hastings, Bexhill, and District Light Railways Company for the construction of the proposed line between Kewhurst and the Fountain Hotel, West Marina, so far as the same will be within the borough, be assented to under certain conditions. In the event of these terms and conditions being assented to by the company it will be left in the hands of the town clerk to take all necessary steps for the protection of the Corporation provided the Light Railway Commissioners and the Board of Trade consent to the order, and subject to these conditions being inserted in the order the Corporation will support the company's application before the Light Railway Commissioners. The Public Lighting Committee's report, which was adopted at the last meeting of the Town Council, stated that the purchase of the undertaking of the Hastings and St. Leonards Electric Light Company, Limited, had been duly completed. There had been a total expenditure of £62 095. 4s. 2d., being in excess of the sum of £58,000 sanctioned by the Local Government Board for the purchase of the undertaking by £4.095. 4s. 2d. The committee also reported that the Board of Trade, having been duly satisfied that the purchase by the Corporation of the company's undertaking had in accordance with the terms of the company been carried into effect, had fixed Jan. 1, 1899 as the date when such order should come into force and have effect, and as the date for the commencement of the order. As soon as the sanction of the Local Government Board to the borrowing of the money for the purchase of the undertaking was received they appointed a sub-committee for the management of the electrical department. The sub committee had submitted various reports, under one of which it was provisionally arranged that a separate and distinct electrical department should be established under the general and financial control of the Council, acting through this committee, and under the immediate direction and management of its electrical engineer; that the electrical engineer should act quite independently of the borough engineer, except when any alterations or extensions of the buildings might be required; that the electrical department should have its own separate stores, and as far as possible carry out its own repairs on the premises; that the undertaking should be carried on as if it were a private trading concern, with separate offices, separate books, and separate accounts with the treasurer, that it should deal with and render separate accounts to the various departments or committees of the Council, to which energy might be supplied as if they were private customers; that the services of the officials and staff of the company should be retained for the present, the principal officials being electrical engineer (Mr. L. Andrews) and assistant engineer (Mr. C. W. Kennaway). The committee had also arranged with Prof. Kennedy, who acted as consulting engineer to the company, to act in a similar capacity for the Council, on the same terms as he did for the company. The committee recommended that application be made to the Local Government Board for their sanction to the borrowing for a period of at least 30 years of the sum of £4,095, expended in excess of the loan of £58,000 sanctioned for the purchase of the undertaking; and that the method of charge for energy supplied to ordinary consumers be by the actual amount of energy so supplied, the maximum charge fixed by the Corporation's provisional order for supply by that method being, for any amount up to 20 units, 13s. 4d.; and for each unit over 20 units, 8d. The committee further recommended that application be made to the Local Government Board for sanction to the borrowing for a period of at least 30 years of the sum of £32,768, the total estimated cost of the works: new plant and machinery, extension to buildings, charging to sub-station, system of mains, extension of mains, as specified in the electrical engineer's report of Jan. 30, £22,184; extension of mains, etc., £10,584—total, £32,768. With regard to the subject of free wiring, etc., the committee have under consideration the question of the desirability of adopting, if practicable, some system by means of which the initial cost may be made less burdensome. The committee are of opinion that beyond the slight adjustment that will be necessary in order to avoid exceeding in some few cases the maximum charge of 8d. per unit fixed by the provisional order, it will not be expedient, for the present year at least, to deviate from the system and scale of charge adopted by the company, and which are as follows: incandescent lighting, 6d. per unit for all current consumed, and 1s. each per quarter for all 8-c.p. lamps or their equivalent burning at one time; arc lighting, 6d. per unit for all current consumed and 30s. per quarter per lamp, no meter rents being charged for either incandescent or arc lighting; a few consumers who use many lamps and little current are charged 9d. per unit for the first 200 units and 8d. per unit for the remainder of current consumed, and 5s. per quarter meter rent; for places of worship the charge is 6d. per unit and 5s. per quarter meter rent. The committee hope, however, that they may shortly be in a position to recommend the reduction of the price to a maximum charge of 6d. per unit.

PROVISIONAL PATENTS, 1899.

FEBRUARY 13.

3137. **Improvements in the construction of electric conduits or cable carriers.** John Johnston Green, Commercial-street, Halifax.

3141. **Temporary cord connections for telephone switch-boards, etc.** Alfred Broadbent, 15, Kremlin-drive, Liverpool.

3151. **New or improved apparatus for imparting a preliminary heating to refractory filaments of electric lamps in order to render the same conductors of electricity.** Charles Andrew Lee, 43, Paulton's-square, Chelsea, London.

3152. **A means of operating hydraulic machinery by electricity.** William Henry Willatt, 4, Westcott-street, Holderness-road Hull.

3160. **Improvements in and relating to electromagnetic cut-outs and other like apparatus specially applicable to electric arc lamps.** H Smithson and Edgar R. Sharpe, 60, Oscar-terrace, Dorset-street, Hulme, Manchester.

3177. **Improvements in or relating to electrically-illuminated advertising mediums or the like.** William Thomson Bell, 111, Hatton-garden, London.

3182. **Charging stand and contact for storage batteries.** George Herbert Condict, 60, Queen Victoria-street, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, July 18, 1898, being date of application in United States.) (Complete specification.)

3187. **Improvements in and connected with road vehicles driven by electric current from conductor.** Alfred Mills Taylor and Charles Henry Greenbank, 77, Chancery-lane, London.

3189. **Improvements in insulators.** Frederick Henry Withycombe, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

FEBRUARY 14.

3233. **Improvements in cables for carrying electric currents.** Lynde Belknap and August Sundh, 55, Chancery-lane, London. (Complete specification.)

3252. **Improvements in lining electric wood casings or conduits with steel or other metallic substances.** Charles John Wightman and Arthur Hudson, 70, Harris-street, Bradford.

3269. **A new or improved tilting device for the shades of electric incandescence lamps.** Max Railing, 73, St. Stephen's-road, Upton Park, London.

3311. **Improvements in or relating to arc lamps.** William Phillips Thompson, 6, Lord-street, Liverpool. (Christian J. Toerring, United States.) (Complete specification.)

3316. **Improvements in or connected with electrically-propelled and (or) controlled vessels.** Richard Benjamin Painton and William Herbert Bainbridge, Norfolk House, Norfolk-street, Strand, London. (Complete specification)

FEBRUARY 15.

3339. **Improvements in electric traction.** Ernest George Pink, 24, Boones-road, Lee, London.

3374. **Improvements, method of, and means for correctly and automatically guiding the trolleys of the connecting arms of cables, of electric trams, electric railways, and the like.** Charles Herbert Mounsey and Joseph Frederick Walsh, 8, Quality-court, Chancery-lane, London.

3387. **Improvements in trolley apparatus for use in connection with electric traction.** Isaac Everson Winslow, 47, Lincoln's-inn-fields, London. (Complete specification.)

3389. **Jointing conductors of the metal oxides to wires in incandescent electric lamps.** Herbert Moul, 8, Hythe-road, Willesden Junction, London.

3391. **An improved connector for electric light and power circuits for theatrical and other purposes.** John Archbutt, 3, Cursitor-street, Chancery-lane, London.

3392. **Improvements in automatic switches for starting and stopping electric motors.** Powell-Jones and Co., 7, East India-avenue, London.

FEBRUARY 16.

3434. **Improvements in teledynamic controlling apparatus for steering engines.** James Lewis Boothman and William Hastie, 121, West George-street, Sheffield.

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3440. Improvements in and connected with means for electrically lighting railway car lages. Emil Dick, 4, Corporation-street, Manchester. (Complete specification.)

3469. Improved primary battery. Louis Encausse and Louise Encausse, 40, Chancery-lane, London.

3477. Safety contact interrupter for suspended electric wires or cables. Roger Ducornot, 18, Buckingham-street, Strand, London.

11158a. Improvements in electrical couplings for railway cars. Henry Harington Leigh, 22, Southampton-buildings, Chancery-lane, London. (Frank Julian Sprague, United States.) (Date claimed under Patents Rule 19, May 16, 1898.) (Complete specification.)

11158b. Improvements in pilot apparatus and reversing mechanism for controlling electric motors. Henry Harington Leigh, 22, Southampton-buildings, Chancery-lane, London. (Frank Julian Sprague, United States.) (Date claimed under Patents Rule 19, May 16, 1898.) (Complete specification.)

FEBRUARY 17.

3518. Improvements in automatic electrically signalling the adjustment of dummy clocks. Rudolph Philipp Gerland, Kempscote, Coleraine road, Westcombe Park, London.

3531. Improvements in or connected with electric batteries. Ernst August Jahncke, 78, Fleet-street, London.

3536. Improvements in and relating to telegraph and like cables. Joseph Arthur Lovell Dearlove, 4, Great Winchester-street, London.

3570. Improvements in or connected with storage batteries. Walter Osmond Rooper, 115, Cannon-street, London.

3586. An arrangement for connecting accumulator cells and the like. Ferdinand Faber, 5, Hatton-garden, London. (Complete specification.)

3591. Improvements in telephone switch apparatus. Lars Magnus Ericsson, 4, South-street, Finsbury, London. (Complete specification.)

3594. Improvements in arc lamps. Henry Baggett, Norfolk House, Norfolk-street, Strand, London.

3597. Improvements in or relating to electric railway switching and signalling apparatus. Alfred Julius Boult, 111, Hatton-garden, London. (The Continental Hall Signal Company, Belgium.) (Complete specification.)

FEBRUARY 18.

3646. Improvements in or relating to the electrolysis of salts in solution and apparatus therefor. Antoine Joseph Outhenin Chalandre, Louis Jean Baptiste Colas, and Charles Jules Gérard, 111, Hatton-garden, London.

3665. Improvements in electric incandescence lamps. Oliver Imray, Birkbeck Bank-chambers, Southampton buildings, Chancery-lane, London. (Walther Nernst, Germany.)

SPECIFICATIONS PUBLISHED.

1897.

15238.* Electric resistances. Bachmann and others. (Amended specification.)

25151. System of automatic telephone exchange. Margowski. (Seigmann-Lui.)

1898.

2040. Electrical fire call. Blenheim.

2389. Secondary batteries. Sherrin.

2455. Electric contacts suitable for railway signalling and other purposes. Burn and Brown.

2584. Manufacture of electric glow lamps. Wise. (Pieper.)

3496. Electrical cut-out apparatus. Andrews.

5066. Electric switches. Belfield. (Davis and Harder.)

5206. Electrically-operated gas-valves for burners. The Actiengesellschaft fur Fabrikation von Broncewaaren und Zinkguss vorm. J. C. Spinn und Sohn, und von Romocki.

6024. Conduits for electric cables. Sykes.

6135. Electric incandescence lamps. Nernst.

6605. Telephonic inter-communication system. Aitken.

6778. Street lanterns for the reception of incandescent electric lamps. Stewart.

6902. Details of electric tramways and railways on a road surface sectional-contact system. Aldred and Carr.

7058. Method of preventing the corrosion of electric battery connections. Underhill and Northey.

24172. Process for obtaining a permanent electrical contact at the covers of voltaic cells. Schloss.

24583. Converting electricat energy into mechanical motion. Thompson. (Bradley.)

25259. Electrical speed indicators. Karl Obst.

26886. Means for manufacturing metallic ribbon, especially applicable for battery electrodes. The Porous Accumulator Company, Limited, and Howell.

27097. Arc lamps. Ottesen.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1899.	Corresponding week 1898.	Increase or decrease.	Total receipts for half-year. 1899.	1898.
		£	£	£	£	£
Birmingham Tramway	Feb. 18	3 925	3,527	+ 398	26,264	24,603
Blackpool and Fleetwood Tramroad	,, 18	178	—	—	1,080	—
Bradford City Trams	,, 5	145	—	—	6,733‡	—
Bristol Tramways and Carriage Co.	,, 17	2 594	2,399	+ 195	—	—
City and South London Railway	,, 19	1,087	1,051	+ 36	8 894	8,565
Dover Tramways	,, 18	147	105	+ 42	1,000	747
Dublin U.T., elec. cars	,, 17	903	716†	+ 187	5,600	4,922†
Dublin S.D. Electric Tramways	,, 17	636	396	+ 240	4,137	2,822
Halifax Corporation Tramways	,, 15	339	—	—	3,801*	—
Liverpool Overhead Railway	,, 20	1,297	1 320	− 23	10,344	10,330
South Staffordshire Tramways	,, 17	640	607	+ 33	4,090	4,145

* Since June 29, 1898. † Including horse cars. ‡ Since July, 1898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	23-24
Bournemouth and Poole Electric Supply, Limited, Ord.	10	13 13½
—— 4½ per cent. Cum. Pref.	10	10½-11½
British Electric Traction, Limited. Ordinary, Nos. 1-30,000	10	16½-17½
—— 6 p. c. Cm. Pf., 30,001-40,000 (all paid)	10	13½-13¾
—— 5 per cent. Perpetual Debenture Stock	100	122-123
Brush Electrical Engineering Limited, Ordinary	2	1¾ 2
—— Non. Cum., 6 per cent. Pref.	2	2⅛ 2⅜
—— 4½ per cent. Debenture Stock	100	111-115
—— 4½ per cent. 2nd Debenture Stock	100	101-104
Callender's Cable Company, Debentures	100	113-116
—— Ordinary	5	12½-13½
Central London Railway, Ordinary	10	9½-10½
——	8	7⅞ 8⅛
—— Pref. Half-Shares	3	3½ 4
—— " "	5	4-4½
Charing Cross and Strand	5	11½-12½
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	8½-9½
—— 4½ per cent. Debentures	100	114-116
City of London, Ordinary	10	18½-19½
—— " 90,001-100,000	10	18½-19½
—— 6 per cent. Cumulative Pref.	10	15-16
—— 5 per cent. Debenture Stock	100	124-129
City and South London Railway, Consolidated Ordinary	100	71-73
—— Ordinary	3	5-5½
—— 4 per cent. Debenture Stock	100	133-135
—— 5 per cent. Pref. Shares	10	14½ 15½
—— " " '96	10	14-15
County of London and Brush Prov. Elec. Light Co., Ord	10	12½-13½
—— " " No. 30,001-40,000	10	12½-13½
—— 6 per cent. Cum. Pref.	10	14½-15½
Crompton and Co.	3	3⅛ 3⅜
—— 5 per cent. Debentures	—	98-101
Crystal Palace District, Ordinary 5 per cent. Stock	100	130 135
—— Preference 5 per cent. Stock	100	142-147
Edison and Swan United Ordinary	3	2½-2¾
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	97-99
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5½-5¾
Electric Construction, Limited	2	2¾-2¾
—— 7 per cent. Cumulative Pref.	2	3-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	103-106
W. T. Henley's Telegraph Works, Ordinary	10	25½-26½
—— 7 per cent. Preference	10	18½ 19½
—— 4½ per cent. Debentures	100	113-116
House-to-House Company, Ordinary	5	9 10
—— 7 per cent. Preference	5	9½-10½
Imperial Tramways, Limited	6	23-24
India Rubber, Gutta Percha, and Telegraph Works	10	23-24
—— 4 per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	13-14
London Electric Supply, Ordinary	3	3¼ 4
—— 6 per cent. Pref.	5	6½-7
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	104-106
Metropolitan Electric Supply, Limited, Ord., No. 1-62,500	10	17-18
—— " " No. 62,501-85,000	4	13¾-14¼
—— 4½ per cent. First Mortgage Debenture Stock	100	118-121
National Telephone, Ordinary	5	5½-6
—— 6 per cent. Cum. First Pref.	10	14-16
—— 6 per cent. Cum. Second Pref.	10	14-16
—— 5 per cent. Non. Cum. Third Pref.	5	5½-5¾
—— 3½ per cent. Deb. Stock, Red.	100	100-102
Notting Hill Electric Lighting Company, Limited	10	17½-18½
Oriental, Limited, 1879	1	1½-1¾
—— £5 Shares	5	7½-7¾
—— £4½ Shares, New	4½	6¼-6¾
Oriental Telephone and Electric Company	1	1¼ 1½
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6¾-7¼
Royal Electrical Company of Montreal	1	160-165
—— 4½ per cent. First Shares Mortgage Debentures	100	107-109
South London Electric Supply; Ordinary	3	2¼ 2½
St. James's and Pall Mall, Limited, Ordinary	5	16½-17½
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	15	38-42
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	100	109-112
Westminster Electric Supply, Ordinary	5	15½-16½

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NOTES.

Dover.—The Town Council have decided to memorialise the Trinity House authorities in support of the scheme now being advocated by Mr. Hobbs, of Ramsgate, for completing the connection of the lightships all round the coast by means of wireless telegraphy.

The Cape-to-Cairo Telegraph.—The short visit made by Mr. Rhodes to Egypt terminated on Sunday evening, and we are informed by the daily Press that during his stay he has made considerable progress in connection with the telegraph line to connect Egypt with Cape Colony.

Telephone Bills.—The second reading of the Bills of the Glasgow Corporation and the National Telephone Company, put down for this week, has been postponed on account of the announcement made by the Financial Secretary to the Treasury that the Government intend to bring in a Telephone Bill during the present session.

London County Council Tramways.—At the meeting of the London County Council on Tuesday last, it was decided to ask Prof. Kennedy to make a full report on the question of electric traction for the Council's tramway lines, for the fee mentioned in our previous issue. The report will, of course, cover the experience gained both on the Continent and in America.

Underground Wires. — The Leeds Chamber of Commerce has expressed to the Liverpool Chamber of Commerce its readiness to participate in a general movement for making a representation to the Government on the advisability of placing telegraph wires underground. The last-named Chamber called attention to the matter in consequence of the inconvenience occasioned during the severe gales by an interruption of the telegraphic service.

Electric Lighting in Marylebone.—On account of the refusal of Parliament to grant a provisional order to the Marylebone Vestry last year, the Vestry decided this year to bring in an Electric Lighting Bill. On Tuesday last the Examiner of Private Bills held that in this case the standing orders had not been complied with. It is now referred to the Committee of Standing Orders to consider whether or not the Bill shall be allowed to proceed.

Iron and Steel Institute.—The Iron and Steel Institute will hold its annual general meeting in London on May 4 and 5, when Mr. E. P. Martin, of Dowlais, will be succeeded by Sir William Roberts-Austen, K.C.B., as president. On the evening of May 4 the annual dinner of the institute will be held at the Hotel Cecil, and on the evening of May 5 the members will be received by the president and Lady Roberts-Austen at their residence in the Royal Mint.

The Result of a Failure.—The Urban District Council of Kingswood recently decided to substitute gas for electricity for the public lighting, and are now advertising for tenders for 300 gas lamps. The ratepayers object to the change, but with the Council's experience with a system which, according to certain experts, was to revolutionise electric lighting, we can hardly wonder that the Kingswood Council is rather shy of moving in the matter. We trust, however, that they will decide to put down a municipal electric light plant for the supply of private consumers, and that from this source street-lighting on a durable basis will also be introduced.

Paris Exhibition, 1900.—The trials which have been made with a short section of electric line constructed by M. de Mocomble are pronounced as very satisfactory, and the erection of a line on this system for the exhibition is now assured. The trials took place near the Quai de Clichy on a line describing a circle of about 300 yards diameter. Twenty-eight three-phase motors were used, coupled in groups of four, placed at different parts of the circle. The voltage used was 212. The frequency of alternation of the current was 25 periods per second. The construction of this moving platform railway is similar to the one shown in the Berlin Exhibition of 1896.

Congo Telegraphs.—While we hear so much in England of the proposed telegraph line which Mr. Rhodes is organising to connect the North of Africa with the South, it may be also mentioned that the telegraph lines of the Congo are making steady progress. News from Brussels states that a wire is already being laid along a side of the Congo River up to a point 800 miles east of Boma. The great aid this telegraph line is rendering to those responsible for the control of the vast areas now held under Belgian supervision, is exemplified by the fact that where previously two months were required to get news from Boma to the Kassai, and two months for a reply, one half-hour now suffices.

The City Electric Lighting.—At last week's meeting of the Court of Common Council of the City of London, the Streets Committee brought up a draft of the proposed reply to the Board of Trade on the applications made to the Board by the Charing Cross and Strand Electricity Supply Corporation, the Metropolitan Electric Supply Company, and the Smithfield Markets Electric Supply Company with a view to dispensing with the consent of the Corporation to the granting of the orders. The question was debated with closed doors, and it was finally decided to inform the Board of Trade that the Corporation, having the purchase of the existing company in mind, was content to deal with it alone.

The Central Electric Supply Company.—We note that a number of the municipal authorities in London are proposing to oppose the Bill of this company. Under the proposed Act the company will have power to supply electrical energy in bulk to both the Westminster and the St. James's and Pall Mall Electric Light Company. We see that the reason given by the Vestry of St. James's, Westminster, for their opposition is that the Bill is calculated to interfere with and prejudice the rights of the local authority in acquiring the undertaking of the St. James's and Pall Mall Electric Light Company at the expiration of the time named in the company's provisional order. The vestries interested are asking the London County Council to assist them in their opposition.

"James Forrest" Lecture.—The seventh annual "James Forrest" lecture is to be delivered this year by Prof. J. E. Ewing, M.A., B.Sc., F.R.C.S, M.I.C.E. Prof. Ewing will choose as his subject the department of physics in which he has worked so successfully for many years, and we do not doubt that in this lecture he will add new facts to the numerous points in connection with magnetism which he has done so much to elucidate. The lecture will be delivered on April 20, at 8 p.m., and owing to the large number of members and their friends who may wish to attend the lecture, this will be repeated the following day at 4 p.m. The Institution of Civil Engineers is to be congratulated on the series of "James Forrest" lectures given up to now, and we are sure that the lecture this year will not prove in any way less interesting than the lectures which have preceded it.

Electric Lighting (Clauses) Act.—Mr. Ritchie is introducing into Parliament a Bill for the incorporation in

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one Act of certain provisions usually contained in all the provisional orders under the Electric Lighting Acts of 1882 and 1888. In asking permission to introduce this Bill on Monday last, Mr. Ritchie explained that the 70 or 80 clauses contained in all electric lighting provisional orders were almost always the same. Their introduction in detail entailed great expense and delay in connection with the orders, and it also created a considerable liability to mistakes. The present Bill provided that, instead of setting out in every electric lighting order the 70 or 80 clauses, these might be incorporated as was the practice now with regard to clauses of the Acts. They would not be stereotyped, but the Board of Trade would have the power to vary them, if necessary, in respect of any particular order.

Tramways in Australia.—We learn from the *New South Wales Railway Budget* that the cable tramway system at North Sydney is to be replaced shortly by the overhead electric system, and the alteration, it is anticipated, will be effected as soon as the power-house at Ultimo is completed. When the conversion is brought about, the whole of the North Shore system, including lines to North Sydney, Military-road, Mosman, Willoughby, and Gore Hill, will be of a uniform character. This shows that in Australia electric trams are establishing as good a record for economical running as in England or the States, and that even the cable tramways, which previously held the record for low cost per car per mile, cannot compete with a well-equipped system with the overhead trolley. On the new lines in Sydney it is intended to introduce combination cars, which will provide separate accommodation for smokers.

Electricity is Life.—A curious instance of electricity being used to liven up a dancing bear was disclosed during the hearing of a county court case at Westminster on Monday last. In this action an electrical engineer claimed for work done in providing an electrical table on which a bear had to dance, and the owner of the bear refused to pay on the ground that the current given out was not sufficient to have the desired effect. It seems, however, that the table was sufficiently active to make both the plaintiff and the defendant glad to get off it when experimenting before the bear was placed on it. The electrical engineer recovered the amount claimed, but we quite foresee that it will be necessary for the technical institutes to extend the range of their courses in the near future if an intimate knowledge of the current and voltage required to produce a given amount of muscular exertion in a bear is to be added to the technical knowledge of students before they enter upon their professional careers.

Huddersfield Tramways.—On Saturday last, Mr. T. H. Moore delivered a lecture before the Huddersfield Liberal Club on the question of tramways and electric traction. He pointed out that, besides the need for further rolling-stock for the extensions authorised to Slaithwaite, Outlane, and Longwood, a sum of over £5,000 annually was spent on repairs to engines. He argued from this that their engines were fast approaching the stage when they would have to be discarded. Instead of spending thousands of pounds on new engines, he urged that it would be better for the comfort of passengers and also of residents along the tramway routes to adopt electric cars. He considered that the ultimate boundaries of the Huddersfield electric tramway would be Elland and Brighouse on the north, Mirfield and Kirkburton on the east, Holmbridge on the south, and Marsden on the west. The handsome offers the Corporation had received for the tramway system as it stood, he considered an argument in favour of the conversion to electric traction. In the discussion which followed the paper, the great majority of speakers were in favour of electric cars being introduced.

Telegraph Disturbed by Salt.—The *Railway and Engineering Review* of Chicago describes a recent unusual interruption to telegraphic communication. It seems that, after a heavy snowstorm, accompanied by considerable wind, the Oregon Short Line Road "lost" all of its telegraph wires, six in number, for a distance of 80 miles north of Ogden, Utah. An inspection of the line revealed the fact that the cross-arms and insulators were covered with a coating of salt from $\frac{1}{16}$in. to $\frac{1}{4}$in. in thickness. The petticoats of the insulators were also heavily coated. This coating, when wet, together with the snow lying on the cross-arms, formed a dead cross. During the middle of the day, when the sun was shining brightly, the salt appeared to dry out, and the wires would "come up" reasonably clear. As soon as the cause of the trouble was discovered, an engine was started out equipped with a large hose, which was used with hot water for washing off the salt coating. It will be readily understood that the salt was carried in the winds blowing over the Great Salt Lake; and as salt is a conductor of electricity several hundred times better than water, the short-circuiting of the wires is easily explained.

Steam versus Electricity.—We gather from the *Electrical Review* of New York some interesting figures with respect to the South Side Elevated Railroad, Chicago. These afford a comparison between the same line when worked by steam and when worked by electricity during the two months of November and December, 1897 and 1898. The road includes, with loops, some 19·5 miles of track, which in 1897 was operated entirely by steam, and in 1898 entirely by the Sprague multiple unit electric system. In addition to all "loop" expenses, there is a rental charge equal to 10 per cent. on the gross passenger receipts of the road. This should be considered really as an interest charge, not as an operative expense. A comparison is made in the ratio of expenses to earnings, excluding rates, taxes, and licenses, when the following figures obtain: In November, 1897, the expenses with steam formed 77·7 per cent. of the receipts, and, again, 73·6 per cent. in December, 1897. With the use of electricity the ratio was reduced to 47·7 per cent. for November, 1898, and to 45·4 per cent. for December, and in the corresponding months the actual receipts were increased from £2,120 in November, 1897, to £7,889 in November, 1898, and a similar increase was shown for the month of December.

The Diesel Oil-Engine.—The inventor of the Diesel oil-engine, which attracted so much notice recently in America, and which, we believe, would be a success but for the mechanical difficulties its working involves, has been devoting further attention with a view of securing the perfection of an oil-engine. The first of these new engines to be publicly shown has lately been on view at Munich. According to *Kuhlow's Review*, this engine is stated to have the remarkable efficiency of 26 per cent., and to give a brake horse-power on a consumption of ½lb. of petroleum per hour. Its operation has four cycles: (1) drawing-in air; (2) compressing it; (3) gradual addition and concurrent burning of a charge of petroleum with the already compressed air; and (4) discharge of products of combustion. The essential speciality of the engine is in compressing the air before adding the oil vapour to it. The oil is forced in afterwards, under stress of a pump, at 600lb. per square inch. The 30-h.p. engine shown at Munich has a piston of $11\frac{2}{3}$in. diameter and $17\frac{7}{10}$in. stroke, and makes 150 revolutions per minute. A feature distinguishing the Diesel from other explosive engines is the absence of noise accompanying its working. The oxidation of the contents

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of the cylinder is much slower than is usual with ordinary gas-engines, and the explosion is milder.

Glasgow Tramways. — The question of which committee of the Corporation of Glasgow shall be responsible for the generation of the electrical energy required for the tramways is being considered by two sub-committees appointed by the Electricity Committee and the Tramways Committee respectively. At the conference between these two sub-committees on the 27th ult., Councillor Paton, the convener of the Tramways Committee, introduced the subject by stating that his sub-committee were of opinion that his department should generate the requisite power, and if it was decided that they were to purchase their electricity from the Electricity Committee they would undoubtedly be most unwilling purchasers. Mr. H. F. Parshall, who has been consulted in the matter, reported verbally that he proposed to recommend that the Tramways Committee should construct a large central electric power station, and put down in it four engines with an aggregate of 17,500 h.p., the engines to be of the slow-speed type, running at the rate of 70 revolutions per minute. The electricity would be distributed at a voltage of 6,500, and the depôts would be utilised as transforming stations to send out the electricity at the present voltage of 550, which is the Board of Trade maximum. Of the 17,500 h.p., three-fourths would be able to drive 575 electric cars. At present there are 385 horse cars and 27 electric cars in use. Further discussion of the subject was adjourned.

Engine-Room Efficiency.—In the running of a central electric light station, the efficiency of working largely depends on the way the plant is handled, and in well-regulated stations it should always be the endeavour of the chief engineers to see that the machines at work are running at their most economical loads. We might perhaps add to this that, in our opinion, engines and dynamos for electric lighting should be designed to give their outputs with the greatest economy at full load. For traction work of course this should not be so, but we do not agree with certain prominent engine makers who claim that the great advantage of their engine is that it is as economical at half load as at full load. A careful examination of such an engine will show that it is small for its work, and that a larger engine would give more economical results at the stated full load. This larger engine would undoubtedly be less economical at, say, half full load, and if the other plant in the station is properly managed, there is no reason why it should not be running always at within a few per cent. of full load. In arranging that this should be the case, the engineer in charge of an electric light station can make a considerable difference in the course of the year in his coal bill. The usual method of keeping a check on the way the plant is used is to compare the output in a given day, as recorded by the electricity meters in the station, with the sum of the products of the outputs of machines that have been running into the hours at which they have been at work.

Ice Troubles in Water-Power Installations.—We learn from a short article in the *Canadian Engineer* that the Lachine Rapids Land and Hydraulic Company, which supplies electric current to Montreal, has had a large amount of trouble with its power plant on account of frazil ice. This company has been regularly delivering about 3,000 h.p. to Montreal, but early in January the subsidiary company taking power had to start up a steam plant because of difficulty in keeping the water-power plant running; two difficulties arising in respect to ice blocking the tail race and the intake. On the first occasion, due to ice forming on the shallow stretches immediately below the tail race, the water-level below the turbines rose 10ft., reducing the available head to only 3ft. The company hope to prevent a recurrence of this trouble by removing rocks in the tail race, and thus providing a deep-level outlet. The intake troubles have been much more serious, and were caused by frazil ice brought down by the current collecting and solidifying between the two booms guarding the intake. The first boom was constructed in such a way that a certain amount of ice was carried along its face by the stream, but the obstruction occurred at the boom inside this. At the second boom the ice froze to such a thickness that it had to be blasted away. The explanation of the formation of this ice at a good depth below the surface is that the river above being kept open by the rapids, the water is cooled down to slightly below the freezing point, and that ice forms almost at once when still water is reached.

French Wiring Rules.—The Chamber of Electrical Industries of France has appointed a commission to revise and complete the rules for electrical installations inside houses issued by the society in 1892. This committee consists of the following gentlemen: MM. R. Arnoux, A. Chance, J. Carpentier, E. Clemançon, P. Eschwège, E. Harlé, A. Hillairet, F. Meyer, and G. Roux. These rules appear to us to be in need of revision if those reproduced in the current number of *L'Electricien* are the 1892 set. For instance, it is stated that the conductivity of the copper used in cables must be at least 90 per cent. of that of pure copper. This limit is much too low, and we think that copper of a specified conductivity of 90 per cent. should be debarred. In determining the size of conductors, we notice that the rule commences by stating that a 3 per cent. loss between the supply terminals and the lamps shall be the maximum. Besides this, the amperes allowed for a given sectional area are specified. In one point further on these rules differ materially from those now in force in England. We refer to the provision of safety fuses at the points where flexible wires are attached to the main conductors. In the French rules a double pole fuse is specified, whereas in England it is now the usual practice to have no fuse at all. As regards the insulation resistance, the low limit given by the formula $R = 5\,E^2$ is allowed. Thus at 100 volts the insulation resistance of 500,000 ohms would be passed. This might be quite satisfactory in a building where a very large number of lamps was used, but in a small installation we think the limit is low. The formula makes no provision for an alteration in the number of lamps, as should be the case, and in this point at least the commission appointed will do well to make a radical change.

The General Power Distributing Company's Bill.—A statement signed by the Lord Mayor of Sheffield, and the Mayors of Nottingham, Lincoln, Derby, Chesterfield, Rotherham, Doncaster, Mansfield, and Ilkeston is being circulated as to the position of those municipalities with regard to the above Bill, which is about to come before the House of Commons for the second reading. The signatories state that, although the Bill gives to the company power to erect a generating station at Sookholme, Notts, and thence to supply electricity over every part of an area of over 2,000 square miles, there is no obligation on the part of the company to erect this station, but they may purchase lands in any part of their proposed district for this purpose. The only obligation upon the company to spend any money on their scheme is that they must spend £50,000 within five years, which insignificant sum, it is observed, has to be spent on the undertaking—that is to say, if they spend this amount in any part of their area they will have the right to keep

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every other part of the area at their mercy as to the time when, if ever, they will exercise their powers. Thus, if the sum of £50,000 were spent upon supplying Sheffield with electricity they could hold their powers in reserve for an indefinite period of time with respect to any other borough—*e.g.*, Nottingham. Most of the boroughs have already expended large sums in establishing electrical works. The final contention of the municipal authorities is that while the town councils are supplying electricity on reasonable terms, a company should not be allowed to come in and compete with them. With this contention we agree, but we trust that the municipal authorities will see their way to make a distribution of power at reasonable rates a more prominent feature in their electric supply undertakings.

The Registration of Small Loads.—At the adjourned discussion on Mr. William Arnot's paper before the Institute of Engineers and Shipbuilders in Scotland the author gave some useful figures and facts about the behaviour of electricity meters at light loads. It will be remembered that the paper was entitled "Meters and Systems of Charging for Electric Energy." It was in answer to questions concerning errors in meters at light loads that Mr. Arnot stated that any average figures would be misleading, particularly with respect to mercury meters. The errors ranged from 2 per cent. to 5 per cent. between one-tenth of the load and full load. Below one-tenth of the load the error was very variable, and depended largely on the previous history of the meter, the strength of the magnetic field, and the purity of the mercury. The starting current varied from ·08 to ·3 of an ampere; about ·2 was a fair average. A test had been made on two Ferranti meters which were employed for measuring currents of short duration in a photographer's establishment. A cluster of about 80 50-c.p. 90-volt incandescent lamps were connected, two in series, across the outer wires. These were put on for about 10 seconds by means of an ordinary double-pole switch. On one side of the system, between one of the outer wires and the middle wire, the lamps of the house were fixed. Before the double-pole switch was closed, putting the photographic lamps into circuit, the one meter was moving slowly and the other standing. From tests taken on the two meters, it appeared that the registration of the meter that was at rest before the double-pole switch was closed was low; but the registration on the meter that was moving slowly before was about 25 per cent. too high. These meters were subsequently removed, and Lord Kelvin's substituted. Meters of the Aron type, Mr. Arnot thought, were possibly the best suited for this class of work.

The Late Baron de Reuter.—The death of Baron de Reuter on Saturday last will remind some of our younger readers that the word "Reuter" appearing with so many items of news in the daily Press had a connection with a definite individual. Baron de Reuter was born in 1816, and was one of the first to recognise the great importance of the electric telegraph as a disseminator of news. When the first line between Aix-la-Chapelle and Berlin was opened in 1849, he at once commenced in the first-named place a telegraphic agency for collecting information for the Press. This agency was developed step by step as the number of wires over the Continent increased, and when in 1854 the submarine cable between Calais and Dover opened up still wider fields Mr. Reuter decided to transfer his chief office to London. After this his business increased by leaps and bounds, and he gained great reputation from his reports of the short war between Prussia and Austria, also during the American Civil War. In fact, the business increased to such an extent that it was in 1865 decided to convert it into a limited liability company. Of the wide-spread distribution of Reuter's agencies now it is needless to speak, as practically every town of any importance is in connection with the main offices of the various capitals of the world. Mr. Reuter also obtained a number of concessions for submarine cables, notably one between England and Germany in 1865, and one between France and the United States in 1869. The history of the private life of the late Baron de Reuter as published in the daily Press shows that he was a man of indomitable energy, and although all speak of the good he has done by the aid of the telegraph, it is well to remember at the same time that all such efforts are reflective, and that Reuter's agency has done great service in extending the telegraphic communication of the world and in urging on improvements in the instruments used in modern telegraphy.

Consolidations in Electrical Industries.—It is not often that we have to find fault with the views expressed in the leaders of our well-edited contemporary the *Electrical World*, of New York, but in their issue for Feb. 4 they speak, in our opinion, too favourably of the large consolidations of electrical manufacturers which have been a special feature in the United States. In that country small firms have been gradually absorbed or wiped out by the competition of their gigantic rivals, and we have yet to see proof that industry is really advanced by such a course. Our contemporary says that "in the manufacture of electrical goods the company operating on a large scale has the same advantage over smaller competitors that exists in other lines, and the growth of rivals is checked by that intended foe of all competition, the patent system, of which great use is naturally made in an industry the first principles of which were just beginning to be understood 17 years ago. The best proof of the advantage of manufacturing on a large scale is the success of the establishments so operating, such, for example, as the Westinghouse Companies, the Western Electric Company, and the Electric Storage Battery Company, and the benefits their work on broad lines have conferred on the science." We think if our contemporary had continued the quotation it would have found a difficulty in claiming success for other large firms, such as the General Electric Company, which, although it has done an enormous business, has never returned to its shareholders interest for the money they invested. In fact, the large firms, such as are spoken of in our contemporary's columns, tend to get into grooves, and although in many cases such concerns can supply goods at prices which defy competition from smaller firms, we nevertheless do not find that they make a real manufacturer's profit. In only too many cases the profit made goes to the financial man indirectly interested in the projects engineered by the firm, to the detriment of real engineering progress.

Distribution of Power Bills.—On Tuesday last three Bills for the supply of electric power throughout large districts in the provinces came before the Standing Orders Committee of the House of Commons. These three were all rejected on account of the failure of the promoters to comply with the standing orders in the points which are detailed in the following account from the *Times*: One of these, the Lancashire Electric Power Bill, proposed to provide electrical generating stations and the erection of buildings and works for the production, storage, and distribution of electricity within a large area in Lancashire. It was proposed that the energy might be distributed by the company, or might be supplied by them wholesale to any local authority, company, or person within the area of supply, though only by means of some system which should be approved in writing by the Board

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of Trade, and subject to the Board of Trade regulations. The second measure, the title of which is the South Lancashire and Cheshire Electricity Company Bill, was similar in purpose, and the third was for incorporating and conferring powers on the Leicestershire and Warwickshire Electric Supply Company, and also, as may be gathered from its title, dealt with an extensive area. The cases came before the Examiner of Private Bills at the usual time early in the session, and he held that the *Gazette* and other notices did not define the parts of the counties to be supplied with electrical energy, but referred the description thereof to a map to be subsequently deposited with the respective clerks of the peace. Nor were certain boroughs and urban districts proposed to be supplied named in the notices. Substantially the same point was raised in the case of each of the three measures, and non-compliance with the standing orders of Parliament was reported by the examiner in each case. This decision was affirmed on Tuesday last by the Standing Orders Committee, which is presided over by Mr. Halsey. The committee, after deliberating for some time in private, informed the parties interested, who were in waiting, that they had decided that the standing orders could not be dispensed with. The effect of this decision is that the Bills are dead so far as the present session is concerned.

Carbolite.—We gather from *Kuhlow's Review* that Mr. H. L. Hartenstein is bringing before the notice of the German public his invention for the production of a substitute for carbide of calcium, which he calls "carbolite." This new substance is produced from molten blast-furnace slag, and the inventor claims that it may be so generally used that the pig-iron blast-furnace slag may come to be regarded as a by-product. This new substance, "carbolite," is described in the patents as calcium-aluminium-silicon-carbide, represented by the formula $Al_4\ C_3$, SiC, CaC_2. According to an account furnished by the inventor, it is manufactured by taking blast-furnace slag direct from the furnace, placing it in converters similar to those used in steel-making, impregnating the molten mass with pulverised coke by means of a gas-blast, and then turning the converters on their trunnions so that the mixture is brought in contact with carbon bars through which a powerful current of electricity is passed, generating the intense heat required to produce the carbides. Our contemporary protests against the glowing picture drawn by the inventor of "carbolite," and points out by the following details that this will not prove the success anticipated. For instance, it should be borne in mind that such slag as Mr. Hartenstein proposes to use contains at the most only 50 per cent. of lime, and it may be easily appreciated that a carbide thus made would be a very poor substitute for pure calcium carbide in the evolution of acetylene. The silica in such slag would combine with the carbon through the agency of the powerful electric current to form silicon carbide, or carborundum, which gives off no gas on the addition of water. The alumina under the same conditions would form aluminium carbide, which on addition of water evolves methane, CH_4, which is only faintly luminous, it being the same in substance as natural gas. The iron oxide in the slag would be reduced to iron carbide, and would thereby add still more impurity to the "carbolite." From this it follows that the "carbolite" would be so mixed with non-gas-making impurities that it would generate only a small amount of illuminating gas as compared with pure calcium carbide. The production of these impurities, which are useless from an illuminating point of view, all cost electrical energy, and thus, although a certain amount of economy might be obtained from using the slag all hot, the waste of electrical energy is likely to over-balance this saving.

Energy Lost in Electric Condensers.—Messrs. E. B. Rosa and A. W. Smith contribute to the January number of the *Physical Review* a most interesting treatise on "A Resonance Method of Measuring the Energy Dissipated in Electric Condensers." The authors point out that the fact that the dielectric of a condenser becomes warmed when an alternating E.M.F. is applied to the terminals of the condenser has long been known, and the study of this heating effect has been undertaken by numerous observers. Thus, Kleiner used a thermo-electric couple embedded in the dielectric to measure the rise of temperature, and noted a considerable heating effect in ebonite, guttapercha, glass, and mica, but none at all in paraffin and resin. He reports that in spite of all attempts by variations of the conditions of the experiment, no heating could be detected in these two last-named substances. On the other hand, Boucherot has made paraffin-paper condensers for use on the 3,200-volt commercial circuits of Paris, some of which became so hot in use that they were obliged to be cut off. The authors explain how inconclusive any method which depends on the determination of the areas of temperature of a condenser is if the energy lost is to be gauged accurately. They explain their method by which the wattmeter can be conveniently used for determining this loss exactly. They insert in series with the condenser a coil of wire having large self-induction, obtained without an iron core. They select the best value of the self-induction of the coil by the following formula:

$$t = 2\pi\sqrt{LC},$$

where t is the period of the fundamental component of the impressed E.M.F., and C the capacity of the condenser. There is another practical advantage resulting from this arrangement—namely, that the resulting resonance raises the E.M.F. at the terminals of the condenser very greatly, saving the necessity of raising the voltage by transformers. And a third advantage now appears in the fact that the wattmeter may be inserted across the low-voltage supply wires to measure the total power expended upon coil and condenser. Then, subtracting the $I^2 r$ loss of the coil, the remainder will be the power expended upon the condenser. This supposes, of course, that there is no iron core and no eddy loss in the copper coil itself. The authors give a full series of diagrams of connections and vector diagrams to explain how the method is employed in practice, and, in conclusion, a series of practical examples are described in detail. In their practical tests, experiments were made on a set of commercial condensers made of tinfoil and paper, the latter being saturated with melted beeswax and resin. Readings were taken at gradually increased temperatures. The capacity of the condenser experimented with was about one-third of a microfarad. The frequency used was 120, and the voltage on the condenser varied from 670 to 900. The watts lost in the condenser varied between 24·3 and 26·5 for a variation of temperature between 30deg. C. and 49½deg. C. When, however, the temperature was increased to 59deg., no less than 77 watts were lost with a voltage of 430 on the condenser. The authors conclude that to find so large a loss in commercial condensers of good repute was a surprise. To find a well-marked maximum as the temperature rose, beyond which the loss decreased as the beeswax and resin composition softened, was a second surprise. To find so large a loss as the last observation shows without the condensers giving way, and without any very large leakage current, was a third surprise. They checked their results by other methods, and found no reason to doubt their accuracy.

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THE CITY OF LONDON ELECTRIC LIGHTING COMPANY'S WORKS AT BANKSIDE.

Tuesday last witnessed the official inauguration of these works as far as the technical Press is concerned. Previously, although the courtesy of the officials was extended to all electrical editors when they wished to see the plant in the station, permission to publish what was to be seen was withheld. The short time elapsing between Tuesday's visit and our publishing day renders it impossible to get full details in this week's issue, but we shall publish further information next week. The following is the autobiography of the company as provided for the visitors last Tuesday, from which we have only cut out one or two prophetic statements, which, after the decision of the Court of Common Council last week, appear to us to be uncalled for:

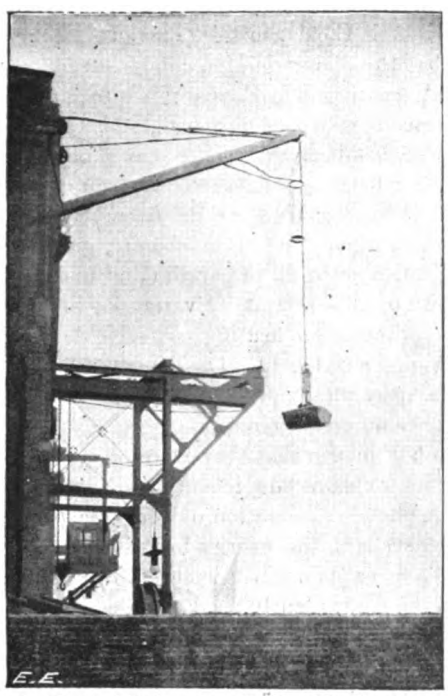

FIG. 1.—The Coal Grab used at the City of London Company's Wharf at Bankside.

"The Corporation of the City of London discussed the question of lighting the City by electricity for many years previously to 1889, when they invited tenders for the supply of electric light to the City. At that time some towns and other districts in London were supplied with electrical energy, in most cases by private enterprise, and though the progress of the growth of such undertakings had been encouraging, they had not then developed into the sound financial condition in which they now stand. The most sanguine advocates of electric lighting then considered the prospects of successfully supplying electrical energy in the City of London were not so certain as to justify the large outlay required, and as the City authorities made unusual stipulations as to the adoption of a graduated scale of charges, terms of purchase, and provisions for depreciation funds, it is not surprising that some difficulty was experienced in getting responsible contractors to undertake the work. The City was eventually divided into three districts, and contracts were entered into by the Corporation with two firms of manufacturers of electrical plant and machinery, with permission to transfer the contracts to an electric lighting company. In accordance with the agreement with the Corporation provisional orders for the three districts were obtained by the contractors in 1890. The Corporation by the contracts imposed exceptional and onerous conditions on the contractors. Such conditions included, amongst others, the lighting of the streets of the City practically at cost; the provision of depreciation and reserve funds and the reduction of charges on the sliding-scale principle after a certain profit had been made. In consideration of the serious risk and obligations undertaken by the contractors the Corporation on its part granted, as far as it was able to do so, the exclusive right of supplying electricity for private purposes for 21 years from 1890.

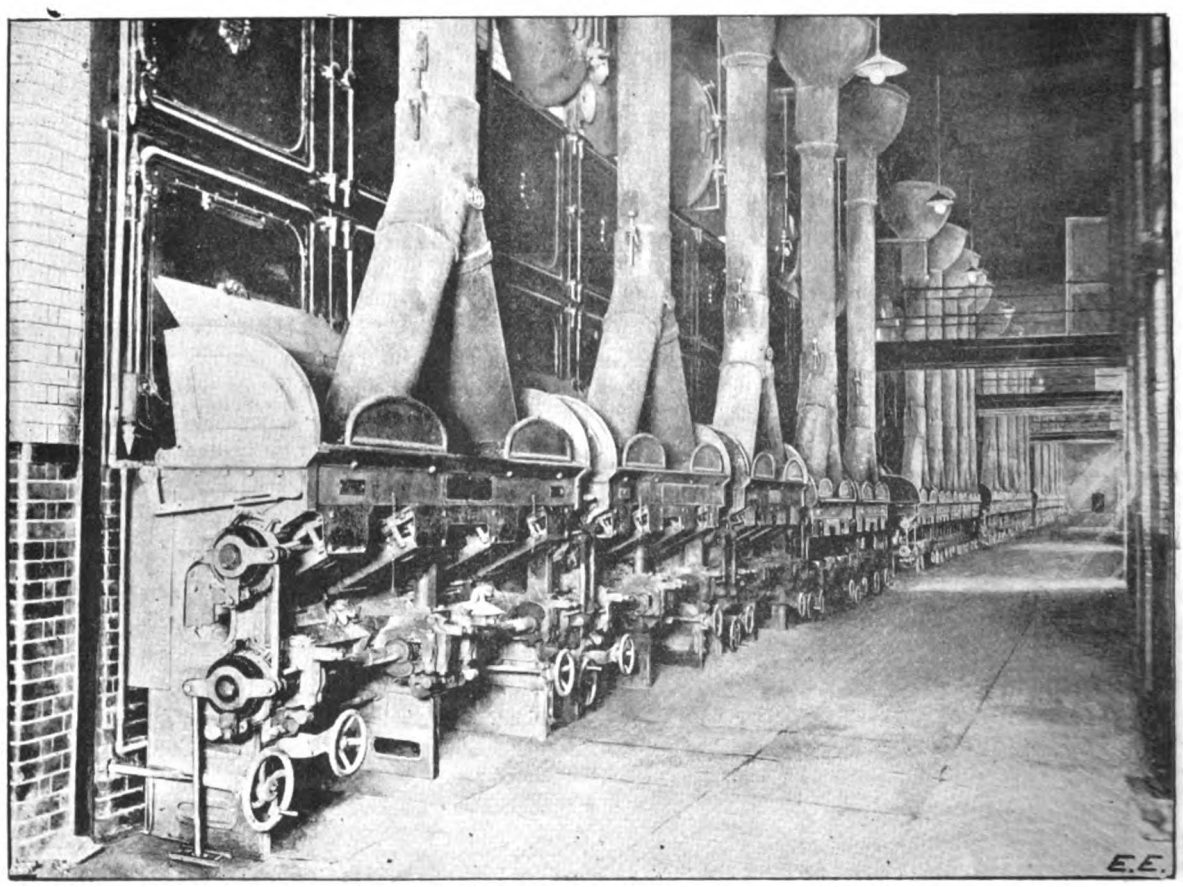

FIG. 2.—The Main Boiler-House at the Bankside Station.

The City of London (Pioneer) Electric Lighting Company was formed to give the necessary financial assistance to the contractors to enable them to commence the work of lighting the City by the contract dates, and to give sufficien

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time for the great amount of work necessary before the present company could be placed before the public. The present company was formed in July, 1891. With the consent of the Corporation and of the Board of Trade, the respective contracts and provisional orders were transferred by the two firms of contractors to the present company. This company also took over the assets, consisting of works executed and cash in hand of the Pioneer Company, and gave a bonus of £25,000 to the shareholders of that company for the risks they had run in rendering themselves liable for £100,000. The risks were serious, as had the present company not been formed, the Pioneer Company's shareholders would have lost all their money. The original contractors supplied further plant to the company, and the contracts with them for the supply of

Fig. 3.—The Engine-Room at the City of London Electric Lighting Company's Works, showing the Electric Overhead Travellers and the Willans-Thomson-Houston Steam Alternators.

plant were cancelled by mutual agreement in 1896. The result is that at the present time no less than 11,660 kw. of plant are available for the purposes of the company, and the cost of this plant, together with all land, buildings, street mains, etc., now amounts to £1,374,689, or at the rate of £117 per kilowatt."

The works of the company which we visited on Tuesday are now all concentrated in the Bankside. In the early days a small station at Wool Quay was used to supply a large portion of the arc lighting and a certain portion of the incandescent lighting in the City, but the whole of the machinery from this station has now been removed. The area at Bankside is several acres in extent, and the company has the advantage of a small frontage on to the river. The building erected on this river frontage is used to contain the machinery for circulating the condensing water, and also the coal-handling machinery. The whole of the coal used in the Bankside works is brought up to the wharf in barges, and is lifted from these by means of grabs, as illustrated in Fig. 1. The grab is worked by hydraulic power, and lifts about three-quarters of a ton at a time from the barge to the top of the building, where the coal is deposited into an automatic weighing machine. The rapidity with which this grab works is surprising, considering the height to which the coal has to be lifted. Thus, 50 lifts per hour can easily be made, which represents the elevation of about 40 tons of coal. The coal, having been weighed in the automatic machine, is discharged into a conveyor, which carries it across the street on a gentle incline up to the longitudinal coal bunkers over the boiler-room. This conveyor consists of an endless chain with large rectangular links which runs in an iron trough. The coal bunkers run the full length of the boiler-room, and are divided into two parts by an enclosed gangway directly under the conveyor. By opening shutes in the bottom of the iron trough of the conveyor, the coal can be dropped on either side of this enclosed gangway. The fuel is supplied to the boilers by means of shutes, which can be seen in Fig. 3. The balloons at the top of the shutes hold about three-quarters of a ton, and are used to record the quantity of coal supplied to each boiler. The shutes open into the gangway above referred to. When one of the balloons is emptied in the usual way, an automatic electrical arrangement lights a signal lamp in the gangway overhead, which informs the coal trimmers that that balloon has to be refilled. The coal is obtained in the gangway by means of doors opening into the bunkers on either side. A small Welsh coal of the

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coking kind is used, and as the coke is dropped from the conveyor close down to the enclosed gangway, it runs by gravity in through the openings, so that little labour in trimming is required. The reserve coal lies further back from the gangway, and in the event of a stoppage of supply, more labour in trimming is then required.

All the boilers are of the Babcock-Wilcox make, and are arranged in batteries containing from four to six boilers. These boilers are all fed by means of Vicar's stokers, and the arrangements give, as a rule, a very smokeless combustion. We say this from experience, as we have an opportunity of observing the fumes given off from the two chimneys both night and morning. Where the difficulty arises in connection with the smoke trouble at the Bankside station is that at times the boilers have to be fired up rapidly to meet sudden demands. In working the boilers, the stokers have only to attend to the fires and to watch the steam-gauges. All the feeding arrangements are directly under the control of the engine-room staff, who also have the valves from each boiler under their supervision. Thus all the feed pumps are placed under the gallery in the main engine-room, and the system of feed pipes is placed along the gallery itself. The ends of the steam-drum of the boilers project through the wall dividing the engine-room from the boiler-house, and the water-gauges, which are arranged in duplicate for each boiler, can thus be easily inspected from the gallery and the feed inlets arranged accordingly. The main stop-valves of the boilers are also worked from this gallery.

The steam-pipes run the full length of the engine-room, and are arranged in duplicate, but all the main steam-pipes are kept alive in order that there may be no trouble in starting up a new range should a sudden demand arise. These steam-pipes are arranged above the front of the gallery mentioned, and the valves can all be conveniently reached from it.

The engine-room consists of one long building, some 430ft. long by 45ft. wide, and the large space thus provided is completely filled with machinery. The general appearance of this engine-room cannot be shown on one illustration, on account of the great length involved. Thus Fig. 3, which is a photograph from the south end of the gallery, shows practically only one half of the plant. All the machinery beyond the bridge which divides the engine-room into two halves, is practically indiscernible. Fig. 4 is a view taken from the bridge, showing thus the second half of the station. The plant now provided is grouped into two parts, which are both complete in themselves, and as a rule the bridge forms the boundary between the machines working in each group. Thus at either side of this there is a complete set of three, or rather of four, switchboards, as follows: a switchboard for the exciters, which are worked in parallel; a switchboard for the exciting circuits of the alternators, which are also supplied in parallel; a switchboard for the alternators, which contain all that is required to work them in parallel; and lastly, a feeder switchboard. The two alternator switchboards contain provision for interconnection, so that one half of the station can lend an alternator to the other half if the need arises. The following general precautions and method of working have been adopted after a prolonged trial, and, we may add, without any disparagement to the engineering staf

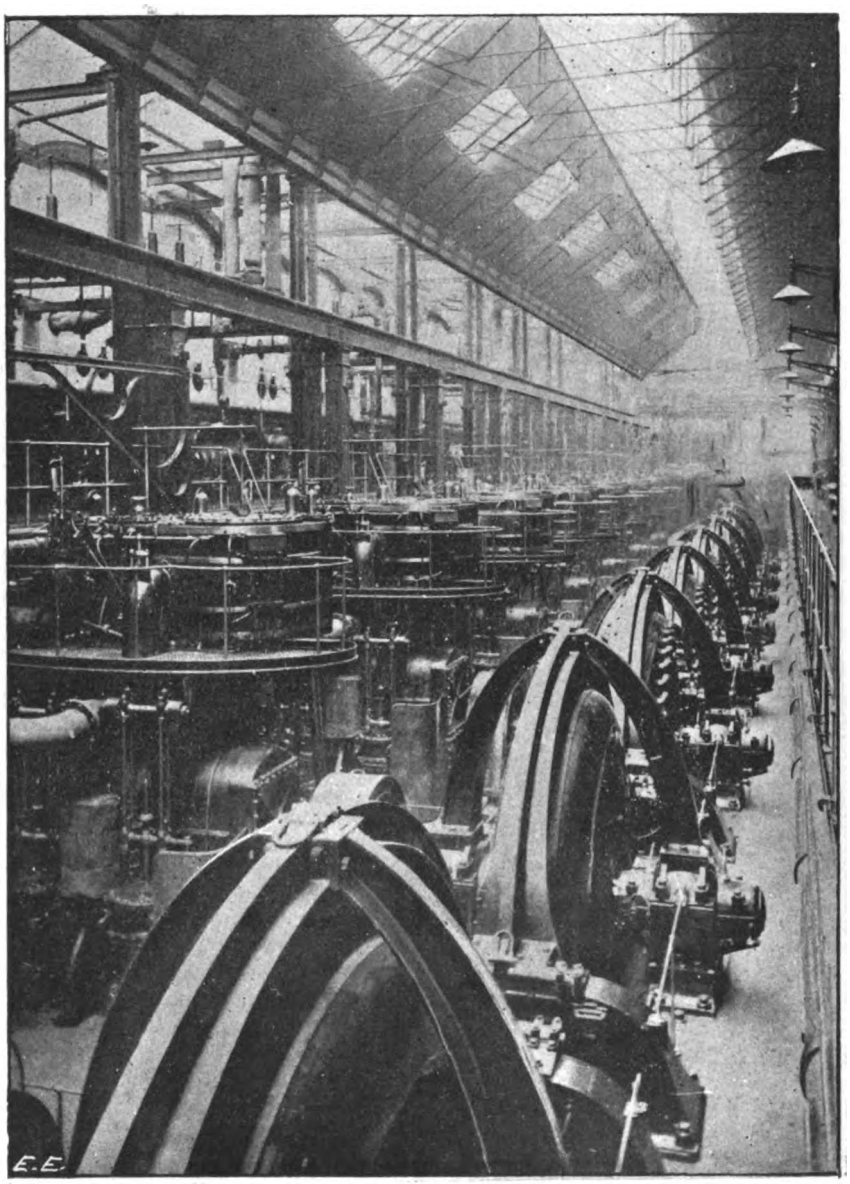

FIG. 4.—The other Half of the Station, with the Brush and Brush-Ferranti and Ferranti Steam Alternators.

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of the City of London Electric Lighting Company, that these gentlemen know more of the troubles of large switching gears than anyone else in the country. The exciters are all worked in parallel on to 'bus bars through non-return current cut-outs, which are relied on to disconnect a faulty exciter before the voltage of the supply is upset. The exciter 'bus bars are connected to the various alternator field coils through fuses, and in the event of one of the fuses going the main circuit fuses are relied on to cut out the alternator in question. The rheostats in these field circuits are only used when the alternators are being put into parallel, and are not touched when the voltage of the whole group of alternators has to be altered. Any such alteration is effected by regulating the fields of the exciting dynamos. This is done by a switchboard attendant, who does nothing else but watch the voltmeters on the 'bus bars and keep the voltage at the value found best for the load going out at the time. The only case in which exciters are driven by a main engine is that of the two large Ferranti alternators, which have direct-current dynamos by their side driven by ropes from the main shaft. The feeders are provided with the usual switch and fuse, as will be described when dealing with the switchboards.

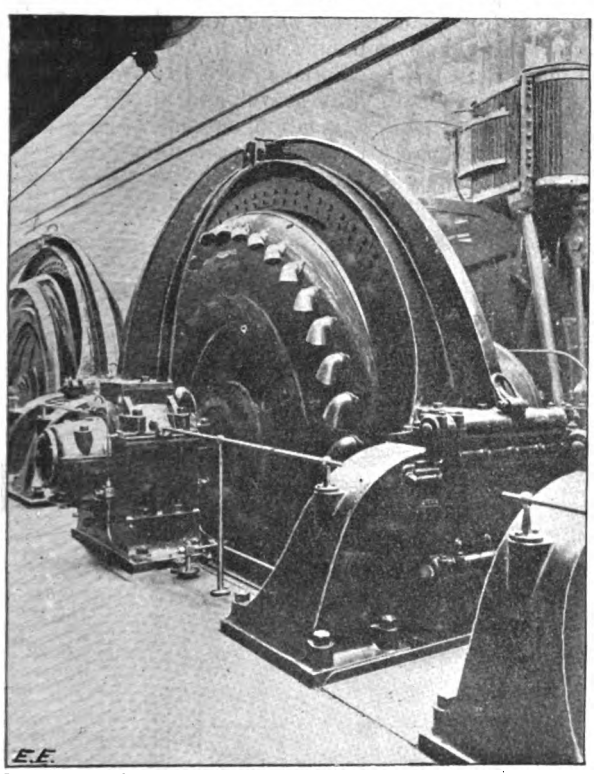

FIG. 5.—One of the Alternators Converted by Messrs. Ferranti, Limited, showing Coils and Ventilating Cowls.

The plant contained in the half of the station shown in the foreground of Fig. 3 consists of eight Willans engines of the three-crank type coupled to Thomson-Houston alternators. These machines run at 300 revolutions per minute, and are each capable of giving 400 kw. at full load. As will be seen in the photograph, two different types of alternators are in use. The general design as far as electrical particulars is the same, however. The machines in which the laminated field cores are exposed are of English make, while those with cast-iron shells over the core-plates are of American manufacture. Besides these eight coupled sets, there are some of smaller output near the bridge in which two Willans engines are direct-coupled to one alternator. Direct-current dynamos are also to be placed on the same shaft shortly, so that the engines can be used to supply the power circuits of the station. At present the alternator and direct-current dynamo, shown coupled by belting just beyond the first steam alternator in Fig. 3, are used for power purposes. The alternator is run as a synchronous motor, being brought up to synchronism by the direct-current dynamo. From this latter machine, used as a dynamo, the overhead cranes are supplied with power, as are also the workshops belonging to the company.

The machinery contained in the other half of the station illustrated in Fig. 4 consists of eight Brush engines coupled direct to alternators of 500 kw. capacity, and two large Ferranti engines each capable of giving out 1,500 kw. The Brush engines were originally connected to Mordey-Victoria alternators, of which at present only two remain. These machines are shown in the foreground of the illustrations. The remaining six 500-kw. alternators have been rebuilt by Messrs. Ferranti, Limited. In the conversion, the old style of field magnets has been retained, but a complete new armature, and also a new system of ventilation, has been added. The general appearance of the converted machine is shown in more detail in Fig. 5. The coils are of the usual Ferranti type, only, of course, the number required has had to be doubled, owing to the field magnets used. The old supports are retained, and a new casting is secured to these, providing recesses into which the coil supports can be secured by means of a sulphur compound The ventilating cowls placed on the field-magnet casting draw in the large volumes of air which are being thrown out at the periphery, thus securing a good cooling action. In this way a pleasant breeze can be felt in the gallery overhead. In working these machines in parallel the governor of one engine is used to control the speed of a group. The rest of the governors are then set so that they will act in case of emergency, but the regulation of the load of the individual engines is then controlled from the stop-valves.

(To be continued.)

HIGH WYCOMBE ELECTRICITY WORKS.

Buckinghamshire does not loom largely in the annals of the end of the nineteenth century. It is almost entirely devoted to agriculture, hence not subjected to the waywardnesses that wait on the manufacturing counties. Its hills and vales are pre-eminently beautiful, though with little or none of the beauty of mountainous scenery. The Thames forms its southern boundary, and from Staines to Henley is well known to boating men. Not far from the southern border is the town of High or Chepping Wycombe, standing on a small stream—the Wick—that rises at West Wycombe and falls into the Thames near Cookham. Chalk hills bound the river valley, and from time immemorial these hills have been luxuriantly covered with beech trees. The abundance of beechwood has given rise to the staple industry of High and West Wycombe—namely, the manufacture of chairs. Besides this industry, however, as might be expected, High Wycombe is the central market of an agricultural district, and thus while not throbbing at fever heat like some of the northern manufacturing towns, pursues the even tenour of its way with a certain amount of progressiveness that keeps it from stagnation. Its progressiveness is shown like the boy who cut more than he could eat, for the Corporation obtained a provisional order in 1894, but finding the work of too onerous a character to carry out, they wisely decided to transfer to a local company, and after negotiating with several people, eventually came to terms with the present company formed under the auspices of Edmundson's Electricity Corporation. The latter corporation has designed and carried out the installation, which was formally opened on Wednesday last.

As we have said, the centre of the chairmaking industry is at Wycombe, there being nearly a hundred factories, large and small—mainly small—engaged in this or allied work. It seems very probable that the company will obtain—as it expects to obtain—a motor load derived from these factories larger in proportion to the lighting load than falls to the lot of most stations.

The recent increase of population of the town has been very large, it being estimated that from the time of the last census in 1891 to the present, the increase has been from about 13,000 to 20,000, more or less, and the signs of the immediate future point to a still more rapid increase, for a new and more direct railway line is projected, which it is expected will bring Wycombe within 35 minutes of London.

It is impossible to discuss the negotiations which resulted in the present arrangement, but it may be mentioned that the town having its order and doing

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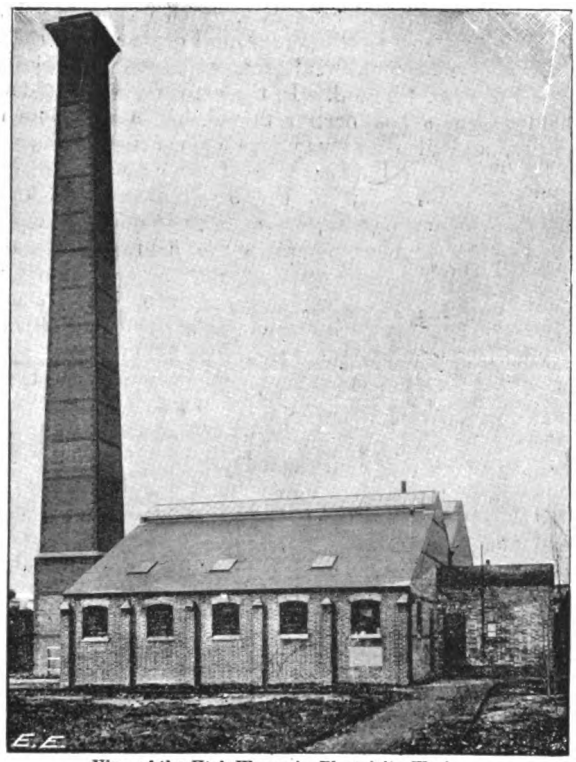
nothing, the authority was approached by Mr. A. Slatter for the transfer. This gentleman, after a long and arduous



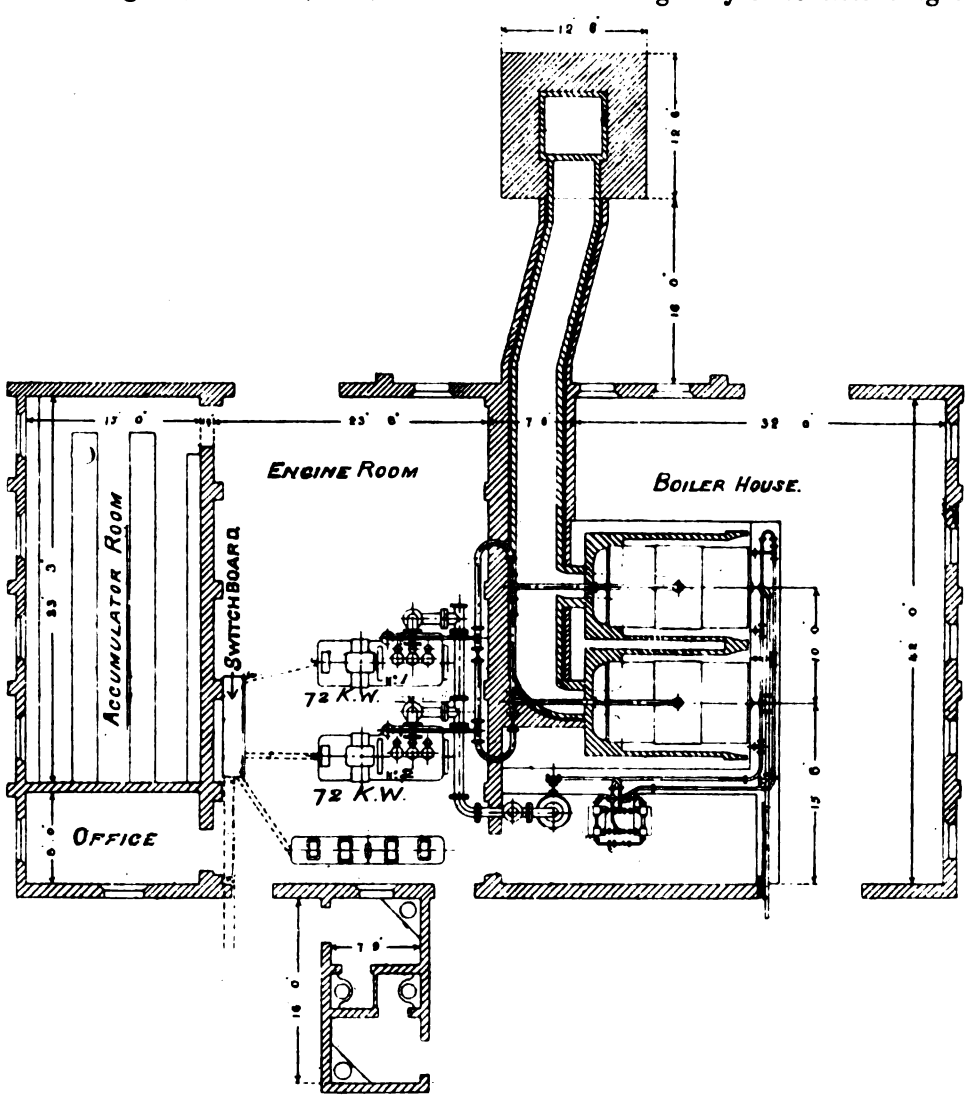
View of the High Wycombe Electricity Works.

fight, succeeded in convincing the authority that a central station would be advantageous, and then, in connection with Edmundson's Electricity Corporation, the present scheme was formulated and agreed to. The agreement contains several new features which we think will be followed in many cases. It was one of the provisions of the transfer that the Council should adopt electricity for the street-lighting, and to-day the whole of the roads are so lighted by five arc lamps and about 200 incandescents. The town hall and police offices are also lit under the same agreement. Another clause compels the company to wire any premises free and accept payment for the same at the rate of 9d. per lamp per quarter until the cost is worked off, no interest on the money expended being allowed; this should ensure the connection of a large number of smaller-class houses, in which class a majority of the premises in Wycombe may be included. It looks as if the company were taking up the work in a spirited manner, for they are also offering arc lamps and motors on hire at easy rates.

The site of the works is as nearly in the centre of the town as possible, and being three-quarters of an acre in extent there is ample room for extension. Being hid away behind cottage property, no trouble has been taken to ornament the buildings, which are, however, lightsome and well adapted for a supply works, and care has been taken to leave ample provision for extensions. In sinking the foundation for the chimney, water was met with 2ft. from the surface, and steam-pumps had to be kept at work day and night until the foundations were in; these were laid on a bed of very hard flint gravel, and all the ballast for the concrete of the foundation, engine beds, etc., was obtained on the site. From this vast underground reservoir will presently be drawn the water for condensing purposes. The chimney is 120ft. high, the internal diameter being 5ft. square.

Boilers.

For the High Wycombe electric light station, Messrs. Davey, Paxman, and Co., Limited, have supplied two of their well-known "Economic" type of boilers. Each boiler



Plan of the Electricity Works at High Wycombe.

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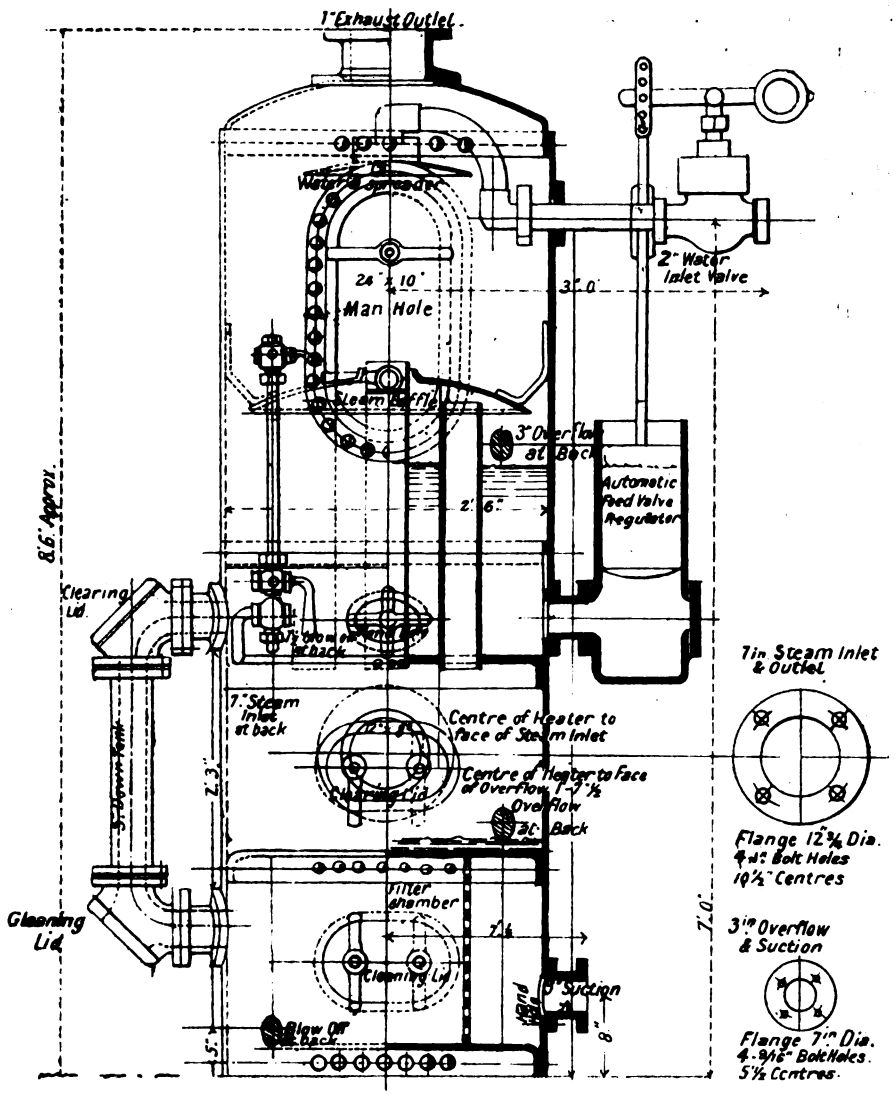
is 12ft. 6in. long by 7ft. diameter, fitted with two furnaces, each 2ft. 3in. diameter, with a working pressure of 150lb. per square inch. Each boiler is provided with Paxman's patent expansion boiler flue, the form of which gives it such strength that thinner plates can be used in its construction than it would be safe to use in the plain flue. This is a great advantage, as it is a well-known fact that the heat passes more rapidly through thin plates, which are thus rendered more durable, because they do not overheat. In this way the full excellence of the material is retained for a great length of time. It is also well known that the strength and durability of a boiler greatly depends on there being proper provision made in its design for expansion and contraction. Where this is not provided for, furrowing and ripped seams are the inevitable result. The expansion boiler flue used in these boilers is claimed to provide completely for this without injuring its efficiency as a stay. The flue is composed of a series of short lengths of plate, which are made of fine, soft, and exceedingly tough steel. The plates are bent in such a way as to be when finished perfectly cylindrical, thus adding to the strength of the flue. They are then carefully welded. When welded, the ends are heated in a suitable furnace and enlarged in a powerful flanging machine in such a way that the end of one plate exactly fits within that of the next. The holes are then drilled through both, and riveting completes the work. It will be seen that both the laps, or doubling of the plate at the seam, as well as the rivet heads, are removed from the line of draught, and consequently escape the scouring action and intense heat of the gases as they pass along the flue Flues made on this principle have withstood severe tests most successfully, and the collapsing strength is almost doubled. This type of boiler was introduced by Mr. James Paxman some 36 years ago, and it is one of the best steam generators before the public, not only for efficiency and durability, but for great economy. This boiler contains a number of good features, among the principal of which are that the boiler is of the internally-fired type, and that the furnace terminates in a brick combustion chamber, which becomes very greatly heated (in fact, almost a white heat). In consequence of this the combustion is very perfect. There is an absence of smoke, which enables the surfaces to be kept clean, and they are able to absorb the heat, which is cut up in a similar way to that passing through the tubes of locomotive boilers. In addition to this the gases pass into a smoke box, and are directed round the external surface of the boiler. This is a greater advantage, perhaps, than is commonly thought of by casual observers, inasmuch as the boiler is kept at a more uniform temperature, and the result is an absence of leakage set up from undue expansion and contraction in the flue, shell, or tubes. The heating surface is of such a character that the distribution of heat has the greatest effect. The boiler has a large capacity at the water-level, thus providing a good steam reserve against sudden calls, and giving a good working margin for the feed supply. The boiler, in proportion to its heating surface, occupies but little space. The tubes are made $\frac{1}{8}$in. larger at the smoke-box end, so that they can be easily removed. There is an almost entire freedom from smoke in consequence of the excellent combustion, and the boiler is capable of standing heavy firing and being worked at high pressures. It is very reliable, and the cost for repairs is understood to be low. The boiler occupying a small space (about half that of the Lancashire boiler), there is only a small amount of brickwork required, and it is, therefore, cheaply set. The cleaning of tubes and flues and also the removing of the



— ELEVATION. — SECTION. —

Feed-Water Heater.—High Wycombe Electricity Works.

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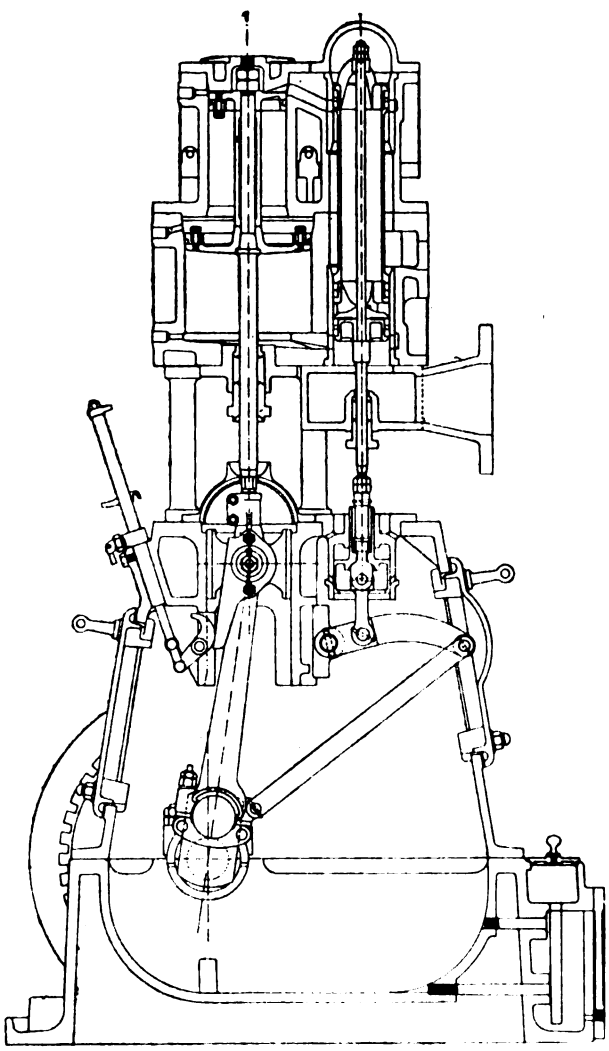
tubes is entirely effected from the front of the boiler. By a new arrangement of the smoke tubes, which the firm has recently patented, easy access can be had to all parts of the boiler for cleaning and examination. A very large number of these boilers are in constant work, and, so far as experience goes, the cost of repairs is said not to average more than 5s. per cent. per annum. These boilers are best worked with a draught equal to not less than $\frac{1}{8}$in. of water (though $\frac{1}{4}$in. is preferable), and they are most economical when being worked at about 5lb. evaporation per square foot of heating surface, and for this purpose the draught should not be less than above stated. In actual daily work these boilers have been found to evaporate 12·2lb. of water per pound of best Welsh coal from feed at 212deg. F.

Feed-Water Heater.

Messrs. Joseph Wright and Co. have supplied one of their "Excelsior" feed-water heaters. The size of the heater



Section of Peache Engine, High Wycombe Electricity Works.

supplied is 96in. by 35in. diameter, and is capable of heating and filtering 1,000 gallons per hour. It, indeed, is not only a feed-water heater, but it contains a filter and oil separator combined. The oil in the exhaust steam is nearly all separated as it enters the heater. It travels up the wrought-iron tubes, striking a steam baffle, and as it approaches the top of the heater it meets a continuous spray of water, which condenses the greater portion of it, leaving the remainder of the steam to go through the exhaust outlet at the top. The fresh water and condensed steam water being heated to about boiling point, travels down through the pipe outside the heater into the bottom compartment, where it is forced by gravity through the large filter chamber to the suction, whence it is pumped to the boilers at about 206deg. F., clean and free from any grease.

Engines.

The Peache high-speed engine is a single-acting engine; that is, an excess pressure is maintained on the pistons in the direction of the crankshaft during the up-stroke, so that a constant thrust is maintained on all bearings, both on down and up strokes. This is provided for by the compression and subsequent expansion of steam in the space between the high-pressure and low-pressure pistons. Distribution of steam is effected by a valve gear deriving its motion from a point on the connecting rod. This valve motion provides in the first place for the placing of the valves in a convenient position at the back of the cylinders. There are no eccentrics on the crankshaft, and therefore room is left for long and well-supported crankshaft bearings. The distribution of steam as between high-pressure and low-pressure cylinders is effected more advantageously by this valve gear than could be done with the usual eccentric motion. The crankshaft and other working parts run in a bath of oil and water. A set of indicator diagrams is herewith given. The distribution of steam in the engine is as follows: The steam enters by a branch on the low-pressure cylinder casting to the centre line of steam-chest, and passes right and left by passages formed in the casting to the other two steam-chests. Steam passes up the annular space outside the valves and under the lip of the high-pressure valve to the top of the high-pressure piston (in the section the valves are shown in

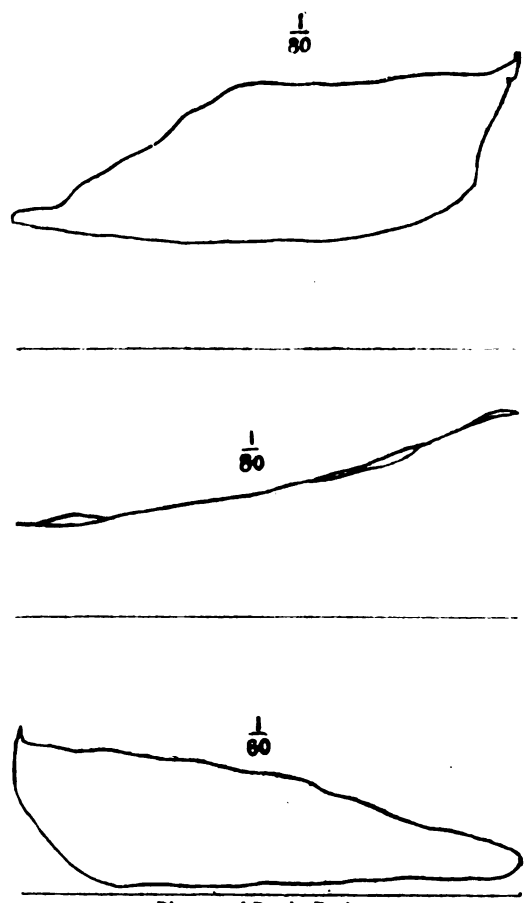


Diagram of Peache Engine.

position of "lead" for the high-pressure cylinders), and on the up-stroke steam is exhausted from the high-pressure cylinder over the top of the valves down to the centre of the valves, and so to the underside of low-pressure piston, being cut off at a little after half stroke in that cylinder, and finally is passed under the low-pressure valve to the exhaust on the next down stroke. At the top of the stroke the high-pressure piston uncovers two small by-pass ports, which communicate with the space underneath that piston, and thus for an instant at the top of each stroke the space called the controlling cylinder is placed in communication with the high-pressure cylinder, and by this means the initial pressure of steam in the controlling cylinder is maintained at a constant ratio of that in the high-pressure cylinder. From an inspection of the diagrams it will be seen that though the steam in the low-pressure cylinder exerts an upward pressure on the low-pressure piston this is not transmitted direct to the crankshaft, but acts in compressing the steam in the controlling cylinder, pushing steam from the high-

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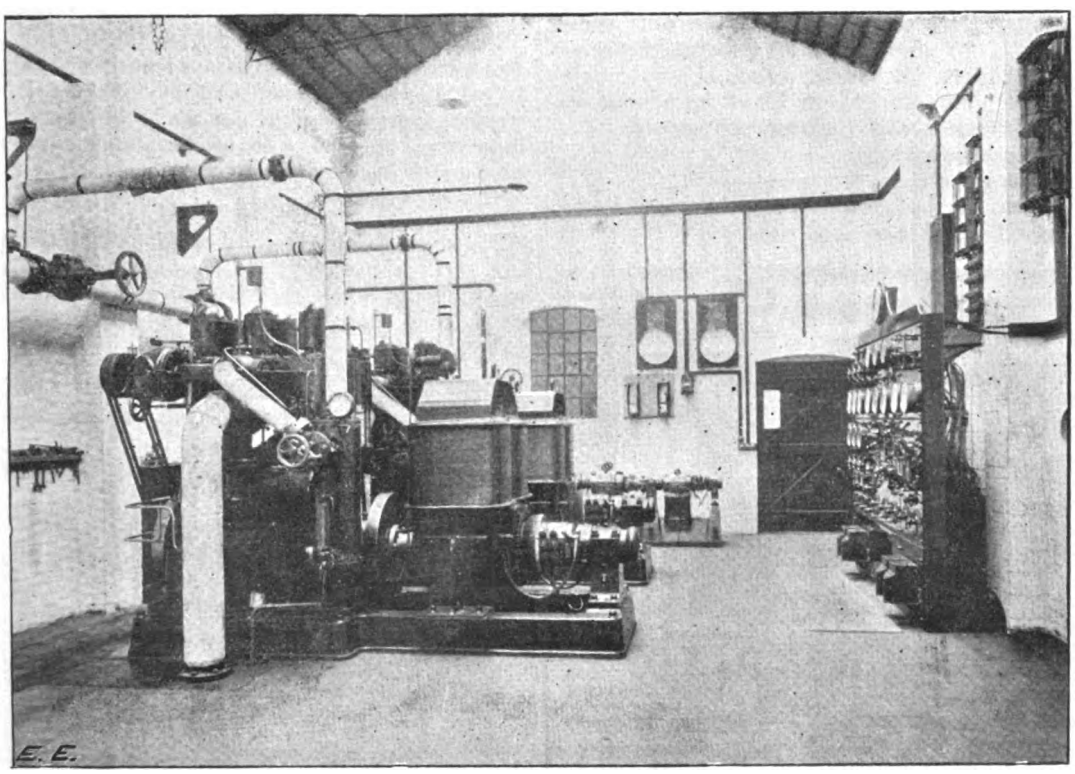
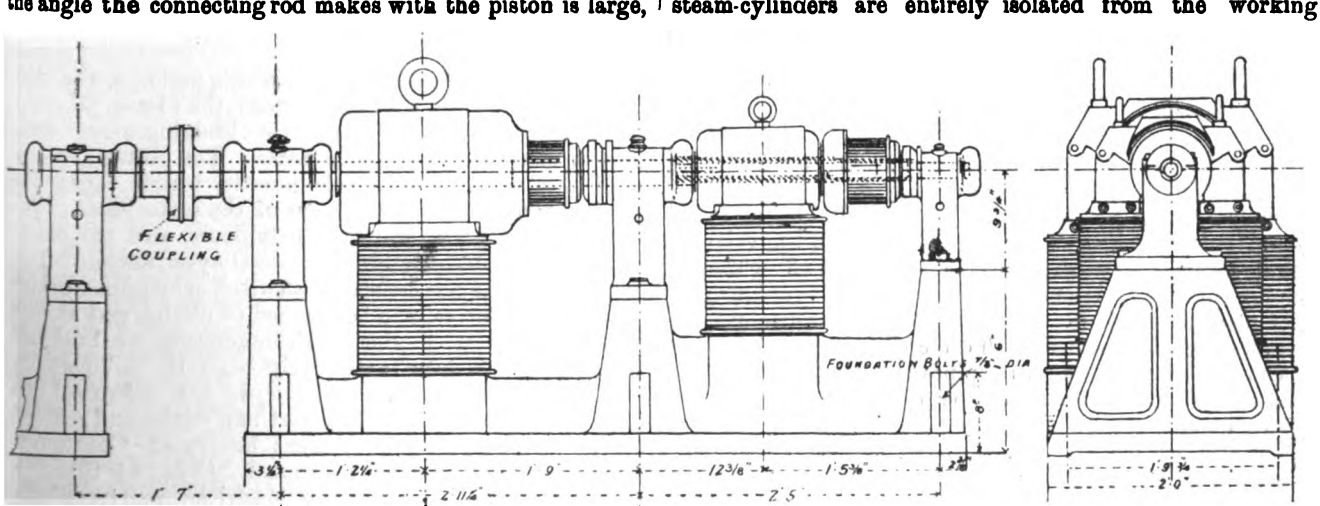
pressure cylinder into the receiver, thus storing up work which is subsequently given out again. In condensing-type engines in which the ratio of expansion and range of temperature is large, a steam jacket is applied to the controlling cylinder, so that the steam in the controlling cylinder becomes a medium for the transfer of heat from the steam jacket to the working surfaces of the high-pressure and low-pressure cylinders. A feature in this engine which at once calls attention to itself is the position of the crankshaft—namely, in front of the cylinder axis. This position is adopted to obviate reversal of pressure and knock, which would otherwise occur in a single-acting engine in which the usual position of crankshaft is adopted. It will be seen that the connecting rod is nearly straight during the down stroke, when the heaviest pressures are being transmitted by it, and that during the up-stroke, when the angle the connecting rod makes with the piston is large, the pressures transmitted are small, but the angle of the connecting rod being always towards the back cross-head guiding surface, the resultant pressure is always on the back slide. Messrs. Davey, Paxman, and Co., Limited, who are the sole licensees, make this engine of the three-crank type only. The arrangement of three sets of tandem cylinders working on a three-throw crankshaft, providing, as is well known, for the practical elimination of vibration, is a matter of the utmost importance where engines are placed in close proximity to important buildings and dwelling-houses. At the same time, the even turning realised by the three-crank tandem type provides for the easy running of alternators in parallel, and is of advantage in giving a very steady current with continuous-current dynamos. The builders claim a very high mechanical efficiency for this engine, as might be expected from the simplicity of the design, and also an exceptionally low steam consumption. Every part is readily accessible, and can be got at for examination or repairs without dismantling the engine. All parts are of strong and substantial design, and can be handled without danger of injury, and, if necessary, replaced from the resources of any ordinary workshop. There are no internal glands, and of the external glands one is subject to low-pressure steam only and the other to exhaust-pressure steam only. The steam-cylinders are entirely isolated from the working chamber. Heat cannot pass from the cylinders to the lubricant bath, and there is thus no danger of the bath becoming overheated or decomposed. When working condensing, it is impossible for oil to be drawn from the working chamber to the cylinders and condenser. Since the firm have taken up the manufacture of this engine, it has been largely adopted for central-station lighting work, and at the time of writing there is some 10,000 h.p. to 12,000 h.p. of these engines at work.



Dynamo-Room, High Wycombe Electricity Works



Balancer Booster Set at High Wycombe Electricity Works.

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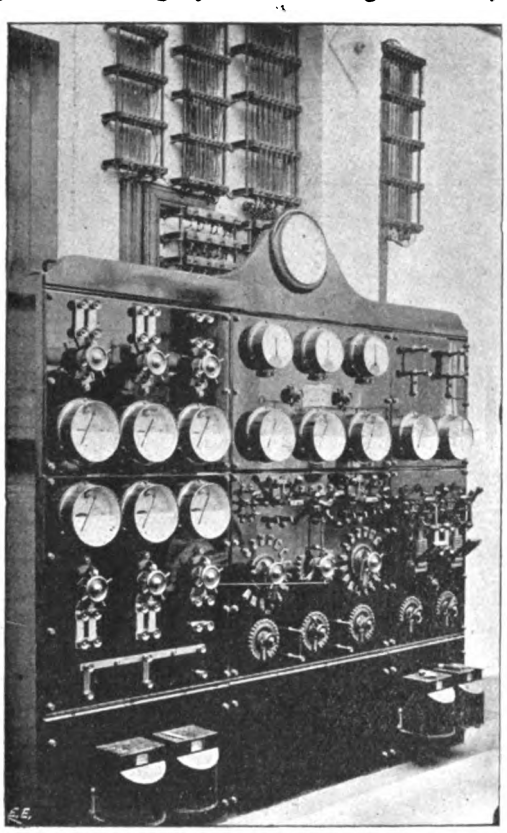
Dynamos.

There are two shunt-wound dynamos, each capable of giving an output of 450 volts 160 amperes at 480 revolutions per minute, arranged for mounting upon extension of engine bed-plate, and coupled direct to the Peache engine. There is also a balancer booster (shown), the balancer consisting of two machines, each arranged for a current of 50 amperes at an E.M.F. of 210 to 230 volts, these machines being coupled together by flexible couplings and mounted upon common girder rails. At each end of the combination is placed a smaller machine for charging the cells, these giving an output of 70 amperes at 70 volts at the same speed as the balancers, the speed being approximately 950 revolutions per minute. The machines throughout are wound with coils under the Eickemeyer patents. The magnets of the balancer booster are fitted with hinged pole-pieces, so that when these are turned back the armatures can be taken out by a direct vertical lift. All the bearings are self-oiling by means of rings. The dynamos



Switchboard at High Wycombe Electricity Works.

were constructed by Messrs. Thomas Parker, Limited, of Wolverhampton.

The Steam-Piping.

The steam-piping has been carried out by Messrs. Babcock and Wilcox, the method employed being the now well-known "ring system." The pipes are divided up into any convenient number of sections by means of the valves, so that in case of need any section can be shut off without stopping the other sections or interfering with the working of the plant as a whole. In ordinary working the steam passes through the main in both directions, so that the size, and consequently the cost of the pipes and valves, is reduced as compared with what would be necessary where two separate mains are supplied.

The main steam-ring is 5in. diameter, with 4in. branches to the boilers and 2½in. diameter branches to the engines. Throughway valves are provided in the ring main, enabling either boiler to supply steam to either engine. By the use of a bend of liberal radius at either end of the ring main, expansion boxes are entirely avoided. The steam-pipes are constructed of best-quality mild steel, whilst the flanges are of stamped wrought iron, and are screwed on hot by a fine thread and brazed, thus ensuring an absolutely steam-tight joint. The tee pieces receiving the connections from the boilers are formed as pocket pipes. These, as well as all other tees used, are made of a special mixture of cold-blast hematite iron and steel of high tensile strength.

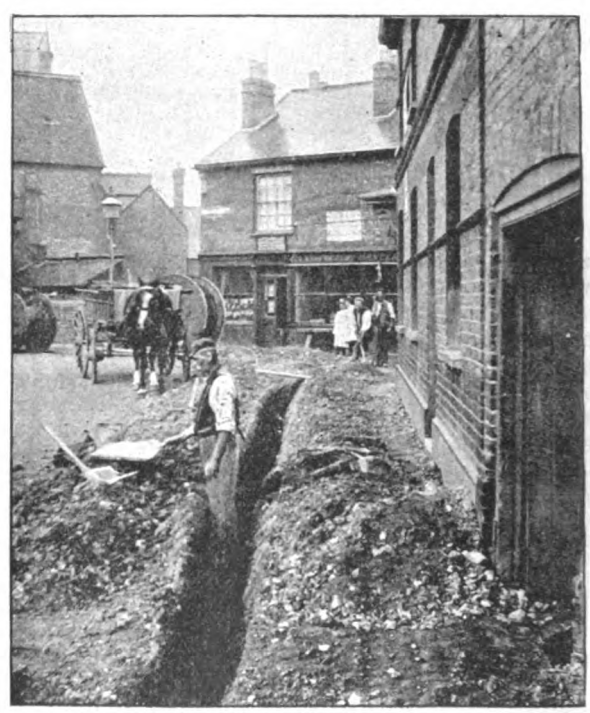
The exhaust branches from the engine, of 6in. diameter, are connected up to a 10in. diameter main, whence the exhaust steam passes to a feed-water heater, but by the arrangement of a by-pass it can be led to the atmosphere direct.

As with the steam-piping, the feed-piping to the boilers is also arranged on the "ring system," and so arranged that either pump can feed either boiler direct or through the feed-water heater. The pipes are all wrought iron, but the flanges are of heavy cast iron made to the manufacturers' special specification.

The steam-main is drained from the cast-iron pockets, to which are connected steam-traps for automatically removing the whole water of condensation. All the joints for the exhaust and feed piping are made by use of corrugated brass rings smeared with mastic, which ensures a perfect joint under the most trying conditions.

Accumulators.

The storage battery consists of 230 of the well-known D.P. "strip" pattern, "F" size, having a capacity of 585 ampere-hours when discharging at 65 amperes for nine hours, and complete with glass boxes, etc. The cells embody all the most recent improvements that have been



Laying Cables at High Wycombe.

introduced in storage batteries, of which, perhaps, the most important is the ½in. spacing between the plates, whereby short-circuiting by means of particles bridging across from plate to plate is no longer possible. The plates are produced by a special electrolytic process, which causes the active material to be formed out of the plate itself. The "protecting coat" is thus extremely dense, and the oxides in the best possible condition for electrolytic action. This special construction is claimed to afford an enormous working area, enabling the cells to be charged or discharged at very high rates without producing disintegration or buckling. These cells have been extensively used in all parts of England for the past 12 years, and we are informed that it has been found necessary to start new works at Lumford, Derby, in addition to the present factory at Charlton to cope with the ever-increasing demand. Cells of this type are now in use in the following electricity works: Folkestone, Shrewsbury, Newmarket, Chislehurst, Winchester, Bromley, Ventnor, and Salisbury.

The Switchboard.

The switchboard was made by Mr. E. Charrington, and is in all respects similar to that at Folkestone, described and illustrated on pp. 616-17-18 of our issue of Nov. 11, 1898, so that it is unnecessary to say more here than it is of enamelled slate, divided into three panels, the panel on the left hand for the feeders, that on the right for the

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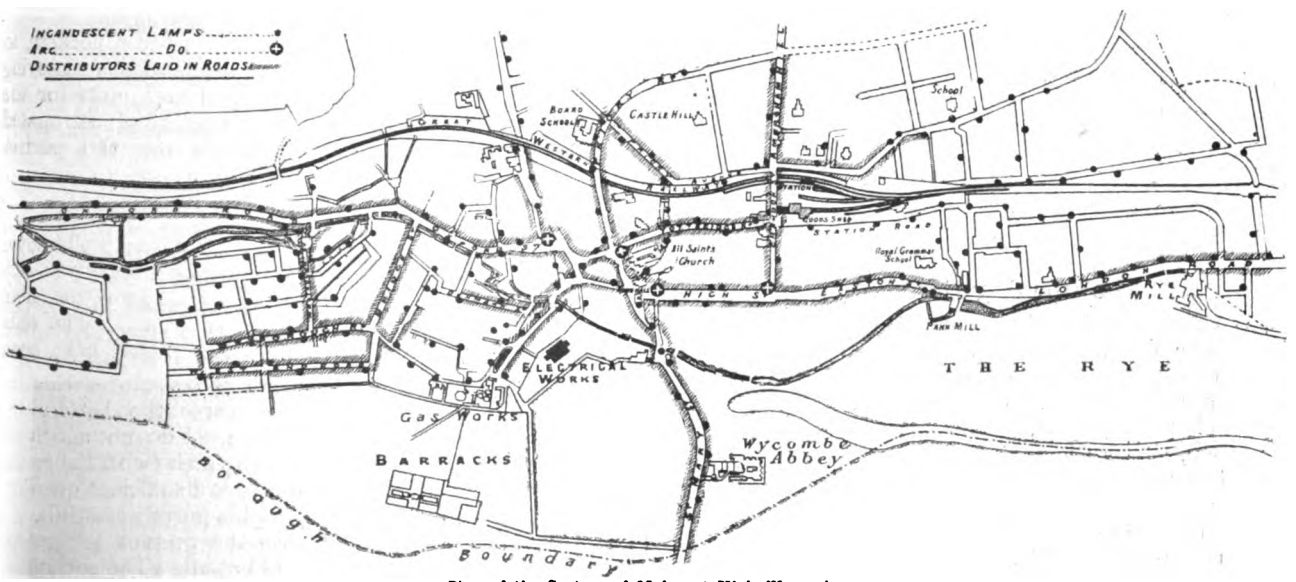
dynamos, that in the centre for the middle wire, balancer set, and accumulators.

The Distributing Mains.

The feeders (three in number) consist of triple-concentric cables insulated with a dielectric of bitumenised fibre, lead-sheathed, yarned, armoured by two steel tapes, and finally yarned and compounded. The sectional area of the conductors are ·10, ·10, ·06. They are taken from the generating station in Lilip-walk to three feeder boxes situated respectively: No. 1, at the corner of Westbourne-street and Desborough-road, supplying the west-end district; No. 2, in Market-square, supplying the central portion of the town; and No. 3, in the London-road, supplying the east-end district. The feeder cables are laid in all cases under the roadways at a sufficient depth beneath the surface to prevent any external injury. The distributing mains consist of three-core cables, each core being insulated with bitumenised fibre, and the whole covered with a lead sheath, yarned outside, and protected with an armouring of two steel tapes, and then yarned over all. These cables are of two different sizes, the larger section being ·075, ·075, ·05, the smaller section ·05, ·03, ·05. They have been laid in all the important thoroughfares of the town, and have been almost entirely laid underneath the roadway, as this was considered most suitable to the conditions of the town. Disconnecting network boxes have been provided at suitable points. In addition to the cable for the supply of house-lighting, a very extensive system of mains has been laid to supply the street lamps. The gas lamps of the town have been replaced by incandescent lamps, supplemented by five arc lamps. Separate cables have in all cases been laid to supply the public lighting, and consist of three-core cables of a sectional area of ·008 for the incandescent lighting, and ·012 for the arc lighting, constructed in a similar manner in every respect to the distributing cables. Suitable switching-on points have been provided so that the lamps may be switched on in groups, of which there are 13.



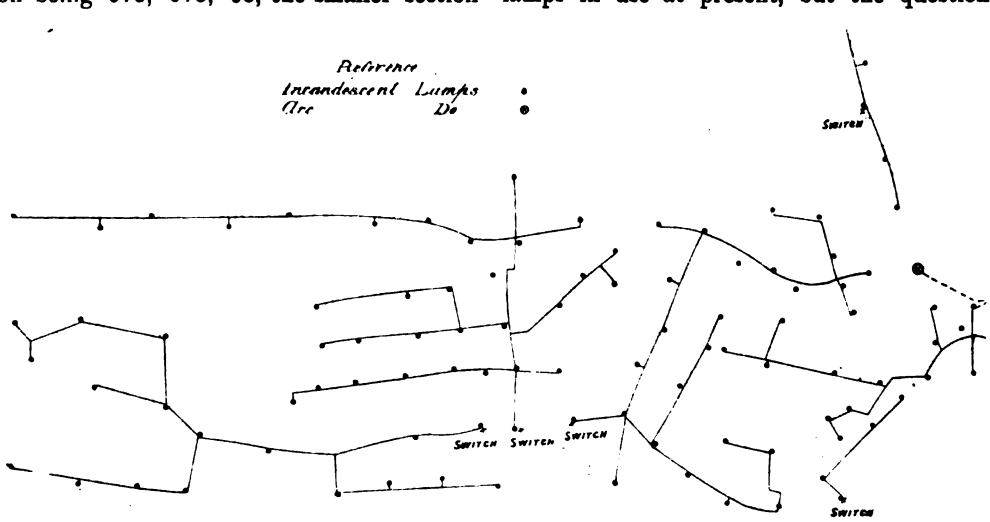
Plan of the System of Mains at High Wycombe.

Cables.

Perhaps the tabular form will show sizes, etc., of cables better. They are of the fibrous type, lead covered, and armoured, with one exception, the feeders being triple concentric, and the distributor three-core. The following are the lengths as laid at present:

Feeder No. 1	662 yards	·100	·06	·100
,, No. 2	321 ,,	·100	·06	·100
,, No. 3	1,020 ,,	·100	·06	·100
Distributors	2,480 ,,	·075	·05	·075
,, ...	5,060 ,,	·05	·03	·05
Arc lamps	420 ,,	·012	·012	·012
Incandescent street-lighting	7,750 ,,	·008	·008	·008
		·008	·008	—

As already mentioned, the chief street-lighting is by means of incandescent lamps, there being only five arc lamps in use at present, but the question of extending these is now under serious consideration. The old gas standards and lanterns have been retained, and the electric lamps are fitted inside the Reason Company's lens reflectors in straight roads, and inside a "Prism" globe at corners or in crooked streets.



Street Lighting Arrangement at High Wycombe.

All the lamps are fitted off separate cables composed of ·008, ·008, ·008 three-core, lead-covered, and armoured, tapped off the distributors at various points in the nearest post, to which are fitted the switches for the circuit. These switches are roughly collected together in three groups, and it takes less than an hour for one man to turn them all on or off.

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Three of the arc lamps are open type, connected between the outer and neutral of the system. The other two are Jandus lamps in series connected in the same way.

The number of lamps connected at the beginning of this year was about 1,800 c.p., which has been increased by nearly 1,000 since, and enquiries are very frequent just now. In several directions new buildings are being erected, and the owners have decided to have them up-to-date and lit throughout by electric light, which shows that the supply is being approved of, and augurs well for the success of the enterprise. The distribution is at 420 volts between outers—that is, at 210 volts between outer and middle wires.

The whole of the mains have been manufactured by Callender's Cable and Construction Company, Limited, and the work of laying and jointing the cables has been carried out by them under the superintendence of their engineer. In addition to this, the whole of the street work, excavation, etc., has been carried out by the Callender Company. The work has been superintended for them by Mr. Laceby.

The Opening Ceremony.

Invitations were issued for the opening ceremony to take place at one o'clock on Wednesday, March 1, and a goodly company of ladies and gentlemen gathered at the station to witness the operation. Unfortunately, Earl Charrington was unable to be present, and his place was taken by Mr. H. Lawson, who apologised for the noble Earl's absence, referred to the progressive spirit of Wycombe, asked the company assembled to walk through the works, and to hear from the lips of Mr. Wigham a brief but lucid description of the apparatus. Mr. Wigham is quite accustomed to this sort of work, and takes to it with great zest. The tour ended, the Mayoress was invited to switch on the light, which duty being satisfactorily performed, a vote of thanks was given to Mr. Lawson and to the Mayoress, and so far the ceremony came to an end. The next item on the programme was lunch at the invitation of the Wycombe (Borough) Electric Light and Power Company. Our space is, unfortunately, too curtailed to enable us to do justice to the luncheon—well served by our host of the "Red Lion"—or the speeches that followed. Mr. Lawson presided, with the Mayor on his right and Mr. Slatter on his left, and about 70 of the foremost men of Wycombe as supporters. All went merry as the proverbial marriage bell, and we hope the success of the undertaking will be commensurate with the good wishes expressed for it at this meeting.

WIRELESS TELEGRAPHY IN 1849.

(*Communicated by* CHARLES BRIGHT, F.R.S.E.)

From the following letter it will be seen that so-called "wireless" telegraphy in some sort of practical form, if not as old as the hills, was at any rate publicly suggested by Mr. J. W. Wilkins—a telegraph engineer of the earliest days—for electrically spanning the English Channel, before what may equally well be called wire-*full* telegraphy had been so applied.

In reading this letter, which appeared in the *Mining Journal* for March 28, 1849, it must be remembered that the terms in use then were widely different from those of to-day, let alone the disparity in views.

The letter was headed "Telegraph Communication between England and France," and read as follows:

"Allow me, through the medium of your valuable journal, to draw attention to a theory upon which a telegraphic communication may be made between England and France without wires; and as this mode of telegraphy seems to be the ultimatum of all wishes upon the subject, I do not hesitate to lay before your readers, for investigation, experiment, or actual use, this, my view of the subject.

"I take for certain (as experiments I have made have shown me) that when the positive and negative poles of a battery are dipped into or connected with any conductory medium the electricity around the positive pole is positive, being diffused in radial lines, and the part around the negative pole is negative in radial lines converging towards it, supplying the electricity requisite for the decomposition of the substances composing the battery. This understood, it is evident that when a positive radial line sets out from the junction of the battery with the earth it makes its way to or is attached by the nearest negative portion of *earth*, at last meeting the negative pole of the battery, restoring the equilibrium. From this it appears that the first portion of electricity will pass in a straight line between the two poles, being the shortest between them, and the rays will then form curves between the poles until, by reason of increasing distance, they are no longer influenced by one another without a better medium of conduction be interposed in their circuit.

"It is natural to suppose that all parts of the earth are not of one uniform density; if so, then some parts are positive and others negative. Then from this it is easy to see that some of the electricity flowing from the positive pole is the means of restoring equilibrium to negative portions of the earth, not necessarily rendered so by the negative pole of the battery, and also positive portions for the same reason rendered neutral or negative (see note No 1 below).

"These rays of electricity may be collected in a certain quantity between the point where they start and where they are rendered neutral, and by the interposition of a metallic medium that shall offer less resistance than the water or earth — obviously the nearer the battery the greater the chance of collecting them. I do not anticipate the distance of 20 miles is at all too much (with the means we can use to compensate it) to collect a sufficient quantity of current to be useful for telegraphic purposes. Still, the quantity would be small, and with the present telegraphic instruments would not be detected at all. The current in the wire of the instrument used must be detected, not by its amount, but that it exists in *any quantity*, however small. If, then, electricity can be collected in France simultaneously with a discharge from a battery in England, all that is required is to find out what to do with it, so that it shall indicate its presence.

"I will now lay before you the arrangement I propose for carrying out this design.

"*No.* 1.—Upon one shore I propose to have a battery that shall discharge its electricity into the earth or sea, having a distance of some 5, 10, or perhaps 20 miles, as the case may be, between the poles.

"*No.* 2.—Let a similar length of wire be erected on the opposite coast, as near to and as parallel with it as possible, having its ends dipping into the sea or earth.

"*No.* 3.—Within the above circuit have an instrument consisting of about 10 or 20, or more, square or round coils of finest wire of best conductibility, suspended on points or otherwise, being part of circuit No. 2. Suspend this coil before or between the poles of an electric or permanent magnet or magnets, and in either case any current through the coil will be indicated by its moving or shifting position (see note No. 2 below). *This* would then constitute the telegraph. It now would only depend upon the distance between the poles of the battery in one case, and the ends of the circuit wire in the other, together with the lightness of the coils of wire used—having reference to their number—and the power of the magnet or magnets used to deflect it, although that would be easy of adjustment, and when once done are certain to be of continuance; at all events, much more so than a submerged wire across the Channel.

"I hope someone will take up this suggestion, and carry it out practically, to a greater extent than my limited experiments have enabled me; for of its truth for long, as well as short distances, I am satisfied, and want of means only prevents me from carrying it out at once. I venture to say what I have on an experience in electricity of 10 years, and a practical acquaintance with electric telegraphs of near five years.—(Signed) J. W. WILKINS.

"*No.* 1 *Note.*—The present electric telegraph is affected by what is *commonly* termed 'Auroras,' or a current of electricity passing along the wires, of course entering and passing through the coils used, thereby deflecting the needle. While inspector of telegraphy on the lines between Rugby and Newcastle, I have known that for hours at a time the telegraphs on particular sections of the road have been rendered useless from this deflection, often moving the

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needle from the perpendicular to either side, and back again, in a few minutes, giving evidence of different currents flowing in the same direction, or the same currents in different directions. As the telegraph wires are terminated at each end with a plate in the earth, these wires are thus portions of the earth itself, and currents flowing from place to place pass along them.

"*No.* 2 *Note.*—The coils under these circumstances would, if between the poles of the magnet, move from any position and lie parallel to the poles, and, if in front of the poles of the magnet, would move from side to side in a plane parallel to the ends of them.

"I claim these movements as design or invention of my own, as telegraphs, working with the least amount of electricity and resistance; and the movement depends not so much upon the current passing as on the power of the magnet or magnets used."

ROYAL INSTITUTION.

PROF. LODGE ON "COHERERS."

On Friday evening last at the Royal Institution Prof. Oliver Lodge, D.Sc., LL.D., F.R.S., lectured on "Coherers." Sir William Crookes presided, and there was a large and interested audience.

Prof. LODGE said one of the peculiarities of an audience like that was that there was always somebody present who knew more about the subject than the lecturer. If anyone asked him what a coherer was he should reply by asking, Do you know what a microphone is? A coherer did for ether-waves what a microphone did for sound-waves. Sound-waves impinged on the microphone and enabled a signal to be received; ether-waves impinged on a coherer and enabled a signal to be received. He might, then, define a coherer as a thing sensitive to ether-waves. Now, he by no means wished to assert that the human eye was a coherer. Five years ago he attempted to prove this to physiologists, but in that attempt he failed. He was not sure, however, that this was not true. People had become very excited lately about wireless telegraphy, but, say, a century ago no one thought of anything else. This was done by showing lights, and the flashing of the heliograph was even now of the utmost importance in the conduct of Imperial warfare at the outskirts of civilisation. Years ago the wonder was, not that there should be wireless telegraphy, but that any wire should be used in telegraphy at all. Waves fell upon the eye and produced a nervous sensation which we called light. But people said, "Oh! we can see; it is nothing." This was because the eye was an instrument they had got accustomed to. He knew less about his own eyes than he did about a coherer. He wished people would think of their own eyes as ethereal instruments, and realise how important ether ripples were to them. Being deaf meant that you had no definite appreciation of air ripples or waves, and the eye must feel vibrations of appropriate frequency to ensure sight. Now, a coherer was a thing that felt ether vibrations, and so established a better electrical condition than existed before. In other words, a coherer was a thing consisting of two bodies, which were alternately united electrically and broken up again mechanically. Illustrating this by various tests, Prof. Lodge showed the effect of electrical influence on rain and on a Scotch mist. As everybody knew, big drops of rain fell during a thunderstorm. Repeating Lord Rayleigh's experiment on a jet of water flowing from a miniature fountain, he showed on a screen how these drops as they issued and fell struck against each other and rebounded. Under the influence produced by a stick of sealing-wax which had been subjected to friction and so electrified, the water-jets were found to no longer rebound, but to become united, thus representing a shower of big raindrops. In the same way a Scotch mist became rain. Having demonstrated the production of Hertz waves, the lecturer showed an experiment which involved a greater degree of electrical power than he had applied in other tests in regard to cohesion, explaining in the meantime that what took place with larger bodies in this direction was symbolical also of what occurred when two atoms combined. A bell-shaped glass jar, containing what the lecturer described as a quantity of dust deposited at the inner base, was filled with smoke or oxide of magnesium, and then placed under electrical influence. The result showed that under the powerful light which was allowed to play on the jar, the dust particles became what Prof. Lodge suggested was in appearance a miniature snow shower, while the smoke was now to be observed adhering to the sides of the glass vessel. It had been said, remarked the lecturer, that this would be a good method of dealing with a London fog, but he did not entirely agree with this. The best way to deal with fogs, unless they were unavoidable, was for people to prevent these themselves by forbidding the entry into London of coal at all, and instead, to bring gas in large quantities from the pits. In further illustration of coherers, he threw on the screen indications of the result of electrical action on a glass tube containing filings. These immediately began to cohere and form a path for the transmission of the current, thus demonstrating that conductivity had been established and resistance overcome by the ether-waves. The lecturer also showed that by a rap with the knuckles—that is to say, by the application of mechanical means—cohesion was destroyed and the resistance was once more increased. Another experiment in illustration of conductivity superseding resistance was shown. A plate of filings was placed on a table, and electric sparks were sent among the filings. The sparks at first succeeded each other with more or less rapidity of succession, until, becoming less frequent, the same fact was again apparent—namely, the substitution of a conducting path for one of high resistance. Prof. Lodge also illustrated the action of earth-waves and their application to wireless telegraphy. In conclusion, he said that the two forces we know least about in physics were cohesion and gravitation.

FORTHCOMING EVENTS.

FRIDAY, MARCH 3.

Institution of Junior Engineers.—At Westminster Palace Hotel, at 8 p.m., "Carbon-Consuming Batteries and their Possibilities," by Mr. W. R. Cooper, B.Sc.

SATURDAY, MARCH 4.

Royal Institution.—At 3 p.m., "The Mechanical Properties of Bodies," by Lord Rayleigh, M.A., D.C.L., F.R.S. Fourth lecture of series of six.

Institution of Electrical Engineers.—Students' visit to Messrs. Easton, Anderson, and Goolden's Works at Erith (train leaves Charing Cross at 10 a.m.).

MONDAY, MARCH 6.

Society of Arts.—At 8 p.m., "Cycle Construction and Design," by Mr. Archibald Sharp, A.M.I.C.E.

TUESDAY, MARCH 7.

Institution of Civil Engineers.—At 8 p.m., "Water-Tube Boilers for Marine Engines," by Mr. J. T. Milton. "Recent Trials of the Machinery of Warships," by Sir A. J. Durston, K.C.B., R.N., M.I.C.E., and Mr. H. J. Oram, R.N., M.I.C.E.

WEDNESDAY, MARCH 8.

Liverpool Engineering Society.—At 8 p.m., Paper by Mr. Bryson Cunningham, B.E., A.M.I.C.E.

THURSDAY, MARCH 9.

Institution of Electrical Engineers.—At 8 p.m., ordinary general meeting.

FRIDAY, MARCH 10.

Royal Institution.—At 9 p.m., "Measuring Extreme Temperatures" by Prof. H. L. Callendar, M.A., F.R.S.

Physical Society of London.—At 5 p.m., "A Study of an Apparatus for the Determination of the Rate of Diffusion of Solids dissolved in Liquids," by Mr. Albert Griffiths, M.Sc.; "Note on the Source of Energy in Diffusive Convection," by Mr. Albert Griffiths, M.Sc.; an Exhibition of Dr. A. Wehnelt's Electrolytic Current Interruptor for Ruhmkorff Coils, by Mr. A. A. Campbell Swinton.

Institution of Civil Engineers.—At 8 p.m., students' meeting, "The Construction of the Elan Aqueduct, Birmingham Waterworks," by Mr. H. Lapworth, Stud.I.C.E

SATURDAY, MARCH 11.

Royal Institution.—At 3 p.m., "The Mechanical Properties of Bodies" lecture by Lord Rayleigh, M.A., D.C.L., LL.D., F.R.S. Fifth lecture of series of six.

Institution of Junior Engineers.—At 7 p.m., Conversazione at Westminster Palace Hotel.

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MUNICIPAL ENTERPRISE.

The question of the scope and sphere of municipal enterprise is, we think, in a fair way to be brought forward for settlement. We have received information that the Government has considered favourably the desire expressed in various quarters to appoint a joint committee of the two Houses to report on the question. Undoubtedly the energetic action of the London Chamber of Commerce, at the instigation of its Electrical Section, has had much to do in determining the action of the Government. Action could not be delayed by the electrical industry when the attempt was made in so many provisional orders and in private Bills to introduce a clause or clauses enabling trading in electrical apparatus. But the necessity to obtain legislative definition of the scope and sphere of municipal enterprise is not a matter only for electrical engineers, but for all classes of traders throughout the country. Every industry will in turn be attacked if the extension of municipal trading is permitted to increase at the rate and in the directions its advocates suggest. The most honest advocate of municipalisation is probably John Burns — of County Council fame. If we mistake not, his contention is that "all private property, all the instruments of production, should be in the hands of the State or the municipality." This view is in direct antagonism to that of Blackstone, who, in his commentaries, states the rights of Englishmen as threefold: (1) the right of personal security; (2) the right of personal liberty; and (3) the right of personal property. So now, as in all past ages of the world, there is war to the knife between those who would respect personal property and those who would confiscate it. The so-called municipalisation of the present day is merely another name for municipal trading, and municipal trading means the confiscation of private rights to property. Our contemporary the *Contract Journal* has formulated a law which it contends defines the sphere and scope of municipal enterprise, and it need scarcely be said that we entirely agree with that law, which is as follows:

Law.—Collective action is necessary for the renewal or restoration of anything

(1) required by each and every member of the community (without his having any choice in the matter) for use in a perfect or in as perfect a state as is attainable, and which

(2) is by such use destroyed or impaired.

The watchword of the business part of the nation should be, "No municipal trading." The idea of trading—that is, working for profit—is foreign to all that really pertains to municipal life. According to the law above stated, municipal action is limited to a few universal necessities; and we have never yet seen the man who dared to publicly state his approval of making a profit out of the necessities of another person. Even the most *blasé* novelist of the *fin-de-siècle* shrinks from fathering such a doctrine, and when such profit is made and known to the public at large it is unhesitatingly condemned. The law, as stated, is rigid, and, like every other law, may

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have a few exceptions tolerated. These exceptions are governed by expediency—the choice of the least of two evils—and around these exceptions controversy will rage till doomsday.

Our object, however, at this particular point is not so much to discuss the general question as to ask our readers to personally consider the matter, and if they come to a conclusion that it is desirable to obtain some legislative definition of the sphere and scope of municipal enterprise, they should take an active part in propagating such views. And, further, if their sympathies are roused, they ought to show such sympathy by an immediate answer to the question on their pockets—how much?

THE NERNST ELECTRIC LIGHT, LIMITED.

The promoters of the company bearing the above name have lost no time since Mr. J. Swinburne, their consulting engineer, read his paper on the Nernst lamp before the Society of Arts. The company's subscription list closed on Wednesday, so that any remarks we may make now come too late to save the investors their application money. Analysing the prospectus, we find that out of a capital of £320,000 the promoters are to receive £270,000, of which £65,000 is to be in cash, £25,000 in preference shares, and £180,000 in ordinary shares, this being the whole issue of this class of share. The general public were asked to subscribe for £115,000 worth of 7 per cent. non-cumulative preference shares. In return for the above consideration they will then participate in the profits arising from the developments of the Nernst lamp. A careful perusal of the prospectus shows, however, that the participation is restricted to the profit arising from the sale of the lamp in Australia, Africa, Asia, and South and Central America. The patent rights in any of these countries cannot, it seems, from the reports of Messrs. J. Fletcher Moulton and A. Colefax, yet be considered safe, and it is only the right to apply that is bought. In fact, in the majority of countries the applications for patents have not yet been acknowledged by the authorities. Similarly, the lamp itself, although promising well, is not yet a commercial article. From the above it will be seen that the unlucky shareholders cannot tell that the Nernst lamp will be a commercial success, or that if this should be the case, they are not as yet assured sole trading rights. All they can tell is that the promoting company stands to lose nothing now, and that it will also take the bulk of the profit in the unlikely event of the over-capitalised concern making headway. A correspondent in a contemporary states definitely that what the promoting company are selling for £270,000 they bought for £3,000, and even the lower price is, in our opinion, sufficiently high for what could be sold. We are sorry to see the development of a new invention being handicapped by such reckless company promoting.

A Jury's Verdict.—A coroner's jury of Georgia, U.S.A., wished to return the following verdict: "That the deceased came to his death by trying to light his pipe by the electric light, which can't be done successful."

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

KILDUCHEVSKY TRANSMITTER.

SIR,—The *Electrical Review's* excuse for publishing a false statement regarding my tests of this transmitter appears to be that the nonsense was contained in a manuscript which somebody (name not given) sent it. From this it is fair to deduce that anybody can get anything inserted in the *Electrical Review* at the cost of a postage stamp.

The *Electrical Review*, it seems, *had* heard of artificial cables without resistance bobbins, although this contention is not borne out by the wording of its leading article, which clearly reads that resistance bobbins constitute an evil inseparable from such apparatus. The proper course would have been to have banned improper cables, pointing out that others existed which were innocent of inductive reaction.

The whole "leader," in fact, points perilously ditchwards. It exaggerates "the all-important element of gauge." "A very bad telephone would work well through 5,000 miles if the wire were of sufficiently large gauge." This, of course, does not follow. Metal, dielectric, and mode of erection, have to be considered. A mistake in any one of these would neutralise the largest gauge. There is no authentic record of any telephone having spoken 5,000, or even 2,000 miles. Why, then, say that "a very bad telephone" would do so? The leader writer apparently had in his mind speaking through a resistance-box with the equivalent resistance of 5,000 miles plugged out—a common trap for tyros.

Then the tests through a looped wire, so unequivocally condemned, might be quite effective and conclusive. It all depends upon how the loop is made up. If it goes and comes on the same poles, or even on the same road or railway, it is useless; but if the return half is so far removed from the out-going that perceptible induction between them cannot take place, then the test is good. Nothing of this is suggested in the *Electrical Review's* article, which simply condemns all loop tests.

To my mind, the mere fact that it is possible for such an article to be written in the year 1899, constitutes the clearest possible demonstration of the evil effects on British telephony of the monopoly of which the *Electrical Review* has been so strenuous a champion.—Yours, etc.,

A. R. BENNETT.

44, Manor Park-road, Harlesden, N.W.,
Feb. 25, 1899.

SIMPLE SIGNALLING THROUGH A SINGLE WIRE.

SIR,—From your note on p. 225 of the *Electrical Engineer*, Feb. 24, you appear to doubt the possibility of signalling through a single wire, but from some experiments I made on Aug. 25, 1898, it seems to me quite possible. For the transmitter, I used an ordinary shocking coil, wound with about ¾lb 24 B.W.G. primary, and ½lb. 36 B.W.G. secondary, with three terminals, P, P S, and S, and six Leclanché cells; for receiver, one Leclanché cell, one-ohm galvanometer, and coherer in series. The coherer consisted of a glass tube, ½in. diameter and 6in. long, filled with iron filings, corked at each end, and wires passing through these to the filings. My object was to telegraph without connecting wires, but in this I generally failed, although sometimes I could get the apparatus to act. I then connected a wire to one end of coherer, and to P, P S, and S in turn, and got a deflection of 15 divisions on galvanometer scale. I then short-circuited the secondary and joined this to coherer, with the same result. I then put resistance in this wire, and increased it up to 1,200 ohms, but still got the same deflection. With this resistance in or out, and a dead earth on any part of it, I still got a deflection of 15deg. I then put a 6in. length of ordinary sewing cotton in series, brought it down to about 12deg., and as I increased this to 24in., the deflection fell gradually to zero. When the coherer was short-circuited, the

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galvanometer gave a deflection of .23 divisions. From this it appears that simple wire signalling is quite possible, even through very high-resistance line wires, without much loss of power, and a dead earth on the wire will not interfere with the working of the apparatus. By using a simple line wire, there is no necessity for tuning, the signals being led where desired, and only very small battery power at each end being required.—Yours, etc.,

J. GILHAM.

[N.B.—We do not doubt the possibility of signalling by a single wire, as a large proportion of the telegraphic signals are, and always have been, sent by a single wire. The question is, what part in the transmission is affected by Hertzian waves; and we see nothing in Mr. J. Gilham's letter to show that signals were sent by such a means, or that the coherer acted otherwise than as a resistance.—ED. *E. E.*]

THE REFLECTION OF CATHODE RAYS.

BY A. A. CAMPBELL SWINTON.

The following is an abstract of a paper by Mr. A. A. Campbell Swinton communicated by Lord Kelvin, F.R.S., to the Royal Society on Feb. 9:

The author has investigated the para-cathodic rays, so called by Prof. S. P. Thompson, which in a focus tube proceed from the front surface of the anti-cathode, and cause the green fluorescence of the glass. By means of a tube in which these rays cast the shadow of a wire upon the opposite end of a tubular annex he has studied their magnetic deflection, and finds it to be in a similar direction to that of cathode rays. By means of another tube containing a small Faraday cylinder, into which some of the para-cathodic rays were caused to pass, he has determined that the para-cathodic rays carry negative charges. The author has previously shown that para-cathodic rays produce Röntgen rays where they strike the glass; they also produce green fluorescence, hence he concludes that para-cathodic rays are simply reflected cathode rays.

The mechanical force exerted by these reflected cathode rays appears to be exceedingly small, and is insufficient to account for the inverse rotation of radiometer wheels, which, as described by the author in the *Phil. Mag.* for October, 1898, occurs when the wheels are placed just outside the cathode stream. Indeed, all experiments designed to produce rotation by the impact of reflected cathode rays failed, and in some cases the wheels were found to rotate most persistently in a contrary direction, showing that whatever be the cause of such inverse rotation, it is more potent than the force of impact of the reflected rays.

The reflection of cathode rays is largely diffused, but not altogether so; experiments with a polished concave platinum reflector, capable of rotation, gave under certain conditions distinct visual evidence of true specular reflection, with equal angles of incidence and reflection. In addition to the specularly reflected rays the anti-cathode reflector was also found under certain conditions to give off a well-defined beam of other rays normal to its surface, which caused fluorescence of the glass. The exact nature of these normal anti-cathode rays calls for further investigation.

The author has studied and quantitatively measured the electric charges carried by reflected cathode rays for different angles of incidence and reflection by means of special apparatus. A tube was constructed for this purpose in which a polished flat platinum reflector could be set at different angles to the incident cathode rays. This tube was fitted with a movable Faraday cylinder which was capable of rotation round the reflector, so that throughout a single plane the whole field traversed by the reflected cathode rays could be explored. The amount of negative charge imparted to the movable Faraday cylinder at different positions, and with different angles for the reflector, were measured both by a reflecting galvanometer and also by a quadrant electrometer. Many complete series of observations for different positions both of reflector and cylinder were made, and all agree in showing that the field of reflected cathode rays is not uniform, but increases more or less gradually on both sides up to a maximum, which occurs almost exactly at the point that makes the angle of reflection equal to that of incidence.

Further experiments show that the amount of charge carried by the reflected rays increases as the angle of incidence is made more slanting, and that the electrification of the reflector itself, which is strongly negative when the incidence of the primary cathode rays is normal, gradually falls to zero as the incidence is made more slanting, until with very slanting incidence the electrification becomes slightly positive.

The author compares this result with that described by him in the Royal Society *Proceedings*, vol. lxiii., pp. 434-435—viz., that cathode rays which strike the anti-cathode normally, are more efficient in producing Röntgen rays than those which impinge upon it very much on the slant.

The author points out that these results support the view that the Röntgen rays are actually due to the electric charges carried by the cathode-ray particles being imparted to the anti-cathode.

LONDON TELEPHONE SERVICE.

CONFERENCE AT THE GUILDHALL.

A conference of delegates from the Corporation of London, the County Council, vestries, and district boards of the Metropolis was held on Wednesday last at the Guildhall to consider the question of the Bills being promoted by the National Telephone Company during the present parliamentary session.

The LORD MAYOR expressed his pleasure in meeting so large and representative a conference on a subject which was of the greatest importance to the citizens of London, and, on the part of the Corporation, he wished them God-speed in their counsels, hoping that their best wishes would be realised there and elsewhere.

Mr. A. C. MORTON then occupied the chair. He said that invitations to the conference had been accepted by all the vestries and district boards with two exceptions, Chelsea and Woolwich. Chelsea had already decided to oppose the Bills, but no reply had been received from Woolwich. If the Bills became law, the company would have practically the right to make any use they liked of the streets, and if that was to be allowed, they might as well do away with local government altogether.

Mr. KIMBER (Wandsworth) moved: "That, in the opinion of this conference, the powers sought by the National Telephone Company would, if granted and exercised, seriously prejudice the rights and powers of the several local authorities, and would be inimical to the interests of the State."

Mr. RIDLEY (Wandsworth) seconded the motion.

Mr. COLLINS (Lee) said the motion must commend itself to every delegate present. As to the method of opposing the Bills, this could be considered later on.

The resolution was then put, and carried *nem. dis.*

Mr. ALGAR (City of London) moved: "That, in the opinion of this conference, representing the London County Council, the Corporation of London, and the vestries and district boards of the Metropolis, the Bills being promoted by the National Telephone Company in Parliament should be most strenuously opposed."

The resolution having been seconded by Mr. FITZGERALD (Islington) and carried,

Mr. BROOKE-HITCHING (Marylebone) moved: "That the authorities represented at this conference be requested forthwith to petition against the said Bills, and to ask their representatives in Parliament to oppose the Bills on second reading, and to take every possible measure to prevent the same from becoming law."

Mr. WHEELER (Westminster) seconded the motion, which was also unanimously carried.

After some little discussion as to the mode of procedure to be adopted as a consequence of the foregoing resolutions,

Mr. DODSON (Lewisham) moved, "That in the event of these Bills passing a second reading in the House of Commons, the Corporation be asked to arrange for another conference to consider how the opposition can best be promoted."

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This was seconded by Mr. JENKINS (St. James's) and carried, as was also the following: "That a copy of the resolutions and proceedings of this conference be forwarded to the Prime Minister and Earl Kimberley, to the First Lord of the Treasury (the Right Hon. A. J. Balfour, M.P.), the Financial Secretary to the Treasury (the Right Hon. R. W. Hanbury, M.P.), Sir Henry Campbell-Bannerman, M.P., her Majesty's Postmaster-General, and the various authorities represented at this conference."

The proceedings terminated with the usual vote of thanks.

ELECTRIC LIGHTING AT HACKNEY.

The Vestry of Hackney is now considering a long report presented by Mr. Robert Hammond on the question of electric lighting in their district, and also on the use of a refuse destructor in connection with the scheme. Mr. Hammond's report is a bulky volume, extending to over 300 paragraphs, and it is thus impossible for us to do more than give a general outline of his conclusions in this week's issue. He discusses in all four schemes. The first deals with electric lighting only throughout the best districts. This work Mr. Hammond recommends should be carried out on the low-tension three-wire system, with 250 volts at the consumer's terminal. For an estimated number of 75,000 lamps fixed and 50,000 of 8 c.p. alight at one time, Mr. Hammond estimates the total expenditure would come to £225,367 without the cost of obtaining the necessary site. As the total capacity of the plant would be 1,800 kw., this cost works out at £125 per kilowatt, which seems to us to be heavy. The second scheme is practically similar to the first, except that refuse destructors are added, which would be worked as an integral part of the scheme. The total cost of this, with a refuse destructor capable of destroying 38,000 tons per annum, would be £247,367. The third scheme is a small one intended to cover only the compulsory area under the electric lighting order. This Mr. Hammond estimates can be carried out at an expenditure of £71,873. In this case a plant of 739 kw. output would be provided. If, in addition, refuse destructors were added, the total expenditure would rise to £88,873. The last scheme, which is also discussed in two parts, is intended to cover the whole area of the Vestry without any exception or choice as to the best streets or districts. This provides practically for every householder in Hackney, and requires an estimated expenditure of £710,000. We need hardly say that the Electric Lighting Committee of Hackney have not adopted this last scheme, but they recommended the Vestry to accept a scheme of electric lighting combined with refuse destructors, which involves an expenditure, exclusive of the cost of site, of £242,367. If the Vestry should adopt this scheme, Mr. Hammond proposes to spread the expenditure over four years in the following way:

At the end of	first year's	operation	£107,772
„	second	„	157,910
„	third	„	204,090
„	fourth	„	242,367

We hope to refer to Mr. Hammond's report more in detail in another issue.

INSTITUTION OF ELECTRICAL ENGINEERS, Mar. 2.

At last night's meeting of the Institution the following were the candidates balloted for.

Foreign Member.—T. Norberg-Schulz, Director, Municipal Electric Works, Christiania, Norway.

Member.—(Father) E. Lafont, S.J., C.I.E., Professor of Physics, Saint Xavier's College, Calcutta.

Associate Member.—H. McCormick, 64, Gloucester-road, Bootle, Liverpool.

Associates.—G. Davis, 34, Victoria-street Westminster, S.W.; E. H. L. Dickson, 4, Christ Church Villas, Malvern-road, Cheltenham; A. J. Howard, Euston Villa, Cheddon-road, Taunton; E. Howl, The Quarries, near Dudley; A. Lindsay, 104, Armadale-street, Dennistoun, Glasgow, N.B.

Students.—B. G. Burgess, Electricity Works, Lynmouth, North Devon; T. C. Nesbitt, 129, Trinity-road, Upper Tooting, S.W.

NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

[*Copyright.*]

CLI.

The Elieson lamina accumulator was utilised for traction in the Elieson electric motorcar for several months during the latter portion of 1897. The plates are composed of sheets of corrugated or *perforated* lead; the corrugations being alternately vertical and horizontal. These sheets are contained in an envelope of perforated and corrugated lead, with transverse rivets for the purpose of giving mechanical strength to the plates. I am not acquainted with the method of "forming" the plates, but nitric acid is probably an active agent in the process. It is stated, however, that the lead envelope is "protected" during the formation, so that it retains its strength and supports the plates more thickly coated with active material. It has also been claimed that buckling does not occur, and that extremely high rates of discharge are possible—a battery weighing 27lb. having been discharged at 190 amperes for 10 minutes without damage to the plates. The normal rate of discharge and the corresponding capacity per pound of cell are for the "C" or motorcar type as follow:

$$\frac{\text{Amperes}}{\text{lb.}} = \cdot 86\,; \quad \frac{\text{Ampere-hours}}{\text{lb.}} = 3 \cdot 7\,;$$

the time of discharge being $\frac{3 \cdot 7}{\cdot 86} = 4 \cdot 3$ hours.

At half the normal rate of discharge the values are:

$$\frac{\text{Amperes}}{\text{lb.}} = \cdot 43\,; \quad \frac{\text{Ampere-hours}}{\text{lb.}} = 4 \cdot 57\,;$$

the period of discharge in this case being over 10 hours.

In the "T/B" type of cell, for heavier traction work, the values for the full rate of discharge are:

$$\frac{\text{Amperes}}{\text{lb.}} = 70\,; \quad \frac{\text{Ampere-hours}}{\text{lb.}} = 5 \cdot 0\,;$$

the period of discharge being seven hours.

But the capacity is sensibly increased if half this rate of discharge be taken; the values becoming:

$$\frac{\text{Amperes}}{\text{lb.}} = \cdot 35 \text{ and } \frac{\text{Ampere-hours}}{\text{lb.}} = 6 \cdot 25.$$

The time of discharge will then be about 18 hours.

The above figures are based upon the data supplied by the Elieson Lamina Accumulator Company, Limited; and I think there is no reason to doubt their substantial accuracy. No doubt the capacity of their cells has been overstated in reports by certain "experts"; but the exaggeration, which was not so serious as it was made to appear, was rectified by the price-list of the company itself. The present stage of progress, be it small or great, has been reached by long and patient endeavour. In June, 1896, Mr. C. P. Elieson wrote: "As an instance of the improvements which have taken place in traction cells, I may perhaps be allowed to mention that whereas the cells used by me for traction work in 1885-7 (which were of the Planté type) weighed 76lb. for a capacity of 120 ampere-hours, I am now manufacturing cells on the Planté principle which for a weight of 72lb. give an output of 360 ampere-hours."

In America, favourable results would appear to have been obtained with this battery in tramcar traction. An experimental line about two miles long was laid down in the town of Mount Vernon to enable Mr. Elieson to run a car with his storage battery. The track was laid directly on the road surface, there was no attempt at grading, and the curves were frequent. Nevertheless, the car was kept running without any breakdown for two or three months (August to October, 1893), and the town authorities, for whose satisfaction the trials were made, expressed themselves thoroughly pleased with the results.

CLII.

In the Blot accumulator the thickness of the lead strips was originally only 20 mils, but the thickness is now varied according to the rate of discharge and the capacity required. The similarity between some of the main features of this cell and of the Rooney rapid-discharge accumulator has already been referred to (CL.); but no nitric acid is used

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in the formation of the Blot plates, nor are the peroxide plates enclosed in a perforated receptacle. Moreover, in the Blot accumulator, the lead strips, alternately corrugated and embossed or milled, are not "burned" directly on to the upper bar or bars of a frame, but are wound on a forked core or "shuttle," which is afterwards cut in half, the forks of the shuttle being soldered both to the strips and to the frame. Thus the ends of the strips hang loosely, being maintained in position by transverse bars attached to the frame, an arrangement which allows of free expansion and contraction, so that buckling is out of the question.

The battery is capable of withstanding very high rates of discharge. At the General Post Office, discharges at the rate of 12 amperes per pound of plates were repeatedly taken, the cells being afterwards left on short-circuit for 24 hours before recharging.

The normal rate of discharge per pound of *plates* and the corresponding capacity are as follow:

$$\frac{\text{Amperes}}{\text{lb. (plates)}} = \cdot 45\,; \quad \frac{\text{Ampere-hours}}{\text{lb. (plates)}} = 4 \cdot 54\,;$$

the time of discharge being 10 hours.

It is very desirable that data for calculating the rate of discharge and the capacity per pound of *cell* should be given in all papers, prospectuses, and price-lists relating to secondary batteries; but where this is not done maximum values per pound of cell complete, in light ebonite boxes, may be obtained by multiplying the values per pound of plates by ·7. Thus the above ratios per pound of cell, instead of per pound of plates, become

$$\frac{\text{Amperes}}{\text{lb.}} = \cdot 315, \text{ and } \frac{\text{Ampere-hours}}{\text{lb.}} = 3 \cdot 18.$$

The "shuttles" and frames in the Blot secondary cell are said to be made of "non-oxidisable alloy." The discovery of such an alloy, outside of what have been termed the "noble" metals, would be a great achievement, and one that I have failed to accomplish during 20 years of work in this direction. Taking into account the total peroxide surface, the density of current (LXXXVI.) in the Blot battery at the normal rate of discharge is only

$$\Delta = \cdot 0075.$$

CLIII.

The so-called "Chloride" secondary battery has already been referred to at considerable length (LXXVI.-LXXX.). In Figs. 2 and 3 (pp. 134 and 135) curves applicable to three different modifications of this battery are given. The curve "R" applies to the form of cell which is designated by this letter, and which is manufactured in this country by the Chloride Electrical Storage Syndicate, Limited, in Philadelphia by the Electric Storage Battery Company, and in France by the Société pour le Travail electrique des Métaux. In the "R" cell—as was previously stated—the use of pellets of fused lead chloride has been discontinued in the case of the peroxide plate, which is virtually of the Planté type, and is known as the "R" or "Standard Manchester" plate. "This plate," says Mr. Treadwell, "was brought out by Rhodin (American patents 567,044-5, 1896), and is constructed essentially like the original Brush plate; though the 'active material or material to become active' is a spiral of ribbon lead, instead of the paste or cement used by Brush." The difference here indicated is, it may be observed, a very important one; and it may also be mentioned that great practical difficulties were encountered and had to be overcome in the prevention of "clogging" of the spirals, by which the circulation of the electrolyte was impeded, and in maintaining perfect contact between the lead spiral and the perforated support or "grid."

The curves, R (Figs. 2 and 3), show that the battery can, if necessary, be discharged in about 38 minutes, but at the sacrifice of over 50 per cent. of the maximum capacity. It shows, also, that practically no gain in capacity is obtained by prolonging the period of discharge beyond five or six hours. The capacity does not appear very high when compared with that of the special traction cell (Curve C) manufactured by the French Company; but it should be explained that the data on which the Curve R is based were obtained in 1895—at which time the capacity would have been considered high—and that the capacity of the modern "R" "Chloride" cell, for central-station work, has, since the above period, become augmented by something like 30 per cent. This conclusion is supported by the results obtained with the largest storage battery that has yet been installed—the 460-ton accumulator supplied to the Chicago Edison Company by the Electric Storage Battery Company of Philadelphia. Each of the 166 cells of this enormous battery weighs 6,200lb., and the capacity of each cell is said to be 22,400 ampere-hours when the time of discharge is eight hours, or 13,750 ampere-hours when the time is 1¼ hours.

CLIV.

The curve S was obtained with a perfected cell (either "TB" or "S") of the original form—that in which the pellets of fused lead chloride were used for the peroxide as well as for the spongy-lead plate. The curve tells us that the battery can be discharged in little over one hour, but at a sacrifice of 59 per cent. of the capacity obtained when the complete discharge takes place in 12 hours. It tells us, moreover, that, even then, the maximum capacity is not obtained, for the curve is very appreciably rising between the points where the ordinates correspond to the abscissæ 11 and 12. This fact signifies that by reason of the thickness or the want of porosity of the active material in one or both of the plates, the electrolyte requires more than 12 hours to obtain full access to it. Combined with the additional fact of the high specific capacity, it also means that the battery is, electrically at least, an excellent one for long-continued discharges, and that the rate of discharge is high for so high a capacity. And it further indicates that, in spite of its high capacity, the battery is not well adapted for short periods of discharge, or, at least, that it is susceptible of great improvement if high rate of discharge is a desideratum.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

145. Describe, with a sketch of connections, a magnetic cut-in and cut-out for use with a dynamo charging accumulators.—R. T.

146. Describe an electric brake as used on an electric tramcar.—P. T.

ANSWERS.

Question No. 140.—What is the action of a choking coil in an alternate-current circuit? If one arc lamp taking 10 amperes is being used on a 100-volt circuit, what power will be taken from the mains if a choking coil is used in series with the lamp?

Best Answer to No. 140 (*awarded* 10*s.*).—The action of a choking coil on an alternating-current circuit is to adjust the pressure, and, therefore, to control the current between any two points—such as lamp terminals—and is a form of electromagnet with very small ohmic resistance but very large inductance, which may be varied as desired by varying the position of the iron core in the electromagnet relatively to the coil. The function of this coil is to choke or throttle the alternating current without dissipating energy to the same extent as would be the case if ordinary rheostats were used. The only loss attending the use of a choking coil is the sum of the ohmic resistance of the coil and the hysteresis of the iron core, both of which are comparatively small. The choking effect is due to self-induction, whereby a back pressure is produced, the

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tendency of which is to obstruct the current in its own path. This self-induction is caused by the whirls or loops of magnetic lines belonging to one part of a circuit enclosing those of another, so that whenever the current is growing or dying away these loops of magnetic lines will be cutting across some other part of the circuit, and the amount of this cutting of magnetic lines that goes on when the current of unit strength grows or dies away is the coefficient of self-induction (L) which is proportional to the square of the number of spirals so reacting, and the presence of an iron core helps the magnetic field due to each convolution to thread itself around all the other convolutions.

Let A = the sectional area of the iron in the coil;
l = the length and μ = the permeability of the magnetic circuit and S representing the number of spirals; then

$$L = \frac{4\pi S^2 \mu}{10^9 l}.$$

It will be seen that the coefficient of self-induction of any coil depends upon its form and size, and upon its magnetic properties—that is, the quantity of iron in the coil—and the inductance, and consequently the reactive power, will be constant for a given frequency so long as the relative position of the iron core and the coil remain the same, but by withdrawing the iron core to a greater or less extent the inductance, and therefore the reactive power, may also be varied. The magnitude of this reactive power depends entirely upon the rate of change in the strength of the current, and will have its maximum value when the current is at zero value, so that it is evident the impressed E.M.F. in a circuit containing self-induction is made up of two component pressures, one of which overcomes the ohmic resistance, and the other overcomes the back pressure due to self-induction. Now, if these two component pressures be represented by the lines, A C and B C, Fig. 1, respectively at

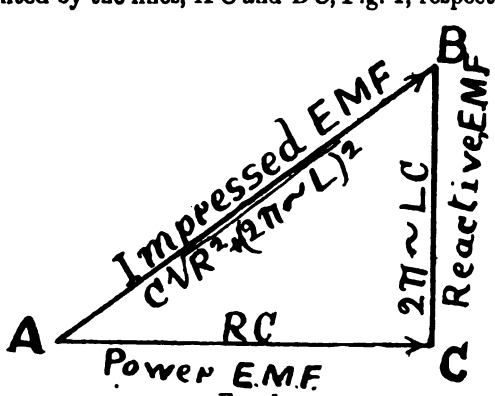


FIG. 1.

right angles to each other, the line A B will represent the magnitude and direction of the resultant of these E.M.F.'s. Now, $AB^2 = AC^2 + BC^2$; or the impressed E M.F.^{2} = the power E.M.F.^{2} + the reactive E M.F.^{2}; and if E = the impressed E.M.F., R = the ohmic resistance, C = the current, then RC = the power E.M.F., and $2\pi \sim L C$ = the reactive E.M.F., ($\sim$) representing the frequency,

then $$E = C\sqrt{R^2 + (2\pi \sim L)^2},$$

and $$C = \frac{E}{\sqrt{R^2 + (2\pi \sim L)^2}}.$$

From the above statement it will be seen that C is less than it would be if self-induction were absent, so that the quantity of electricity traversing a circuit containing self-induction is limited by the impedance—*i.e.*, $\sqrt{R^2 + (2\pi \sim L)^2}$—or, in other words, inductance in an alternating-current circuit displaces the current relatively to the E.M.F. (or produces a lag), also a back E.M.F. in consequence of which the current is impeded or choked in proportion to the magnitude of this impedance. Then if the ohmic resistance is small, and the factor $2\pi \sim L$ is large, then the current, and consequently the rate of expenditure of energy, in the circuit depends upon the magnitude of the reactance.

Now consider a circuit, taking a current of 10 amperes, where it is required to effect a drop in pressure such as that in question. Assuming the lamp itself to have a resistance equal to six ohms, then the pressure required at the terminals will be 60 volts, so that a drop of 40 volts is necessary. This can be effected by introducing a choking coil into the circuit capable of setting up a reactive E.M.F. of 80 volts "at the frequency employed," which will cause a drop in pressure equal to 40 volts, without the attendant loss of energy—that is, assuming the ohmic resistance and hysteresis of the coil are so small as to be negligible, Fig. 2.

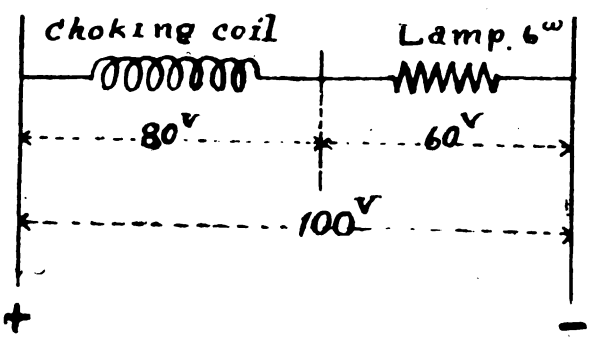


FIG. 2.

But in any case the only necessary waste of energy is that due to the ohmic resistance of the choking coil and lamp and any hysteresis effect due to either. The connections of the choking coil and lamp and the distribution of the pressure are shown in the accompany diagram.

Now, since the impressed E.M.F. in the above question = 100 volts and the power (or lamps) E.M.F. = 60 volts, and the reactive E.M.F. due to the choking coil = 80 volts, then referring to Fig. 1 we know that $AB^2 = AC^2 + BC^2$;

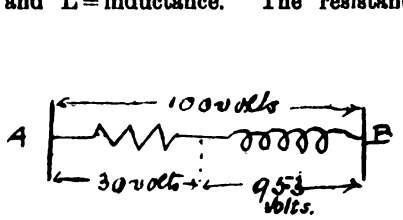
and if E represents the impressed E.M.F.,
e „ power E.M.F.,
e_1 „ reactive E.M.F.,

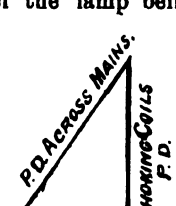
then $$E^2 = e^2 + e_1^2, \text{ and } e_1^2 = E^2 - e^2,$$
$$= 100^2 - 60^2, = 6{,}400$$

then $$e_1^2 = 6{,}400,$$
$$\therefore e_1 = 80;$$

then the power taken from the mains will be: $60 \times 10 = 600$ watts + any loss due to hysteresis, and resistance of choking coil, which in the above is supposed to be negligible.—BAGOT.

Answer to No. 140 (*awarded* 5*s.*).—The presence of inductance in an alternating circuit has the effect of displacing the current relatively to the E.M F., thus giving rise to an idle component of the current, and lowering the power factor. But, like many other things, inductance is not an unmitigated evil, and in some cases is made to serve a very useful and important purpose. The following case shows how considerable economy may be effected by pressing inductance into service: The inductance takes the form of a choking coil—that is, a coil whose inductance is great compared with its resistance. Let an arc lamp which takes 10 amperes at 30 volts be required to run on 100-volt mains; periodicity, 100 $\sim$ per second. We will treat the lamp as a simple non-inductive resistance and assume sine law. The impedance of the coil will be equal (approximately) to the reactance = $p \times L$, where $p = 2\pi \times$ periodicity, and L = inductance. The resistance of the lamp being





taken as three ohms, the impedance of the whole circuit, A B, across the mains will be $\sqrt{3^2 + p^2 L^2}$. Now, the current required is 10 amperes, and the P.D. is 100. Hence we must have

$$10 = \frac{100}{\sqrt{9 + p^2 L^2}},$$

from which we find $p L = 9{\cdot}53$,

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so that $L = \frac{9{\cdot}53}{2\pi \times 100} = {\cdot}015$ henry,

A coil having this inductance will therefore reduce the P.D. so that the lamp will work at 30 volts.

There is one point which must be noted. If a non-inductive resistance is used to reduce the P.D., then the P.D. at the terminals of this resistance will be $7 \times 10 = 70$ volts, and the P.D. across the mains is the sum of the P.D.'s across the lamps and resistance respectively. But if a choking coil be used, then, calling $i\,e$ the unknown P.D. at the terminals of the choking coil,

(since P.D. = current × impedance)

$$i\,e = 10 \times p\,L = 10 \times 9{\cdot}53 = 95{\cdot}3 \text{ volts.}$$

The sum, therefore, of the P.D.'s across the lamp and choking coil respectively, does not give the P.D. across the mains. The reason for this lies in the phase difference between the two quantities. In the case where a simple resistance is used, the two P.D.'s are both in phase with the current; but the P.D. of the choking coil is in quadrature with the current, so that in this second case the P.D. across the mains is represented by the hypotenuse of a right-angled triangle, having its two sides equal to the P.D.'s across the choking coil and lamps respectively, as shown in the figure.

The obvious advantage of a choking coil over a simple resistance lies in the fact that the former absorbs very little power, and if we could entirely get rid of resistance, the coil would absorb absolutely no power. A simple resistance in the above case would absorb $7 \times 10^2 = 700$ watts, while the lamp itself absorbs only $10 \times 30 = 300$ watts.

In reply to the last part of the question, the power taken from the mains would be a little over 300 watts.—W. D. MACGREGOR.

Answer to No. 140 (*awarded* 5*s.*).—The effect of putting the choking coil in series with the lamp is to cut off a certain number of the effective volts from the lamp, but although there may be more volts across the terminals of the choking coil than across those of the lamp, and the same current goes through both, yet the choking coil absorbs much less energy. The reason of this is that the current lags in phase nearly 90deg. behind the potential difference at the terminals of the choking coil, whilst it lags by a much smaller angle behind the potential difference at the terminals of the lamp. During slightly more than half the period of the applied E.M.F. the current in the choking coil will be flowing in the same direction as the E.M.F. is tending to drive it, and during the remainder of the period it will be flowing in the opposite direction, and thus be giving energy back to the circuit. A similar effect also holds for the lamp owing to the inductance of its series coil, but owing to the much smaller lag produced, it is not nearly so marked.

The power factor, which equals the cosine of the angle of lag, is seldom less than 0·8 for arc lamps, whilst for choking coils it may be 0·05 or even less.

Taking the example given, we shall assume that the lamp takes 35 volts across its terminals, and that the power factor is 0 8. So that the lamp takes 280 watts. We shall also assume that the power factor of the choking coil is 0·05. The angle of lag of the current behind the potential difference at the terminals of the choking coil is, therefore, 87·1deg., and behind the potential difference at the terminals of the lamp it is 36deg. The difference of phase between these two potential differences is 51·1deg., and the vector sum of the two is 100, hence the potential difference across the choking coil is nearly 89 volts, and, therefore, the power absorbed by it is $0{\cdot}05 \times 89 \times 10$—*i.e.*, 44·5 watts. Hence, in this case a good choking coil would absorb about one-seventh of the total energy taken from the mains—namely, 324·5 watts.—T. C. R.

Question No. 141.—In a public supply at 230 volts, are consumers paying proportionately less for their light when the voltage falls to, say, 200 through want of power at the station, the meters used registering in Board of Trade units?

Best Answer to No. 141 (*awarded* 10*s.*).—Although the candle-power of an incandescent lamp falls off rapidly as we diminish the voltage, yet as the volts are diminished the resistance of the lamp increases, and hence the watts taken by it diminish rapidly, and so we cannot answer this question without appealing to experiment. The candle-power curve of a 230-volt lamp must be the same as that of a 110-volt lamp, as practically the only difference in many cases is the proportional increase in the length of the filament. The following table gives the result of one of Dr. Fleming's experiments on the luminous efficiency of a 16-c.p. Edison incandescent lamp:

Working volts.	Candle-power.	Watts.	Watts per candle.
74	0·9	35	38
92	5	56	11
97	7	65	9
100	9	69	7·8
108	15	82	5·6
110	16	84	5·2

From this table we see, for example, that at 110 volts we could get an illumination of 144 c.p. by means of nine lamps consuming 756 watts, whilst at 100 volts we would need to have 16 lamps, taking 1,104 watts. Hence for a drop of about 10 per cent. in the volts, we have a drop in the efficiency of the conversion of electricity into light of over 30 per cent. Of course for larger drops in the voltage the efficiency of conversion will fall off much more rapidly.—J. C. R.

Answer to No. 141 (*awarded* 5*s.*).—From the appended table, by Mr. Preece, it will be seen that any change in pressure at the terminals of an incandescent lamp makes a proportionately greater change in candle-power. In fact, a variation of 1 per cent. within the Board of Trade limit, 235 to 225 volts, makes a difference of from 5 per cent. to 6 per cent. in candle-power. If we take quantity consumed into consideration, 1 per cent. drop in pressure would mean about ·7 per cent. drop in quantity, still giving the same 5 to 6 per cent. drop in light:

239·2	volts	= 20	candle-power.	
236·9	,,	= 19	,,	,,
234·6	,,	= 18	,,	,,
232·3	,,	= 17	,,	,,
230·0	,,	= 16	,,	,,
227·7	,,	= 15	,,	,,
225·4	,,	= 14	,,	,,
222·3	,,	= 13	,,	,,
220·8	,,	= 12	,,	,,

From this it will be seen that a drop of 30 volts on a 230-volt system, or some 13 per cent., would mean a very great difference in light obtained. There have been no experiments carried out down to this pressure, so that the exact figure is unobtainable, but the decrease would probably be 40 per cent. at the very least—that is, a drop of some 12 or 13 per cent. in the meter bill would cause a decrease in light of about 40 per cent. The consumer is thus in reality paying very much *more* for his light at the reduced voltage, and from his point of view, leaving out of consideration the question of lamp renewals, it is much more economical to run the lamps, if anything, above their normal voltage rather than below.—H. F. E. B.

[N.B.—Many answers sent in reply to this question were disqualified because the senders did not thoroughly read the question. The type of meter is mentioned in the question, and was not left for consideration.—ED. *E. E.*]

KINGSTON-UPON-THAMES.

The following is the fifth annual report of the borough electrical engineer (Mr. J. E. Edgcome, M.I.M.E., etc.) to the Lighting Committee:

I beg to present herewith my report for the year ending Dec. 31, 1898, being the fifth annual report on the working of the electricity undertaking of the borough.

Extension of Machinery and Buildings.—The work of extending the buildings for the reception of new machinery, which I mentioned in my last report as being in hand, has been completed. The new plant has been installed and is at work, so that the engine-house, which has been extended to 75ft., now contains the following plant: two arc lighting sets for public street lamps; two exciter sets for supplying exciting current to the arc lighting machines and alternators, and for charging

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batteries for launch and other work; five steam alternators, ranging from 40 b.h.p. to 300 b.h.p., the total capacity of the alternating plant being 420 kw., capable of supplying current to 12,400 8-c.p. lamps burning simultaneously. This is, of course, the total capacity, of which one-half should be reckoned as spare plant. There are two switchboards, that on the ground floor carrying four arc light and three exciter main panels; the second is raised 5ft. upon a glazed brick foundation, and contains 17 panels—seven machine, seven distributing, one distributing exciter, one main voltmeter, and one wattmeter panels. The covered way behind the glazed brick foundation, as well as the increased space behind the board itself, proves very convenient for handling cables and connections with absolute safety. The boiler-house, which has been lengthened to 88ft., the new part being widened to 55ft., contains three 200 h.p. Lancashire multitubular boilers, with mechanical stokers of the sprinkling type, and two 400-h.p. water-tube boilers, fitted with superheaters and with stokers of the coking type. Beside the two small donkey engines for driving the sprinkling stokers, a third larger engine has been fixed to drive the entire line of stokers. A large feed pump has been fixed capable of supplying all the boilers at the rate of 4,000 gallons per hour. The extensions of the steam, exhaust, feed, and blow-off pipes have been completed. A new goods entrance has been made into the works yard from Ham-road to facilitate carting coal into the works. A paved coal yard is now being put down with a light tramway to lessen the labour of handling the coal from the yard to the boilers, and I hope this will be completed and working in two or three months' time. Filters have been erected for filtering the water from the condenser before passing it into the boilers, and a filter-house of glass and iron will shortly be erected in front of the boiler-house.

Mains.—Some miles of cable have been laid during the year in completion of the scheme sanctioned in 1897, and of which the mains in Richmond-road and Albany-park were laid at the latter end of 1897.

High-Tension Feeder Cables.—A supplementary high-tension feeder (No 7) of 0·1 square inch section has been laid from the works to the Market-place. No. 3 feeder has been extended to the new sub-station at Clattern House. A further supplementary feeder (No. 5) has been laid from the works to the theatre sub-station, and a new feeder (No. 6) has been laid from the works to Richmond-road, which will be continued through King's-road to Queen's-road at Kingston Hill, so as to give a duplicate supply to the Kingston Hill district. A high-tension main has been laid from Manorgate-road to the new sub-station in Coombe-lane, and another from the corner of Queen's-road, through Wolverton-avenue, to the same sub-station, to enable this district to be worked from either feeder.

Low-Tension Distributing Cables.—The network of cables in the centre of the town, laid down in 1893, has been supplemented by some miles of distributing cables of 0·2 square inch and 0·3 square inch section, which I calculate will be sufficient to supply all future needs of this portion of the borough. These cables have been laid in the Market-place, High-street, Eden-street, St. James's-road, Richmond-road, Fife road, Clarence-street, and Church-street. Distributing mains have also been laid in a portion of Portsmouth-road, in Uxbridge-road, in a large portion of London-road, in Manorgate-road, and Kingston-hill, and in a portion of Wolverton-avenue, Coombe-lane, and Gloucester-road.

Sub-Stations.—Large and commodious sub-stations have been built in the Market-place, High-street (Clattern House), and Coombe-lane, and feeders have been laid to these sub-stations, and distributing cables taken from them to the network. Transformers with a capacity of some hundreds of horse-power have been installed, coupled up to high and low tension switch and fuse boards, and to distributing low-tension plugboards, so that most of the low-tension mains are fed from two separate feeders, the network in the central portion of the town being fed by all seven feeders. In all cases the low-tension cables are subdivided in the sub-stations at the plugboards, which provides every facility for their being disconnected for testing and other purposes.

Progress.—From the revenue summary table it will be seen that the profit on the works for the year is £1,221. 7s. 2d, the profit after payment of interest is £119. 3s. 2d., and the total deficit on the undertaking is £1,112. 0s. 9d. This, as will be seen from the revenue account, is due to the large payments made during the year under the heads of payment of interest and repayment of capital, so that although our profit on the works has considerably increased, the total deficit upon the undertaking is larger than last year. To meet the increased demand for current it has been necessary to spend large sums upon extensions of cables and upon buildings and plant. The cables, however which have been laid in the centre of the borough are, as stated, of sufficient capacity to meet any demand that may arise, so that these cables, which have only commenced to earn revenue, will continue to do so to an increasing extent, and will continue to increase their profit-earning capacity without any additional expenditure upon them. Again, the engine-house is of sufficient size to contain two more sets equal to the largest installed, or one set of double capacity. so that a large addition of revenue-earning plant can be obtained without further expenditure on account of buildings. There is, therefore, no doubt that, although the revenue will increase year by year, the amount paid for interest and repayment of capital will not increase proportionately. As pointed out in previous reports, all the machinery is kept in a thorough state of repair, all costs of renewals and repairs being paid year by year out of the revenue, so that the proportion of the property which is being purchased by these annual instalments will, at the end of each period of 25 years, be a valuable asset without charges upon it either of interest or principal. It is not of course suggested that the properties will be worth an amount equal to that originally expended upon them, as certain sums must be allowed for depreciation, this amount varying according to the nature of the property, being necessarily larger for boilers and machinery, and less for cables, building, chimney shaft, etc.; but I again, however, point out that whatever is in the possession of the Corporation at the end of each period of 25 years is an actual asset, clear of any charge whatever upon it. The result of the year's working shows that we have earned interest upon our capital at the rate of 3 per cent, with a further sum of £119. 3s. towards the repayment of capital. The number of consumers has risen from 163 to 211, an increase of 48; and the number of lamps connected (in terms of 8 c.p.) has risen to 11,586, an increase of 2,656.

REVENUE ACCOUNT, 1898.

Dr.				£	s.	d.
Generation of Electricity.						
Coal and other fuel, including carting	£1,751	3	11			
Oil, waste, water, disincrustant packing, gauge-glasses, sweep and petty stores	174	16	3			
Wages for generation of current	507	14	6			
Maintenance of plant, including wages, small repairs, incandescent lamps, etc.	280	4	9			
				2,713	19	5
Distribution of Electricity.						
Maintenance of mains, including wages of arc lamp trimmer, carbons, small repairs, etc.				228	3	11
Management.						
Salary of engineer and assistant, salary of clerk	275	17	4			
Stationery, printing, and advertising	32	15	3			
General establishment charges—petty cash, office fuel, stamps, etc.	79	14	3			
				388	6	10
Rent, rates, taxes, and insurance				133	13	0
Special Charges.						
Interest on loans	1,102	4	2			
Repayment of principal	1,231	3	9			
				2,333	7	11
Lamps, stores, etc.				15	8	6
				£5,812	19	7

Cr.	£	s.	d
Sale of current per meter, including launch charging, less discounts, and after providing for bad debts	3,827	2	8
Rental of meters and apparatus	133	0	6
Amount for lighting 36 public arc lamps, at £20 per annum, from Jan. 1, 1898, to Dec. 31, 1898 (inclusive)	720	0	0
Sundry sales	20	15	8
	4,700	18	10
Deficit balance	1,112	0	9
	£5,812	19	7

LEGAL INTELLIGENCE.

UNDERGROUND TELEPHONE WIRES.

In the Edinburgh Sheriff Court on the 23rd ult., Sheriff Rutherford gave judgment on the application on behalf of the Postmaster-General for the consent of the Corporation of Edinburgh to the placing of underground telegraph wires under certain streets. Among the grounds on which the Corporation objected were that the wires were not required for the purposes of the Postmaster-General's Department, but were intended for the use of his licensee—the National Telephone Company; and that by the provisions of the Edinburgh Municipal and Police Act, 1879, the streets and roads under which it was proposed to lay those wires would not be opened up without the consent of the Corporation.

The **Sheriff**, in giving his decision, said it was true that under the Telegraph Act, 1892, the Corporation as road authority had a right to veto the exercise of any powers under the Telegraph Act by a licensee of the Postmaster-General, but in the case of the London Corporation it was held nevertheless that the Corporation were not entitled to shackle their consent to works which the Postmaster-General proposed to execute with the condition that the wires should not be used by his licensee, the National Telephone Company. He saw no reason to differ from the conclusion arrived at in that case, first by Mr. Commissioner Kerr, and afterwards by the Railway Commissioners. He thought the objections which they were entitled to raise must be objections of a kind which concerned them as a road authority, and that here the objection which was raised was not in their interest as a road authority at all. As to the fourth objection, the Postmaster-General had applied to the Corporation for their consent, and because they withheld it the matter had been referred to him in pursuance of the Telegraph Act, 1878. If the Corporation were right, no differences, in the sense of the Act, could have arisen between them and the Postmaster-General. He was of opinion that no relevant or sufficient reasons had been stated by the Corporation for declining to give

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the consent required by the Postmaster-General, and he was therefore prepared to give consent, as he was empowered to do by the third section of the Telegraph Act, 1878.

No expenses were allowed.—*Yorkshire Post.*

COMPANIES' MEETINGS AND REPORTS.

CITY OF LONDON ELECTRIC LIGHTING COMPANY, LIMITED.

The ordinary annual general meeting of this Company was held on Wednesday last at Winchester House, E.C., Sir David L. Salomons in the chair

The **Chairman**, before proposing the adoption of the report, referred to the loss to the Board by the death of the Earl of Suffolk. He then said that on that occasion they were recommending a dividend of 4 per cent. less than in the previous year. The shareholders might be afraid that a crisis had come in the Company's history, but when he had explained the facts they would see that this was not the case. Permission had been granted some time ago for the Board to increase the ordinary share capital, and last year an amount of £200,000 was issued. They would understand that though it had been issued it did not bring in its share of the revenue during the period dealt with. This, of course, made considerable difference. Also, up to the end of 1897 it had been the custom to charge a portion of the management to capital expenditure, but this custom had been stopped, and the whole amount was charged to revenue. The Board had also found it advisable to reduce the price of electricity from 8d. to 7d. per unit, and this had been done. The reduction was apparently much appreciated, as the number of applications had increased considerably. Other sources of decrease might be found in the extremely bright weather, there being practically no fog, and to the increased cost of coal. All these things combined accounted for the reduction. If the ordinary capital had remained the same, the dividend would have been 7½ per cent. instead of 6 per cent. Their buildings on the river side had now been taken over by a shipping company, and this would bring in about £4,000 per annum for ground rent, and they would receive the cost of the buildings. They had had some few alterations at their works, but compared with other London companies they produced electricity quite as cheaply, if not cheaper, than all of them. The total number of lamps connected up till that date was 365,560, and the applications received, 382,750, leaving just over 17,000 awaiting connection. They believed they had the most difficult lighting area in London, or, in fact, in the world. The full load was only required for a short time in the year, and also in the day. The time when the lighting was really paying ranged from about 3.30 p.m. to 8.30 p.m. They had a sufficient reserve of plant to enable them to connect a very large number more lamps. Some very absurd rumours had been put about that the capital of the Company had been watered. This he assured them was not the case. The directors intended to oppose with all their power the applications for provisional orders made to the Board of Trade by the Charing Cross and Strand Electricity Supply Corporation, the Smithfield Markets Electric Supply Company, and the Metropolitan Electric Supply Company, and the objections of their Company thereto were now being considered by the Board of Trade. With regard to the case of the Company opposing the entering into the City area of outside companies, he might add that it seemed inconceivable that the Board of Trade would now depart from their previous course. The Corporation also had not given their sanction to the scheme, and the directors anticipated that the Board of Trade would refuse the demand.

The motion was seconded by **Colonel B. H. Martindale** and adopted.

Mr. H. Young asked if it was not a fact that, owing to certain machinery not being delivered, the correct pressure had not been kept up and some of the meters registered too much and others too little?

Mr. Roberts said there was one point about the threatened opposition. He had made numerous enquiries of various customers as to the supply, and in most cases found that the light was giving dissatisfaction.

Mr. Prevost said he presumed that at the time the sliding scale was instituted it was known that it would make a great difference in the dividend, and that being so he wished to ask whether the directors did not think that a premium of £8 on the new shares was too large. Some of the shareholders would be a bit funky about taking up the new capital, and he thought the least the directors could do was to issue the next shares at par.

Mr. Braithwaite asked whether, if by any chance any other company got access to the City, this Company would not be relieved of the onerous contract which it had at present with the City Corporation?

The **Chairman**, in reply, said that for a few days during the past year an unfortunate state of things did exist which might have caused the Company some loss, but the difficulty was due to two causes over which they had no control—namely, bad coal and the non-delivery of steam-pipes up to contract date. He was sorry to say people had been going round the City with petitions and had made representations which were absolutely untrue. Sometimes complaints from consumers were numerous; on the whole they were exceedingly few in number. In the majority of cases the people themselves were to blame. With regard to the price at which the new capital would be issued, it was impossible for him to tie the hands of the Board. As to the applications for provisional orders made to the Board of Trade by other companies, the chairman read a letter which the Corporation had directed to be sent to the Board of Trade, stating that, having regard to the terms of the agreement entered into for lighting the City by electricity, the Corporation was unable to approve of the orders, and under the circumstances they had no observation to make in reference thereto. That letter showed clearly what was in the minds of the authorities.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION, LIMITED.

The annual general meeting of this Company was held at the offices, Maiden-lane, on Monday.

Mr. W. F. Fladgate presided, and, in moving the adoption of the report and statement of accounts (which were published in our last week's issue), referred to the satisfactory progress that had been made by the Company during the period under review. Their new areas, the southern portions of Holborn and St. Giles, had been unproductive so far, for the reason that it had not yet been possible to connect up the mains there. But the Board had no reason whatever to doubt that when they were in a position to do so, they would be productive of great gain to the Company. A memorial, with 5,000 signatures appended, had been obtained in support of their application for a provisional order for lighting the City, and these signatures were those of firms and corporations of the highest standing. They included 29 of the leading bankers, 81 of the principal insurance offices, and 82 newspaper proprietors. This, he thought, was sufficient to show that a large class of persons in the City were of opinion that competition should prevail there as in other districts of London. If their Company could secure from the Board of Trade and from Parliament the powers for which the directors were asking, he did not hesitate to say that it would be a good thing for them. Their net earnings during the past year amounted to £21,377, as compared with £18,907 in the previous year, and this enabled them to recommend the payment of a dividend on the ordinary shares at the rate of 8 per cent., and to carry forward £3,292 after making substantial reserves.

Mr. G. H. Brougham Glasier seconded the resolution, which was unanimously carried.

The following motion, proposed by the **Chairman**, seconded by **Mr. Glasier**, and supported by **Colonel Young**, was subsequently passed: "That the capital of the Company be increased by the creation of 20,000 new ordinary shares of £5 each, to rank equally with the existing ordinary shares in the capital of the Company, and that such shares be offered in the first instance to the members in accordance with Clause 4 of the articles of association of the Company, and that the directors be, and they are hereby empowered to fix the issue price and the terms of issue."

The proceedings closed with the usual votes of thanks.

LONDON ELECTRIC SUPPLY CORPORATION, LIMITED.

The ordinary general meeting of this Company was held yesterday at Cannon-street Hotel, E.C., Lord Wantage, V.C. presiding.

The **Chairman** said the capital of the Corporation had been reduced by £222,000 by writing down the nominal amount of the ordinary shares from £5 to £3 each. This reduction had enabled the Board to write off £181,688 on various works in the capital account, and the whole of the preliminary expenses and debenture discount accounts. The capital account then stood at £736,521. The issue of £200,000 first mortgage debenture stock enabled the Board to pay off the whole of the debenture debt and loans on June 30 last, and the undertaking passed again into their hands from July 1. The number of lights added during the year was 31,221, being an increase of 25 per cent., the total number of lights at Dec. 31 being 155,319, and the same ratio of increase had continued in the present year. The new 2,000-h.p. plant was finished in October, and had worked satisfactorily during the winter. New distributing mains had been laid from Newington-causeway to Greenwich, and in the whole of their compulsory area in Bermondsey and partly in Rotherhithe. The plant and machinery had worked satisfactorily during the year, and had been entirely maintained out of revenue. The prolonged strike in the South Wales coalfield added materially to the generating costs during the year, coal having to be obtained from the North, and extra hands put on in connection with it. The profit for the half-year ended Dec. 31 was £13,535, which, with interest on deposits, made a total of £13,827. Out of this the interest on debentures—viz., £3,344. 3s. 7d.—had been paid, leaving £10,482. 19s. 7d. to be dealt with. The Board propose to deal with this amount by payment of a dividend of 6 per cent. on the preference shares for the half-year ending Dec. 31, carrying forward a sum of £3,275. 9s. 7d.

The report was seconded by **Mr. R. de Q. Quincey** and adopted.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY.

The twentieth ordinary general meeting of this Company was held on Friday last at Cannon-street Hotel, E.C.

Mr. S. Gedge, M.P., who presided, congratulated the shareholders on the increase in the dividend and bonus. This amounted to 2 per cent. more than was paid last year. Since 1895 their share capital had been increased by 27 per cent., and the value of their freehold land, buildings, etc., had also advanced to the same extent, and while their ordinary share capital was £150,000, it was

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represented by freehold land, buildings, etc., of the value of £150 809. In the same period their stock-in-trade had increased by 166 per cent., and in December last was £116,082 Less than 4 per cent. of this was old stock, and this was being written down every year, and it was by no means overvalued at the sum of a little over £4,000. The remainder was very largely expenditure on orders in hand. If they had completed three-fourths of an order they would only put down three-fourths of the cost, but they would not take credit for the three-fourths of the profit that had been earned. The stock-in-trade consisted of a considerable quantity of raw material, in valuing which they looked at two things—what they had paid for it and what the market price was. If the articles represented by this item has risen in value since they were bought they were put at their cost price, while if they had fallen in value they were taken at the market price. They were very careful not to make an over-estimate. A considerable amount of the sum mentioned also represented stock in-trade for orders which had to be met immediately. In the old days, when they had not sufficient capital, they could not supply the goods wanted until they had made them, but they now kept a sufficient stock to meet orders immediately they received them. In regard to the current year, they were still continuing their progress. The orders up to that day were just 28 per cent. more in value than a year ago, although last year they received a very large order indeed the week before their meeting. This year they had not had the fortune to obtain such an order, but as a rule the large orders did not yield so good a profit in proportion as the smaller orders. The £10 shares issued last year were offered at £18 and subscribed for at that figure, and the £20,000 premium thus made was put to the reserve fund. They were also transferring to this fund the ordinary £7,500 which for the last three years they had added to it, and the reserve account now stood at £62,500. The shares were taken up by the shareholders without the least expense by way of commission or otherwise, a point to be particularly observed at a time when so much was being said about large commissions being improperly paid by directors of companies to get out their capital. He could say they paid no commission at all, except to their own agents. The reserve under the cable-repairing contract with respect to the Bahamas and Florida cable amounted to £5,352. This cable was laid in 1892, and since then not a single penny had been expended on it, the only expense being a small one on repairs to cable huts. The cable laid by the Company in 1891 between Halifax and Bermuda he understood had also not required any expenditure, although this was a matter out of their own hands. These facts, however, showed that their under-water work was exceedingly good. Since 1895 the net profits of the Company had increased by 45 per cent., and the dividends and bonus had risen gradually from 8 to 14 per cent. Their new works would be ready for opening in July.

The report was seconded by the **Hon. Randolph Stewart**, and adopted.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY, LIMITED.

The thirty-fifth annual meeting was held on Tuesday at the offices, Old Broad-street, Sir Robert G. W. Herbert presiding. The report, already published in a former issue, was adopted. In the course of the discussion general satisfaction was expressed at the establishment of a pension fund.

The **Chairman** stated that the scheme would not at present extend to the mechanics and operatives at the works, whose position was different from that of the clerks. There had been an increase in the cost of coal and raw material, therefore they had been obliged to raise the prices of their manufactured work. With reference to the large amount they carried forward, with their uncertainty of obtaining considerable orders, and their desire to maintain a steady dividend, they thought it best to carry forward all they could within reasonable bounds. Under their articles of association they were obliged to have a reserve fund of £50,000, and this amount was in consols. There was a prospect of good employment for their works in the current year.

IMPERIAL TRAMWAYS COMPANY.

The general meeting of shareholders was held on Tuesday at the Grand Hotel, Broad-street, Bristol. Mr. George White presided.

The **Chairman** said with regard to the London United Tramways that, with powers to convert eight miles of its existing line into electric lines and authority to build another 13 miles of route of electric tramways, there was a very bright prospect. He had great hopes that in about 12 months hence the whole electric system of tramways would be in operation. The scheme to extend the lines from Brentford, through Twickenham, Teddington, and Hampton Wick, to Hampton Court would prove of such immense value to the whole of London's six millions of people that he could not doubt the Light Railway Commissioners would grant the necessary powers, in which case they would have a route length of about 35 miles of electric lines in the West London suburbs. The Acton Urban District Council had asked them to tender for the supply of electricity for lighting their district. The Middlesbrough, Stockton, and Thornaby electric tramways system, which was opened for public traffic on July 16 last, over which nearly four millions of passengers were carried, had earned £21,092 up to Dec. 31, resulting in a net dividend of 7 per cent. upon the outlay. At the request of the local authorities, they were promoting about six miles of extensions of their electric tramways under the Light Railways Act, and they hoped to obtain the necessary powers within the next few months, and lose no time in building the lines. In May they would deposit plans and an application for the construction of eight miles of electric lines in Darlington. The general result of the year's working was that out of the available surplus, after paying debenture interest and also 6 per cent. on the preference shares, the directors recommended a 7½ per cent. dividend on the new ordinary capital of the Company.

The report and dividends were carried. Mr. George White was re-elected a director, and Messrs. James Fraser and Sons were re-elected auditors. The remuneration of the directors, including that of the managing director, was fixed at £750.

A special meeting was afterwards held, at which the following resolution was confirmed: "That the draft order now being promoted before the Light Railway Commissioners, entitled 'An order authorising the construction of light railways in the counties of Durham and York,' be, and the same is hereby, approved, subject to such additions, alterations, and variations as the Light Railway Commissioners or the Board of Trade may think fit to make therein."

BRIGHTON AND ROTTINGDEAN SEASHORE RAILWAY COMPANY.

The annual meeting of the Brighton and Rottingdean Seashore Electric Tramroad Company was held on the 28th ult.

The directors, in their report, state that the car ran throughout the whole of last year. The number of passengers carried in the year 1898 was 112,548, and the total receipts £2,752. 3s. 3d. The working expenses amounted to £1,859 6s. 1d., and the net profit to £892 17s. 2d., which was just sufficient, after providing for insurances and fixed charges, to pay the interest on debentures and loans. The electric supply was now obtained from the Brighton Corporation, which had enabled the staff to be much reduced, and the ensuing year should show a considerable reduction in working expenses, so that the directors confidently anticipate that a dividend will now be earned. It was stated that the directors had been negotiating for some time with a firm with a view to getting a second car on lease.

The report was adopted.

The retiring directors, Alderman J. J. Clark and Mr. R. J. Pope, were re-elected. Mr. W. J. D. Boult, of 27, King-street, Cheapside, was appointed auditor in place of Mr. E. J. W. Sang, who had been co-opted on the board of directors.

GATESHEAD TRAMWAY COMPANY.

The seventeenth annual meeting of shareholders of the Gateshead and District Tramways Company was held on Wednesday at the depôt of the Company, Gateshead. The report, which recommended a payment of a dividend at the rate of 2 per cent., and the carrying forward of a balance of £2,004. 3s. pending the final completion of the arrangement between the Company and the British Electric Traction Company, Limited, was adopted.

BIRMINGHAM ELECTRIC SUPPLY COMPANY.

The report of this Company for the year 1898 states that the sale of the sale of the Company's business to the Corporation requires the confirmation of Parliament. The amount of net profit, including £989 brought forward from last year, is £18,516. It is proposed to pay a dividend of 6 per cent. per annum, which payment will absorb £11,999, leaving £1,209 to be carried forward. Any subsequent profits will go to the Corporation.

CHELSEA ELECTRICITY SUPPLY COMPANY, LIMITED.

Directors: J. Irving Courtenay (chairman); Nugent Daniell; Emile Garcke; G. N. Marten; Major-General Webber, C.B. (retired R.E.). Managing engineer: Frank King. Secretary: S. J. Cluer.

Report of the directors (with abstract of accounts) to be submitted to the shareholders at the ordinary general meeting of the Company to be held at their head offices, 19, Cadogan gardens, S.W., on Monday, March 6, 1899, at 11.30 a.m.:

In November, 1898, an issue of £40,000 debenture stock was made at the price of 108½ per cent. This issue was fully paid up in January, and a Stock Exchange quotation has been applied for. The balance of premium received in 1898, after deducting expenses of issue and certain special law and incidental expenses, has been carried, as on previous occasions, to the reserve fund. The total of the reserve fund now stands at £46,818. 3s. 4d. The whole of the authorised share capital (£200,000) has now been issued, and debenture stock to the amount of £100,000 has also been issued. It becomes necessary, therefore, to take powers to increase the authorised share capital so that future issues may be made as required by the progress of the business. The proposed alteration of the articles of association of the Company in regard to directors' fees does not increase the amount now payable under Article 70 until a dividend of more than 6 per cent. is paid on ordinary share capital. Early in last year the shareholders approved a draft Bill for the compulsory purchase of certain properties required for the purposes of the business. That Bill was successfully carried through Parliament, the Chelsea Company being the first to obtain an Act for powers for compulsory purchase of land within the area of supply. The result of the Act is to enable the Company to acquire at reasonable cost such

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lands and premises as it requires. The sum of £2,500 has been added to the renewals and depreciation fund out of the net revenue. After deducting this amount, and after payment of interest on debenture stock (£2,822. 15s. 10d.), there remains a balance of £12,923. 3s. 6d. The directors recommend that this balance shall be applied as under: interim dividend of 6 per cent. per annum on the preference shares for the half-year to June 30, 1898 (paid July 1, 1898), £900; interim dividend of 5 per cent. per annum on the ordinary shares for the half-year to June 30, 1898 (paid July 1, 1898), £4,250; dividend of 6 per cent. per annum on the preference shares for the half-year to Dec. 31, 1898, £900; dividend of 7 per cent. per annum on the ordinary shares for the half-year to Dec. 31, 1898, making a total dividend of 6 per cent. for the year, £5,950; balance to be carried forward to next account, £923. 3s 6d. The number of lamps connected on Dec. 31, 1898, was 112,587, an addition of 15,949 during the year. The retiring directors, Mr. Nugent Daniell and Mr. E. Garcke, are eligible for re-election. The auditors, Messrs. Cooper Bros. and Co., offer themselves for re-election.

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1898.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel, including expenses on the same	4,494	18	7			
Oil, water, cotton waste, and engine-room stores	661	9	2			
Wages of men and proportion of engineers' salaries	1,752	5	7			
Repairs, maintenance, and renewals as under: buildings, £207. 12s. 8d.; engines and boilers, £796. 17s. 2d.; dynamos, £29. 5s.; instruments, tools, and sundries, £183. 15s. 3d.	1,217	10	1			
Sundry costs not included in the above	197	17	8			
				8,324	1	1
Distribution of Electricity.						
Wages at out-stations, meter winding, and reading	949	9	3			
Stores used at out-stations	83	19	2			
Repairs, maintenance, and renewals as under: mains, £68. 8s. 10d.; accumulators and apparatus at distributing station and motor-transformers, £387. 5s. 7d.; meters on consumers' premises, £46. 15s. 10d.	502	10	3			
				1,535	18	8
Rent, Rates, and Taxes.						
Rents payable	626	7	6			
Rates and taxes	1,233	2	1			
				1,859	9	7
Management Expenses.						
Directors' remuneration	1,000	0	0			
Salaries of staff	1,112	14	2			
Salary or commission of collector	120	0	0			
Stationery and printing	144	14	1			
General establishment charges	265	13	7			
Auditors of Company	52	10	0			
				2,695	11	10
Law and parliamentary expenses				33	10	1
Special Charges.						
Insurance	245	12	7			
Wayleaves	7	0	0			
				252	12	7
Balance carried to net revenue account				16,661	17	1
				£31,363	0	11

Cr.	£	s.	d.
Sale of current (less allowances made)	29 473	13	4
Rental of meters	1,215	2	3
Transfer fees	60	15	0
Rents receivable, discounts, and sundry small accounts	613	10	4
	£31,363	0	11

Dr. GENERAL BALANCE SHEET, DEC. 31, 1898.	£	s.	d.
Capital account—amount received	292,620	0	0
Sundry creditors for plant and buildings	6,662	16	6
Sundry creditors on open accounts	3,342	16	11
Debenture stockholders for interest accrued	1,423	14	0
Reserve fund, being balance of premium	46,818	3	4
Net revenue account—balance at credit thereof, £12,923. 3s. 6d.; less interim dividend paid, £5,150	7,773	3	6
	£358,640	14	3

Cr.	£	s.	d.
Capital account—amount expended, £332,291. 9s.; less renewals and depreciation fund account, £8,670	323,621	9	0
Stores on hand—coal, £354. 18s. 8d.; general stores, £4,006	4,360	18	8
Sundry debtors for current supplied, etc., less bad debts deducted	12,128	14	4
Cash at bankers, £18,490. 12s. 9d.; in hand, £38. 19s. 6d.	18,529	12	3
	£358,640	14	3

DUBLIN AND LUCAN TRAMWAY COMPANY.

The half-yearly general meeting of the proprietors of the Dublin and Lucan Steam Tramway Company was held on the 23rd ult. in the Conyngham-road Terminus, Mr. Wm. Mooney, chairman of directors, presiding. The report, which was adopted, states that, notwithstanding the transition period from steam to electric haulage through which the Company is still passing, and the consequently reduced tram service, the net income of the past half-year will be sufficient not only to pay the debenture interest and preference dividend, but, in addition, to discharge one half-year of the latter, which had been previously in arrears. The directors were disappointed that more rapid progress has not been made with the electrical equipment. The delay had been occasioned entirely by the difficulty in procuring a suitable site for a station, but one had been secured recently, and the line would probably be working by electricity before the next half-yearly meeting of the Company.

NOTTING HILL ELECTRIC LIGHTING COMPANY, LIMITED.

The twelfth ordinary general meeting was held on Wednesday at 140, High-street, Notting Hill-gate. Sir. William Crookes, F.R.S, presided. The report and the payment of a dividend at the rate of 6 per cent. per annum, less income tax, on the ordinary shares were agreed to.

An extraordinary general meeting was afterwards held, at which the resolution approving the Kensington and Notting Hill Bill was confirmed.

HOVE ELECTRIC LIGHTING COMPANY, LIMITED.

Directors: Colonel A. J. Filgate, R.E. (chairman); Colonel H. Wood. C.B. (vice-chairman); Harold A. Hoare, Esq.; Carleton F. Tufnell, Esq. Engineers: Messrs. Crompton and Co., Limited, London and Chelmsford. Secretary: Francis R. Reeves, Esq., M.I.E.E.

Seventh report of the directors (with abstract of accounts) to be presented at the annual general meeting of the shareholders to be held at the City Terminus Hotel, Cannon-street, E.C., on Wednesday, March 8, 1899, at 12 noon:

The directors beg to submit the annual statement of accounts and balance-sheet made up to Dec. 31, 1898, and have pleasure in again reporting that the progress of the Company continues satisfactory. The units sold to customers during the past year were 350,354, as compared with 268,243 for the previous 12 months, while the gross revenue amounted to £9 480. 7s. 1d., as against £7,269. 11s. 4d. in 1897, an increase of £2,210. 15s. 9d. On the other side of the account the gross expenditure of £4,390. 8s. 11d. is an increase of only £723. 7s. 3d. over the expenditure of the previous year. The net result is a profit for the year of £5,089. 18s. 2d., an increase of £1,486. 8s. 6d. over the profits for the year 1897. In congratulating the shareholders upon the excellent result the directors would point out that the reduction in price of current, mentioned in last year's report, has been amply justified, as it has had the effect of increasing the number of customers and the demand for current. The directors have no doubt that the most profitable policy which can be adopted by the Company will be to further reduce the price, but until the station has been enlarged, and ample provision made for dealing with a further greatly increased demand for current, it will, in the opinion of the Board, be inadvisable to make any further reductions. The number of lamps and motors connected to the Company's system at Dec. 31 last was equivalent to 36,967 8-c.p. lamps and the number of houses connected to 513, as compared to 27,777 lamps and 397 houses at Dec. 31, 1897. To the net revenue of £5,089. 18s. 2d. has to be added the sum of £214. 13s. 2d., balance brought forward from last year, making a total amount of £5,304. 11s. 4d. After deducting debenture interest paid and accrued, and the interim dividend paid in October last, and providing for income tax, there remains a net balance of £3,264. 15s. 3d. at the credit of the revenue account. The directors propose to write the sum of £247. 17s. off the preliminary expenses account, to place £1,000 to the reserve fund, to declare a dividend (payable on April 15 next) at the rate of 8 per cent. per annum for the half-year on the share capital, making, with the interim dividend, 6½ per cent. for the year, and to carry the balance, £400. 1s. 5d., forward. The reserve fund, by the addition now proposed to be made, will stand at £5,287. 17s., and a further sum of £191. 3s. 1d. has been added to the depreciation and maintenance reserve account, which now stands at £1,105. 13s. 1d. Since the date of the last report the directors have issued 1,000 of the new £5 shares at the price of £7 each, the premiums being added to the reserve fund. They have also issued £700 of 4 per cent. debenture stock, making the total debenture charge at the present date £25,000. During the year now past the expenditure on capital account was £10,641, bringing up the total capital expenditure at Dec. 31 last to £77,450. 12s. 2d. Two new steam dynamos of 350 h.p. and 40 h.p. respectively, besides an additional Babcock and Wilcox boiler, have been placed in the generating station. Over £4,500 has been expended on new mains and strengthening the existing feeders and mains, and £1,120 on additional meters and demand indicators. The continual increase in the Company's business has forced upon the directors the consideration of the extension of the lighting station and additions to the generating plant therein. To meet the cost of these and of further extensions to the Company's mains, it will be necessary to raise additional capital. The directors propose, therefore, to issue the remaining 1,000 £5 shares, bringing the total subscribed capital

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of the Company up to £50,000, and such shares are offered to the members *pro rata* according to their holding in the Company at the price of £7. 10s. per share. It is further proposed that the nominal share capital of the Company shall be increased to £100,000 by the creation of 10,000 additional shares of £5 each, the new shares to be issued as and when required. The necessary resolution will be submitted to the meeting. The directors regret to report the death of Mr. Robert Payne, F.C.A., who had been auditor of the Company since its commencement. They have appointed as auditors of the Company for last year Messrs. J. H. Duncan and Co., chartered accountants, of 39, Coleman-street, who now offer themselves for re-election for the current year. In accordance with the articles of association Mr. Harold A Hoare retires from the board of directors by rotation, but offers himself for re-election.

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1898.

Dr. Generation of Electricity.	£	s.	d.	£	s.	d.
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£1,289	8	0			
Oil, waste, water, and engine-room stores	179	3	8			
Proportion of salaries of engineers, superintendents, and officers	254	12	0			
Wages and gratuities at generating station	572	7	2			
				2,295	10	10
Repairs and Maintenance.						
Amount expended	408	16	11			
Balance set aside in accordance with the contract with Hove Commissioners	191	3	1			
				600	0	0
Rents, Rates, and Taxes.						
Rents payable	183	3	4			
Rates and taxes	47	10	2			
				230	13	6
Management Expenses.						
Directors' remuneration	450	0	0			
Salaries	421	15	2			
Stationery and printing	53	0	7			
General establishment charges	179	14	8			
Auditor of Company	10	10	0			
				1,115	0	5
Special charges—insurances				149	4	2
Total expenditure				4,390	8	11
Balance carried to net revenue				5,089	18	2
				£9,480	7	1

Cr.	£	s.	d.
Sale of current (350,354 units)—private consumers, after allowing rebates and providing for bad debts	8,770	1	3
Public lighting	178	1	0
	8,948	2	3
Rental of meters and other apparatus on consumers' premises	529	12	4
Transfer fees	2	12	6
	£9,480	7	1

GENERAL BALANCE-SHEET, DEC. 31, 1898.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	43,910	0	0
4½ per cent. debentures	7,300	0	0
4 per cent. debenture stock	17,700	0	0
Loans from bankers	1,000	0	0
Sundry creditors	3,002	4	2
Consumers' deposits	72	0	0
Creditors for interest	169	1	3
Unclaimed dividends	16	18	6
Reserve fund	4,287	17	0
Depreciation and maintenance account reserve fund	1,105	13	1
Net revenue account—balance at credit	3,264	15	2
	£81,828	9	2

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	77,450	12	2
Stores on hand Dec. 31, 1898: coal, £44. 2s.; oils, waste, and general stores, £31. 5s. 9d.	75	7	9
Sundry debtors for current supplied, etc., to Dec. 31, 1898	3,933	18	7
Cash at bankers, £318. 16s. 8d.; in hand, £49. 14s.	368	10	8
	£81,828	9	2

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY COMPANY, LIMITED.

Directors: Alderman T. G. Gibson, J.P. (chairman): Dr. Robert Spence Watson; Dr. J. T. Merz; Colonel F. F. Sheppee; J. Tennant, Esq.; J. H. Armstrong, Esq.

The eleventh ordinary general meeting of the Newcastle-upon-Tyne Electric Supply Company, Limited, was held at the Company's office, New Bridge-street, Alderman T. G. Gibson, chairman of the directors, presiding. The report, given in detail herewith, was adopted, and a dividend of 4½ per cent. for the half-year ended Dec. 31 was declared, making 8 per cent. for the year. Dr. Spence Watson and Mr. James Tennant, the retiring directors, and Mr. Thomas Harrison, retiring auditor, were re-elected.

The report of the directors for the year ended Dec. 31, 1898, states that the demand for electricity continues to improve, the units sold having been 803,789, against 660,906 last year. The total profit for the year, including the balance brought forward from last year, represents a sum of £6,020. 18s. 3d. Out of this the directors recommend a dividend of 8 per cent. for the year, on account of which an interim dividend of 3½ per cent. was paid on July 15 last, leaving a further dividend of 4½ per cent. now payable to the shareholders. The total dividend will absorb £4,026. 18s. 1d., and the directors propose to deal with the balance of £1,994. 0s. 2d. as follows: to increase the reserve and depreciation account by a further sum of £1,000, which, together with the premiums on shares issued during the year increases the account to £7,700; to carry forward to next year the balance of £994. 0s. 2d. The capital expenditure has been increased during the year by about £15,000, in which sum is included the cost of another large set of generating plant and the general extension of the Company's system to meet the growing demand for electrical energy. Arrangements are being made for still further increasing the capacity of the supply station, and also for supplying continuous current for power and other purposes, for which several applications have already been received. The special expenditure above mentioned has been met by the issue of 3,000 new shares, sanctioned at the last meeting of shareholders. The retiring directors are Dr. R. Spence Watson and Mr. James Tennant, who are eligible and offer themselves for re-election. The auditor, Mr. Thos. Harrison, also retires, and is eligible for re-election.

Dr. BALANCE-SHEET, DEC. 31, 1898.	£	s.	d.	£	s.	d.
Nominal capital—20,000 shares of £5 each				100,000	0	0
Issued and allotted—9,370 shares, fully paid				46,850	0	0
3,000 shares, £1. 5s. called up				3,750	0	0
				50,600	0	0
Calls paid in advance				2,548	10	0
				53,148	10	0
Five per cent. mortgage debentures				25,000	0	0
Creditors on sundry accounts				17,428	16	2
Reserve account, as at Dec. 31, 1897	£5,204	3	7			
Added from 1898 profits	1,000	0	0			
Premium on issue of 3,000 shares at 30s. per share	4,500	0	0			
	10,704	3	7			
Less transfers to capital expenditure suspense account	3,004	3	7			
				7,700	0	0
Profit and loss account—balance as per directors' report of Jan. 31, 1898	651	19	9			
Profit for year to date	5,368	18	6			
	6,020	18	3			
Less transfer to reserve account, £1,000; interim dividend at 7 per cent. per annum for half-year to June 30, 1898, £1,738. 10s. 10d.	2,738	10	10			
				3,282	7	5
				£106,559	13	7

Cr. Capital Expenditure.	£	s.	d.
Buildings and plant, as at Dec. 31, 1897	58,293	7	9
Additions to date	13,133	1	7
	71,426	9	4
Meters, transformers, etc., as at Dec. 31, 1897	£11,781	9	0
Additions to date	2,297	13	5
	14,079	2	5
Land purchased, as at Dec. 31, 1897	10,998	1	4
Cost of provisional order, as at Dec. 31, 1897	659	14	11
	97,163	8	1
Capital Expenditure Suspense Account.			
Preliminary and formation expenses, as at Dec. 31, 1894	1,123	12	10
Preparatory and experimental work, as at Dec. 31, 1894	1,880	10	9
	3,004	3	7
Less transfers from reserve account, *per contra*	3,004	3	7
	0	0	0
Loose plant and tools	610	12	11
Office furniture	318	16	0
Special expenditure on new offices	136	10	10
Less one-third written off	45	10	3
	91	0	7
Stocks at valuation	2,185	10	5
Debtors on current supply and for work done, etc.	5,665	15	1
Cash in bank and in hand	524	10	6
	£106,559	13	7

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Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Station charges—salaries, wages, coal, water, and maintenance	3,946	10	7
Street charges—salaries and maintenance	567	12	1
Rents, rates, taxes, and insurance	390	13	3
General charges—directors' remuneration, £262. 10s.; office salaries, legal and accountancy charges, stationery, stamps, telegrams, etc., £1,335. 4s. 7d.	1,597	14	7
Balance carried down	8,139	18	7
	14,642	9	1
Special expenditure on dynamo reconstruction, etc., during year	1,295	2	8
Interest—on debentures, £1,250; on purchase price of land, £345. 1s.; on loans, £1. 16s.; on bank overdraft, £4. 1s. 7d.; less interest received, £125. 1s. 2d.	1,475	17	5
Balance carried down	5,368	18	6
	£8,139	18	7

Cr.	£	s.	d.
Current supply—Household	12,964	14	8
Public lamps	588	0	0
	13,552	14	8
Apparatus rental	1,079	7	0
Profit on sale of lamps	1	4	11
Transfer fees	9	2	6
	14,642	9	1
Balance brought down, being gross profit for year	8,139	18	7
	8,139	18	7
Balance brought down, being profit for year	5,368	18	6

BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED.

The following interim report for the half-year ended Dec. 31, 1898, was submitted at a meeting of shareholders at the Cannon-street Hotel on Thursday: The works at Loughborough, including the new shops completed, have been well employed, and the volume of orders received during the half-year has been satisfactory. The further extensions at the Company's works at Loughborough, rendered necessary by the increasing demand for plant and rolling-stock for electric traction purposes, are making satisfactory progress. Various important contracts in connection with electric lighting and electric traction undertakings have been secured and are in hand. An interim dividend for the half-year at the rate of 6 per cent. per annum has been declared on the Company's preference shares.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Betanzos (Spain).—The Municipality will receive tenders for the electric lighting of the town by 2.30 p.m. on 16th inst.

Aberdeen.—The Electric Lighting Committee are prepared to receive tenders for the supply of copper strip. Tenders by 10th inst.

Southport.—The Corporation offer for sale two Browett and Lindley engines and Mather and Platt alternators. Tenders by March 21.

Glasgow.—The Corporation are prepared to receive tenders for the reconstruction of tramways, as detailed in specification. Tenders by 15th inst.

Bury.—The Electric Lighting Committee invite tenders for the supply and erection of one Lancashire boiler, with steam and other pipes. Tenders by March 20.

Madrid.—The Public Works Department are inviting tenders for the building of an electric tramway in the city. Applications must be sent in by p.m. on April 14.

Southend-on-Sea.—The Corporation are prepared to receive tenders for the temporary transfer of their powers under the Southend Electric Lighting Order, 1891. Tenders by April 6.

Greenock.—The Board of Police are prepared to receive tenders for contract No. 4, mains (low-tension system), including erecting arc lamps, poles, etc., for their electricity works. Tenders by March 16.

Manchester.—The Tramways Committee of the Corporation invite applications from practical carriage builders for the position of manager for their car building and repairing works. Applications by 13th inst.

Poplar.—The Guardians invite tenders for steam turbines and dynamos (direct coupled), electric motors, battery of accumulators, electric cables, wiring, and fittings, main switchboard, and distribution boards. Tenders by March 22.

Winchester.—The Town Council invite tenders for the electric lighting of a portion of the public offices, clock tower, etc., at the Guildhall, and at the public library and art school. Specifications can be obtained from the Surveyor. Tenders by 7th inst.

Edinburgh.—The Council invite tenders for the following works in connection with their electric lighting station in Macdonald-road: Contract No. 7: Condensing plant, with water-cooling tower, feed-water tanks, and filters. Tenders by March 6.

Hereford.—Tenders are invited by the Town Council for erection and completion of the buildings in connection with the electricity station in Widemarsh-street. Specification can be obtained at the office of Mr. John Parker, A.M.I.C.E. Tenders by 5 p.m. on March 13.

Southampton.—The Corporation invite tenders for the supply of stores, etc., required in the electricity department during 12 months, according to specification and conditions to be obtained upon application at the Electric Light Works, Back-of-the-Walls. Tenders by 2 p.m. on 6th inst.

Brighton.—The Corporation invite tenders for supply and erection of a 20-ton travelling crane at the electricity generating station, North-road, Brighton. Specifications, etc., may be obtained from Mr. F. J. Tillstone, town clerk, Town Hall, Brighton. Tenders by March 6.

Stockport.—The Committee of the Stockport Sunday School invite tenders for the efficient electric lighting of the whole of their premises from the town supply. Tenders to be submitted to Mr. W. B. Leigh, hon. secretary, Committee Room, Stockport Sunday School, not later than March 24.

Ambleside.—The Urban District Council invite tenders for the supply of gas-engines, generators, boosters, switchboard, and battery, and the laying of mains. Particulars may be obtained from Messrs. Hopkinsons and Talbot, 29, Princess-street, Manchester; or 26, Victoria-street, London, S.W.

Pernambuco.—The Government of the State of Pernambuco invite tenders for the construction of an electric tramway to run between that city and Olinda, situated at about three miles distance. Tenders, duly sealed, must be addressed to the Secretaria da Industria, Pernambuco, and should be received there not later than March 18.

Dublin.—The Great Northern Railway Company (Ireland) invite tenders for erection at Amiens-street, Dublin, of an electric power-house, 75ft. long by 23ft. wide, to be built of brick, with steel principal roof. Specification, etc., may be obtained at the office of the Company's Engineer-in-Chief, Amiens-street Terminus, Dublin. Tenders by 10 a.m. on March 13.

Edinburgh.—Tenders are invited by the Corporation for installing the electric light at Tollcross tramway power station. Specification, forms of tender, and plans of the building can be obtained at the office of the Resident Electrical Engineer, 5, Dewar-place, Edinburgh, on deposit of £2. 2s., which will be returned on receipt of a bona fide tender. Tenders by March 6.

Lewes.—The Corporation invite offers from responsible companies or persons willing to establish an electricity supply undertaking under and subject to the provisional order of 1898. Particulars may be obtained at the offices of Mr. F. J. Warden-Stevens, Connaught Mansions, 34, Victoria-street, Westminster, S.W., or at the office of the Clerk, Town Hall, Lewes, on deposit of £5. 5s. Tenders by March 24.

Brighton.—The Council are prepared to receive tenders for the purchase of the following materials: (lot 1) about 1¼ tons of pure electrical copper (cable ends with insulation and lead burnt off); (2) about 17½ tons of old cast-iron firebars; (3) about 11 tons of second-hand straight and tee cable joint boxes, with screw filling plugs (similar to Siemens's pattern), and a few street disconnecting boxes. Tenders by March 6.

Dundee.—The Gas Commissioners invite tenders for the supply and erection of the following plant at the electric station, Dudhope-crescent-road Dundee: (Contract No. 12) four Lancashire boilers; (13) two 450-h.p. steam-engines and dynamos; (14) one 700-h.p. steam-engine and dynamo. Specifications, etc., may be obtained from Mr. Walter H. Tittensor, Dudhope-crescent-road, Dundee, on deposit of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders by March 15.

West Hartlepool.—The Town Council invite tenders for the erection of an electric light station in Burn-road, in accordance with amended plans and specification prepared by Mr. C. Stanley Peach, F.R.I.B.A. Bills of quantities, prepared by Mr. H. T. Neilson, can be obtained upon payment of £2. 2s., which sum will be returned upon the receipt of a fully priced-out and bona fide tender. Particulars may be obtained from Mr. J. W. Brown, borough engineer. Tenders by 4 p.m. on 13th inst.

Belfast.—The Electric Committee are prepared to receive tenders for the supply and erection of the following: (Section C 12) switchboard extensions. Specifications and conditions of contract may be obtained on application to Mr. Victor A. H. McCowen, city electrical engineer, on payment of £1. 1s. per copy, which sum will be refunded on the return of the specification with a bona fide tender. Sealed tenders, endorsed "Tender for Switchboard Extension," must be sent to Sir Samuel Black, town clerk, by 12 a.m. on March 16.

Canterbury.—The Corporation invite tenders for supply and erection of the following plant for the municipal electricity works: (Section A) boiler-house plant (one Lancashire boiler and accessories, mechanical stokers); (B) engine-house plant (one 150-kw. steam dynamo and accessories, condenser, steam, exhaust, feed, blow-off, and sundry pipes, valves, etc.); (C) extension of switchboard; (D) extensions of mains (insulated cables). Specification, etc., may be obtained at the offices of Mr. Robert Hammond, M.I.C.E., M.I.E.E., 84, Victoria-street, Westminster, London, S.W., on payment of £5. 5s., which sum will be refunded on the

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return of the specification filled up with a bona fide tender. Tenders by March 14.

London, W.—The Vestry of Hammersmith invite tenders for the supply and erection of the following machinery by May, 1900: Contract A, three water-tube boilers; B (1), two 1,000-h.p. slow-speed engines, coupled direct to B (2), two 600-kw. alternators; C, underground feeders; D, cast-iron pipes. Specification, with general conditions and form of tender, can be obtained at the office of Mr. W. P. Cockburn, vestry clerk, Town Hall, Hammersmith, on and after 27th inst. upon payment of £2. 2s., which will be returned on receipt of a bona fide tender. Specifications and drawings may be seen, but not obtained, at the office of Mr. A. H. Preece, 39, Victoria-street, Westminster. Tenders must be delivered at the Town Hall, Hammersmith, by 5 p.m. on March 15.

Shanghai.—The Shanghai Municipal Council invite tenders for a concession for constructing and working about 23 miles of electric tramways on the trolley system in the streets of Shanghai. The special attention of tenderers is drawn to the fact that the tender (if any) recommended by the Council will require ratification by the ratepayers. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 being deposited with Messrs. Pook and Co., which sum will be retained by the Council, and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China (telegraphic address Dynamo, Shanghai; "ABC," fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Tramway Concession," must be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, and received by 12 noon on June 30.

Shanghai.—The following resolution in reference to the telephone system in Shanghai was passed at the last annual meeting of the ratepayers of the Foreign Settlements at Shanghai, north of the Yang-king-pang: "Resolution VIII.—That the Council be and is hereby authorised to enter into negotiations with the China and Japan Telephone Company or any other company, and in its discretion grant a franchise with a view to the community being supplied with an adequate and efficient telephone service at a fixed maximum charge." In accordance with the above resolution the Shanghai Municipal Council invite tenders for a concession for a period of 30 years for the exclusive right of establishing and working a telephone system in Shanghai. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 sterling being deposited with them, which sum will be retained and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China. Telegraphic address, Dynamo, Shanghai (ABC, fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Telephone Concession," to be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, by 12 noon on March 31.

RESULTS OF TENDERS.

Derby.—The tender of Messrs. Babcock and Wilcox, Limited, has been accepted, at £2,340, for two boilers and accessories.

Whitechapel.—The District Board of Works have accepted a tender for the erection of a new dust destructor at a cost of £17,740.

Buxton.—The Urban District Council have accepted the tender of Callender's Cable and Construcion Company for £3,750, for electric light mains, feeders, etc.

Birmingham.—The Committee recommend the acceptance of the tender of the Birmingham Electric Supply Company, Limited, at £1,974, for lighting the Council Chamber.

Fulham.—The Electric Committee have recommended the acceptance of the tender of Messrs. Wilkinson Bros., at £22,755, for the erection of electric supply station buildings.

Leeds.—The Town Council have accepted the tender of Messrs. John Fowler and Co. for the supply of steam-pipes and connections for the extension of the generating station, at £1,390.

Shoreditch.—The Vestry have accepted the tender of the Electric Construction Company for supplying and fixing a new booster, at £399, and for rewinding the armature of the present one at £41.

Kingston.—The tender of Messrs. Weeks and Co., of Chelsea, for the construction of the filter-house at £49. 10s. has been accepted. Subject to the approval of the Council, guards for the switchboard will be ordered from Messrs. Siemens at £98.

Glasgow.—The Tramways Committee have accepted the tender of Messrs. MacCartney, M'Elroy, and Co., Limited, London, for the overhead construction required for the conversion of the Govanhill line in extension of the High-street route, of £3,912.

Edinburgh.—The Electric Light Committee have accepted the following tenders; J. Kinnear, mason and joiner work, at about £25 000; Carrick and Ritchie, Easter-road, overhead cranet, £500; and Pritchetts and Gold, London, for batteries, between £6,000 and £7,000.

Manchester.—The Great Central Railway Company invite tenders for the supply during 12 months ending April 30, 1900, for electric light material (contract No. 20). Specification, etc., may be obtained from Mr. O. S. Holt, secretary, London-road Station. Tenders by March 14.

Islington.—The Electric Lighting Committee have received 11 tenders for the extension of the central station, and the Vestry have accepted the tender of Messrs. Patman and Fotheringham, 15, Park-street, at £20,951, for the completion of the work within a period of nine months.

Leicester.—The Corporation have accepted the tender of Messrs. Manlove, Alliott, and Co., of Nottingham, at £6,755. 19s. for all the work and appliances for a six-cell destructor, including three Babcock and Wilcox boilers, automatic charging wagons, forced-draught apparatus, engine, mortar mill, clinker crusher, and shafting complete.

Bury St. Edmunds.—The Town Council have accepted the following tenders for supply of electric lighting plant:

Fowler and Co., engine-house plant	£5,793
Grimwood and Sons, buildings	3.470
Callender Cable and Construction Company, mains	2,994
Davey and Co., boiler plant	1,495

Lowestoft.—The Council have accepted the following tenders (subject to the consent of the Local Government Board being obtained to a loan): (Section A) Messrs. Babcock and Wilcox, boilers, economisers, feed pumps, etc., £1,761; (B) Messrs. Babcock and Wilcox, pipework, etc., in engine and boiler house, £660; (C) Messrs. Musgrave and Co., Limited, steam dynamos and motor-boosters £2,833; (D) the Chloride Electric Storage Syndicate, Limited, storage batteries, £1,534; (E) Messrs. Laurence, Scott, and Co., main switchboard and connections, £875; (F) Messrs. Carrick and Ritchie, overhead engine-room travelling crane, £265; (G) the Callender Cable and Construction Company, Limited, underground mains and conduits for private and public lighting, roadwork, etc., £8,162. 10s.; (H) Messrs. J. W. Brooke and Co., Limited, Lowestoft, arc lamps and posts, £757.

BUSINESS NOTES.

Barrow.—The electric light was turned on for the first time on Monday.

Morecambe.—The electric light was switched on at the West-end Pier on Friday last

Removal.—Mr. Sydney Morse is removing his offices on March 7 to 37, Norfolk-street, Strand.

St. Pancras.—Mr. G. T. Chandler has been re-elected to fill the vacancy on the Electricity Committee.

Thurlstone.—The Urban District Council have decided to oppose the National Telephone Company's Bill.

Gateshead.—All amendments to the draft Bill of the tramways company have now been finally agreed upon.

Canterbury.—The opening of the Corporation electricity works will take place on the 10th inst. at 4.30 p.m.

Twickenham.—The District Council have decided to petition against the National Telephone Company's Bill.

Shoreditch.—The Vestry have decided to ask two or three firms to tender for the erection of a new switchboard.

Gainsborough.—The Urban District Council have decided to petition against the National Telephone Company's Bill.

Bexhill.—It is reported that a syndicate has been formed to build an electric tramway to connect the town with Hastings.

Hastings.—The report of the Lighting Committee in favour of acquiring the electric light company's undertaking has been adopted.

Bolton.—The Local Government Board have sanctioned the use for electric purposes of the land on Spa-road forming part of the gasworks.

Hampton.—The District Council have unanimously promised to help the London United Tramways Company to obtain their Bill.

Annfield Plain.—The Urban Council have appointed a committee to consider the question of lighting the district with electricity.

Colchester.—The borough surveyor is preparing a report, together with an estimate of the cost of providing additional plant and mains.

Brighton.—The electric arc lamps of an obsolete type now in the Pavilion grounds are to be replaced by up-to-date lamps at a cost of £10 each.

Chichester.—The City Council have decided to ask Lord Edmund Talbot to oppose in Parliament the General Power Distribution Bills.

Chelsea Electricity Supply Company, Limited.—The transfer books of the Company are to be closed until 7th inst. for the payment of dividends.

Appointments Vacant.—For a vacancy occurring for an electrical engineer, a mechanical draughtsman, and others, we refer to our advertisement columns.

Richmond.—The Town Council have decided to petition against the National Telephone Company, Nos. 1 and 2, and the Telegraph Act, 1892, Amendment Bills.

Glossop.—Colonel Sidebottom, M.P., has agreed to the request of the Council to oppose the second reading of a Bill with reference to electric companies invading the areas of municipal corporations.

Maidstone.—The Urban District Council have accepted the scheme proposed by Messrs. Kincaid, Waller, and Manville for establishing an electric lighting station in combination with a dust destructor for the borough.

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Lowestoft.—The Town Council have decided to apply to the Local Government Board for sanction to a loan of £30,000 for carrying out the proposed electric lighting scheme.

Crewe.—The area of lighting is to be extended so as to include West-street, and will be carried out as soon as practicable, simultaneously with the scheme in Hightown if possible.

Sheffield.—The opening of the electric tramcar system is fixed for the end of May. There will be a universal penny fare from centre to terminus, with intermediate halfpenny stages.

Lewes.—From what transpired at the meeting of the Lewes Gas Company on Wednesday, it appears unlikely that the company will be a competitor for the electric lighting of the town.

Walker.—The Council will oppose the National Telephone Company, the Telegraph Act, 1892, Amendment, and the Walker and Wallsend Union Gas Company (electric energy) Bills.

Lancashire Electric Supply Bills.—The Select Committee on Standing Orders have thrown out the Lancashire Electric Power Bill and the South Lancashire and Cheshire Electric Supply Bill.

Southport and Lytham Tramway.—The Standing Orders Committee of the House of Lords having agreed to allow the withdrawal of a clause in this Bill, it will now go to the first reading.

Leicester.—The Corporation have accepted tenders for the erection of a refuse destructor. It is stated that the heat developed by the destructor will be used in connection with the electric tramways.

Oldham.—The County Borough Council have sanctioned the obtaining of loans to the amount of £6,830 for the erection of destructors at Rhodes Bank and £7,379 for destructors at Hollinwood.

"The Universal Electrical Directory."—We have just received a copy of "The Universal Electrical Directory" (J. A. Berly's) for 1899 from Messrs. H. Alabaster, Gatehouse, and Co., of 4, Ludgate-hill, E.C.

Hoylake.—The Hoylake and West Kirby District Council have resolved to oppose in Parliament the Bills of four private companies for the supply of electricity to various districts, in which Hoylake is included.

Ingleton Electric Lighting and Power Company, Limited.—A company has been registered, with a capital of £4,000 in £1 shares, to carry on, at Ingleton or elsewhere, the business of suppliers of electricity, etc.

Farnborough.—At a recent special meeting of the District Council an offer submitted by the Power and Traction, Limited, for the supply of electric light to the Council was agreed to subject to certain alterations.

Brazilian Submarine Telegraph Company.—The directors have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income tax, for the quarter ended Dec. 31 last, payable on 24th inst.

Barnstaple.—At the meeting of the Town Council on Monday a resolution that the town clerk be instructed to take steps to obtain powers under the Electric Lighting Act, 1882, to light the town with electricity was adopted.

Bournemouth and Poole Electricity Supply Company, Limited. The directors have declared a dividend upon the ordinary shares of the Company at the rate of 4 per cent. per annum, less income tax, for the 12 months ended Dec. 31.

Metropolitan Electricity Supply Company.—The directors announce a final dividend of 5s. per share, making 10s. for the year. The new ordinary capital will receive a dividend at the same rate from the due dates of the instalments.

New Dry Cell.—Messrs. Eardley Howard and Co., 279, City-road, E.C., have placed on the market a new dry cell, "New Era," for telephone work, etc. Amongst the many advantages claimed for it are uniformity, quality, strength, and economy.

Sedgley.—The Urban District Council have assented to the transfer of the undertaking of the Dudley and Wolverhampton tramways to the British Electric Traction Company, and to the alteration of the gauge in connection with the above tramways.

Battersea.—The Vestry have decided to serve a notice on the County of London and Brush Provincial Electric Lighting Company requiring them to take up certain mains which they had laid down in the parish, and also to petition against the company's Bill in Parliament.

Bradbury Electrical Works.—We are informed that, owing to the increased demand for his high-voltage and other specialities, and pending the construction of some new works in Islington, Mr. A. P. Lundberg has taken additional premises in Culford-road, Ball's Pond, N.

Kensington.—The Vestry have decided to support the Vestries of St. Luke, Middlesex, and St. Martin-in-the-Fields in their request to the London County Council and the City Corporation to oppose the National Telephone Company's Bills and the Telegraph Act, 1892, Amendment Bill.

Imperial Tramways Company.—The report for the past year states that the revenue account shows an available balance of £12 510, and after payment of interest on the debenture stock it is proposed to pay a dividend at 7½ per cent. per annum on the ordinary capital, and to carry forward £225.

Aberdeen.—A report from the engineer has been adopted with reference to the extension of the electric station, recommending that two new boilers should be obtained at an estimated cost of £2,910, and that a new engine should be obtained, the total cost of boilers and engines being estimated at £7,500.

Stoke-on-Trent.—At the last meeting of the Town Council, it was decided to join Nelson and other towns in petitioning against the proposed Secondary Education Bill. A sub-committee was appointed to visit various places at which there had been an installation of the electric light for public purposes.

Liverpool.—At the Town Council on Wednesday the opposition to the proposed erection of an electric generating station upon land in Lister-drive, Newsham-park, was unsuccessful. The Council have placed £44,000 at the disposal of the Electric Power and Lighting Committee for the purposes of electric lighting.

South Shields.—The Town Council are prepared to supply (subject to the sanction of the Board of Trade) electric energy to the union workhouse at the same price as charged in the borough, on the Guardians undertaking to use the electric light to the amount of at least £300 per annum for a period of five years.

Stockton.—Colonel A. G. Durnford, R.E., one of the Local Government Board inspectors, held an enquiry on the 24th ult. into the application of the Town Council for the approval of the Board to use for electric lighting purposes certain land situate between the gasworks and the houses fronting to Alberto-street.

Hanley.—At the meeting of the Town Council last week, Messrs. R. A. D. McAlister (Edinburgh) and R. G. Linscott (Eccles) were appointed junior assistant engineers at the electricity works. It was resolved to increase the salary of Mr. W. Adams, assistant electrical engineer, by two increments of £10 per annum each.

Newcastle Tramways.—At the meeting of the City Council on Wednesday a resolution was passed in favour of the leasing of the tramways. At the same time notice of motion was given for the next meeting as follows: "That the working of the new tramways be retained in the hands of the Corporation, and that they be not leased."

Devonport.—A scheme has been prepared to light the area recently added to the borough of Pennycross and St. Budeaux, under which it is proposed to establish a temporary generating station and instal the electric light forthwith. It provides for laying eight miles of electric cables for public and private supply. The cost will be £8,000.

Direct Spanish Telegraph Company.—The directors have decided to pay, in addition to the dividend at the rate of 10 per cent. per annum on the preference shares, an interim dividend at the rate of 4 per cent., free of income tax, on the ordinary shares, both for the half-year ended Dec. 31 last. Two per cent. of this was paid last October. The balance is payable on the 1st prox.

Chelmsford.—A letter of the Board of Trade, which has been referred to the special committee of the Town Council appointed to consider the question of purchasing the electric lighting undertaking, points out that the use of low-pressure aerial wires is only permissible in cases where the consents of the Board of Trade and the local authority had been obtained.

Ryhill.—Mr. James Taylor, electrical engineer, of Barnsley, has just fitted up an installation of electric light at the residence and in the grounds of Mr. A. B. Southall, J.P., Oatlands, Ryhill. The house is lighted by 34 16-c.p. incandescent lights, and a large light, 1,000 c.p., illuminates the front garden, and, we are told, one-half of the village. It is to be hoped the villagers will soon proceed to light the other half.

Burnley.—The Tramways Committee have passed a resolution approving of the working by the Corporation of the Burnley and District Tramways as soon as the same shall have been acquired by the respective local authorities, and it has been decided that electricity should be the future motive power for the tramways, and that any future reconstruction of the tramways should be upon a gauge of 3ft. 6in. instead of 4ft. 8½in., as at present.

London County Council.—The Council on Tuesday approved the plans and specifications showing the mode of construction and the position and level of the two tunnels which it is proposed to drive under the Victoria-embankment to the south of Charing Cross railway bridge in connection with the Baker-street and Waterloo Railway. The Finance Committee reported the completion of a loan of £21 810 for erecting and lighting the Central London Sick Asylum.

Dundee. — Mr. G. C. Buchanan, harbour engineer, has submitted a report to the Works Committee of Dundee Harbour Trust on the proposed lighting of the harbour by electricity. He estimated that to put down a complete electric lighting installation would cost about £6,000, and was of opinion that if the harbour was to be lighted at all by electricity, the work must be done completely and well. The bills for electric current for lamps in the central thoroughfares for January amounted to £75. 15s. 11d.

Rhyl.—The members of the Urban District Council visited Llandudno on the 23rd ult. to inspect the electric lighting works and refuse destructor, which were shown and explained by Mr. Morton, the electrical engineer. The party later on dined at the Royal Hotel, where the Chairman (Mr. J. H. Ellis) said it was quite right before deciding upon the mode in which they should destroy their refuse to see a system at work in a neighbouring town, and from what they had seen he thought they would decide to adopt a similar system.

Norwich.—The Corporation have decided that a sum not exceeding £6,200 be borrowed under the powers contained in the Norwich Electric Tramways Acts, 1897 and 1898, and the Norwich Corporation Act, 1889, being part of £66,000 authorised to be raised for the purposes of the two first-mentioned Acts; and that the sum be raised by the creation and issue of an adequate amount of Corporation stock as authorised by the said Acts. The directors

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of the tramway company expect that the tramcars will be running in the city by the end of July.

Swansea.—Mr. D. F. Sugrue, superintendent for South Wales of the British Electric Traction Company, on Tuesday took formal possession of the four miles of tramway lying between Pontypridd and Porth, which the company has acquired. It is intended to equip the line electrically. Motorcars are to be started in Swansea to ply to the suburbs. The construction of the British Electric Traction Company's station at St. Helen's was commenced this week, Messrs. Walters and Johns having secured the contract for the structure at about £10,000.

Derby.—The Electric Lighting Committee have decided to employ a local architect to prepare plans and quantities and to carry out the building of the extensions of the station. Mr. W. C. Pinn has been engaged as second assistant engineer in the place of Mr. Black (resigned). Alderman Duesbury has been appointed the chairman of the Tramways Committee for the ensuing year. The borough engineer and electrical engineer have been ordered to report upon the tramways with a view to extensions requiring the authority of Parliament, and the adaptation of the lines to running by electric power.

Hull.—The engineer of the Corporation (Mr. Barnard) has submitted the estimates for the year, showing an expenditure on generation of current of £3,775; on distribution of current, £450; on repairs and maintenance, £1 650; on management expenses, £1 250. The total expenditure was estimated at £14,025. It was estimated that £15,000 would be realised by the sale of electricity, and £570 from meter rents, which would leave a balance of £1 545. The committee had had large demands for which they had not provided in their borrowing powers. The question of supplying the light to Newington is being considered.

Newcastle.—A special meeting of the Tramways Committee of Newcastle Corporation was held on the 27th ult., at which it was agreed to consult Prof. Kennedy with respect to the advisability of adopting some system other than the overhead trolley system of working the tramways in the centre of the town. A deputation was appointed to consult Dr. Kennedy, along with Mr. Charles Hopkinson, and report back to the committee at an early date. Several letters were received from electrical companies offering to supply the power necessary for running the trams. It was agreed, however, that the applications should stand over for the present.

Bermondsey.—The Vestry have proved to the Board of Trade their compliance with the provisions of the Electric Lighting Acts, 1882 and 1888, and the Board of Trade rules in connection with their application for a provisional order to supply electricity in Bermondsey. The Vestry have resolved to petition against the Bill empowering the County of London and Brush Provincial Electric Lighting Company, Limited, to lay trunk mains through the parish for the purpose of connecting systems in surrounding parishes in which they already possess authority, and to purchase some houses in Great Maze Pond for the purpose of erecting a generating station.

Sunderland.—The Council have appointed a special Tramway Committee and invested it with plenary powers, and also sealed a petition to the House of Lords against the Sunderland Tramways Bill. The *Weekly Echo* learns that a big scheme is projected for connecting the towns and villages of the district by tramways. A company has already acquired those of Gateshead, and is negotiating for the trams of Tynemouth. Another company proposes to connect Houghton-le-Spring and Hetton, with the idea of making a connection with Ryhope and Silksworth and with Sunderland, while the latter place is also proposed to be connected with Tyneside by a line which would tap Whitburn, Cleadon, and other places.

Acton.—The District Council, after a long debate, have adopted the following resolution: "That the clerk be instructed to write to the Metropolitan Electric Supply Company, the Hammersmith Vestry, the Ealing District Council, and the London United Tramways Company informing them that the Acton District Council are willing to enter into an agreement with them to take the whole supply of electrical energy required by the district for a period of five years at a uniform rate on condition that they provide and maintain at their own cost all necessary mains from their works to some central spot in the district to be agreed, and all the necessary converting apparatus to give a supply of continuous current at any required pressure."

Nernst Electric Light, Limited.—This Company has been started with a capital of £320.000, divided into 140,000 7 per cent. non-cumulative preference and 180,000 ordinary shares of £1 each, with the object to acquire and work in Australasia, Africa, Asia, South and Central America, and the islands adjacent, of which patent rights have already been granted for Argentine, Cape Colony, Egypt, New South Wales, New Zealand, South Australia, Venezuela, and Victoria, the patent rights of the Nernst electric lamp. The vendor company (Nernst Lamp, Limited) has fixed the purchase price at £270,000, payable as to £65,000 in cash, £25,000 in fully-paid preference shares, and £180,000 by the allotment of the whole of the ordinary shares as fully paid. A subscription for 115,000 preference shares was opened this week.

Wrexham.—At a meeting of the Town Council on the 28th ult., the suggested amendments to the Wrexham District Tramways draft provisional order were considered, and it was decided to waive any claim for rent and annual payment by the promoters of the proposed electric tramways, but to ask for a reduction of the mileage allowed by the Wrexham Tramways Act, 1873, and to suggest that the maximum charge of the company be not more than 1d. per mile, with cheap fares for the labouring classes by certain morning and evening trains. It was distinctly emphasised that the Corporation would consent only on the understanding that the tramway was to be worked by electric power, since the draft order seemed somewhat defective in not referring clearly to application for power to use electricity on the existing tramways.

Manchester.—At a meeting of the City Council on Wednesday the purchase of another piece of land adjacent to the proposed station, at a cost of £2,256, was agreed to, as well as the proceedings of the Tramways Committee recommending that the Corporation were prepared to construct and work by electricity a tramway between Crumpsall and the city boundary, and, subject to the consent of the public authorities, were also willing to construct a continuation of such tramway to Middleton. The committee had also resolved to construct a double line of tramways from Barnes Green to the Middleton boundary. A private company had obtained powers to construct from Middleton down Middleton-road a light railway, which was practically a tramway. It was now sought by them to extend their line. It would be intimated to the Light Railway Commissioners, who were to sit in Manchester on the 7th inst., that the Corporation were prepared to construct these lines.

Kingston.—Mr. Champness, assistant electrical engineer, having received another appointment, Mr. Percy Simpson has been appointed to succeed him. The town clerk has been instructed to inform the Surbiton and Malden Urban District Councils of certain applications recently received for electric current from residents in those respective districts, and to state that the committee would be prepared to consider as to entering into arrangements in regard to the same. Mr. Skewes-Cox, M.P., has replied in regard to the Bills proposed to be brought before Parliament by companies seeking to supply electricity in certain areas that he did not think that such Bills, if passed, would contain provisions under which local authorities would be interfered with, when they were themselves in a *bonâ fide* manner supplying electricity for lighting purposes. The annual report of Mr. Edgcome, the borough electrical engineer, had been issued to the members of the Council, and will be found in another column.

Buxton.—Mr. E. R. Sandford Fawcett, Local Government Board inspector, held an enquiry on the 24th ult. into an application of the Urban District Council for sanction to borrow £25,000 to cover the cost of the new electric lighting works and plant. Prof. Kennedy said all the streets were not included in the scheme. It was a three-wire system, and distributed by trunk mains going to the centre of the town, and there feeding a network of distributing mains. The plant was sufficient for 6 000 8-c.p. lamps. It was suggested that the loan be increased, and the inspector replied that that could only be done by resolution of the Council; they could not go beyond £25,000. Mr. W. R. Bryden, architect, submitted plans of the building. Mr. Grieves, surveyor, said 1,832 square yards was the area to be appropriated, exclusive of land purchased. The railway would be run over the gasworks site. The Urban District Council have resolved to enter into a 12 months' arrangement only with the National Telephone Company.

Islington.—At an ordinary meeting of the Vestry to-day, the consideration of a report from the Works Committee, which is partly disposed of, will be continued. The report recommends that the Vestry consent to the erection of certain overhead wires in existing spans of over 115 yards in length by the National Telephone Company, upon the understanding that the company will be required to remove same, together with the existing wires which have been erected contrary to the by-laws without the permission of the Vestry within the time specified in the Vestry's resolution of Dec. 16, 1898. A resolution will be proposed that the Electric Lighting Committee be instructed to report as to the desirability of extending the electric light to the following roads: Hornsey-road (to parish boundary), Stroud Green-road, Crouch-hill, Blackstock-road, Gillespie-road, Drayton-park, Newington Green-road (to parish boundary in Newington-green), Mildmay-road, Mildmay-park, Balls Pond-road, and to bring up estimates of the respective costs to the Vestry.

Bath.—The Electric Light Committee at its last meeting decided to recommend to the Urban Sanitary Authority that Mr. R. Hammond, the consulting engineer, should retain the responsibility for the work already carried out until he had issued the final certificates, and that he should receive commission upon the sum of £33,892, as agreed. Mr. Metzger advised extensions of cable for public and private lighting, estimated at £6,500. The increased cost of the arc lamps beyond the present price paid for the gas lamps would be £1,000 a year. The report was referred back to the Works Committee to consider whether incandescent lamps could not be used for street-lighting, and whether the Upper Bristol-road should not be included in the extensions. The accounts for 1898, showing a deficit on revenue account of £125, were adopted. The recommendation of the sub-committee on electric trams, referred to in our last issue—viz., that any such system should be initiated and under the control of the Corporation, and that information be obtained from other places—was adopted.

Leeds.—Considerable progress has been made by the Highways Department towards the general establishment of the electric tramways. The single line of rails originally laid down in Harehills-road has now been doubled, and all the necessary poles erected. The poles on the Headingley and Chapeltown routes will probably be all in place within a fortnight. At present pipes are being laid for the feeder wire as well as the telephone wires, which are now to be consigned underground. The work is being carried out under the supervision of the Highways Department, whose officials have done much to ensure its early completion. Mr. E. Talbot, the consulting electrical engineer to the Tramways

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Department, is preparing an estimate of the cost of lighting Boar-lane from the generating station in Whitehall road. At present the electric lights in Boar-lane receive their current from the tramway power station at Crown Point, and are only lit when the electric trams cease running. The Lighting Committee have decided to apply to the Government authorities for power to borrow £150,000 to extend the electric mains in the city, to enlarge the present generating station in Aire-street, and to acquire additional machinery

Windsor.—From a modest beginning made a few years ago the electric lighting company have gradually increased their works and extended their mains, Windsor Castle having recently been connected with the latter. To show the advantages of the electric light for street-lighting, the company originally placed a couple of lights in the public street at their own expense. The result was that they were asked by the Corporation to tender for lighting certain parts of the town. In consequence, the gas company refused to take a contract for part of the town only. On being asked to tender for one year they raised the price and demanded the full amount permissible under the Lighting Acts. The electric lighting company were then asked to tender for the whole of the street-lighting of the town. The tender of the gas company was £1,162 15s. for 11,900 c.p. The electric lighting company offered to erect 228 lights, equivalent to 32,200 c.p., for £1 150 per year. The tender of the electric company has been unanimously adopted, and the company hope to extend their mains throughout the whole of the town in about six months, but the contract allows them nine months to complete the work. The present contract for gas terminates on March 25. In the meantime Windsor will be lighted by oil lamps.

Hull Lighting.—Mr. Law, Local Government Board inspector, has held an enquiry into the application of the City Council for sanction to borrow £16,000 for purposes of electric lighting. The Electrical Engineer said the supply of the light commenced in 1893, and at that time there were 33 customers. There were now 960 customers, and eight miles of mains had been laid in the western portion of the city. The total capacity of the present works was: Dagger-lane, 22,000; Sculcoates-lane, 29,666—total, 51,666. There were, however, equivalent to 69,350 8-c p. lamps connected to the mains, and in addition notice had been received of about 5,800 such lamps now being fitted up. The present plant would be inadequate to meet the demands in the near future unless supplemented by considerable additions. Numerous requests had been, and continually were being, made for an additional supply of current to the area inside the docks; and it was therefore proposed to erect a new sub-station in Osborne-street. It was now proposed to extend the plant at the Sculcoates-lane generating station, and to put down an additional sub-station at Osborne-street, and provisional contracts were now being arranged for plant, buildings, etc. The estimate for machinery was £9,952; mains and connections, £5,108; building, £640; contingencies, £300—total, £16,000. There was no opposition.

Cardiff.—At a meeting of the Tramway Committee of the Corporation on Friday last a letter was read from Mr. J. Barber Glenn, secretary to the Provincial Tramway Company, Limited, regarding the question of doubling the lines in Cowbridge-road, Hayes, Working-street, etc., from which we quote as follows: "With a view to removing any question as to the amount which the Corporation will have to pay for the lines forming the proposed doublings when they are taken over, I am instructed to state that the company will agree to sell these lines to the Corporation at prime cost, less depreciation for the time they have been constructed. Accounts and vouchers can be submitted by the company's engineer (Mr. John Glenn) to the borough engineer, and when he has satisfied himself with their correctness, a certificate can be signed by both these gentlemen stating the length of the lines and the amount which will be due by the Corporation for them, less depreciation on the net amount, to be paid to the company when the lines are taken over can be agreed upon. The company will be quite willing that their engineer shall submit to the borough engineer for his approval a specification of the mode of constructing the lines, and that the work be carried out to the borough engineer's satisfaction. The company will use any section or weight of rail that the Corporation may desire, but the company have about 160 tons of 6in. steel girder rails on hand at Cardiff, and if they are not used the Corporation will have to take them over when the purchase of the undertaking is carried out, unless the company are able to use the rails at some other place, in which case the Corporation will have to pay the cost of transport." The letter, which the Chairman remarked was a very satisfactory one, will be submitted to the Council at the next meeting.

St. George, Hanover-square—At a meeting of the Vestry on March 2 correspondence was considered from the Westminster Electric Supply Corporation asking what attitude the Vestry proposed to take with regard to the Marylebone Vestry Electric Lighting Bill, and calling attention to the fact that the Marylebone Vestry are applying during the present session of Parliament for powers to supply electric energy, not only within the limits of their own parish, but in a portion of that of St. George, Hanover-square. As there are already two companies supplying the parish, the corporation feel called upon to oppose the Bill, and wished to know if the St. George's Vestry would join them, pointing out that as their offer to the Vestry for public lighting comprised 25 arc lamps in Oxford-street, which would be favourably situated for them, as they are in close proximity to their generating station in Davies-street, they would have to modify their terms in the event of electric energy being supplied to them from some other source; also that the costs of standards and lamps in Oxford-street might have to be borne partially, if not wholly, by the Vestry if the electric lighting were undertaken by the Marylebone Vestry, instead of their cost being borne by the corporation. A letter was also read from Mr. Arthur P. Johnson, vestry clerk, Hampstead, stating that that Vestry have had under consideration the Central Electric Supply Company, Limited (powers and works in Marylebone) Bill, in which power is sought for the company to supply certain areas, Hampstead amongst the number, with electricity in bulk, and that they felt a protective clause should be inserted in the Bill to the effect that the company should supply electricity to the companies named in the schedule, and to no other company or person within the area of supply of these companies, and asking whether the St. George's Vestry had considered the matter, and if so, what steps they intended to take thereon.

South Shields.—Colonel Durnford, R.E., has held an enquiry on behalf of the Local Government Board into the application of the Corporation to borrow £20,000 for the extension of the electric light undertaking. Mr. Jeckell, the borough electrical engineer, described the plant that it was proposed to put down. There was no opposition. The electric light undertaking has made rapid strides at South Shields within the last 12 months, as the following figures will show: maximum load Feb. 23, 1898 125 kw.. Feb. 22, 1899 292 kw.; lamps connected Feb. 23, 1898, 5,969, Feb. 22, 1899, 16,514; output at station week ending Feb. 23, 1898, 3,474 units, Feb. 22, 1899. 11,177 units; capacity of plant Feb. 23, 1898, 200 kw., Feb. 22, 1899, 600 kw.; units sold to private consumers quarter ending Dec. 31, 1897, 33,028, Dec. 31. 1898. 79,272, or 140 per cent. increase; month ending Jan. 26 1898, 10,507, Jan. 25, 1899, 28,349, or 169 per cent. increase; month ending Feb. 23, 1898, 8,254, Feb. 22, 1899, 25,870, or 213 per cent. increase. At a recent committee meeting, Mr. Jeckell reported on an application from the authorities of the workhouse, which is 150 yards outside the borough, to be supplied with current. Their annual gas bill is £300. It was resolved that the cables be laid and supply given (with Board of Trade sanction) at same price as is charged in the borough if they will take it for five years. Mr. Jeckell hopes to lay before the committee a large scheme for cable extensions at their next meeting, as it is most desirable to extend these, especially in view of the fact that the gas company have raised their price. A sub-committee have also under consideration the reduction of the price of current from 7d. and 3d. to 7d. and 1½d. and the adoption of some system of free wiring which, in view of the increase in the price of gas, the engineer is very desirous should be brought about as soon as possible. Besides the workhouse there are 2,000 lamps applied for which are not yet connected. An immunity from breakdowns, combined with the comparatively low charges, has been responsible for this rapid development.

Huddersfield.—On Friday last at the meeting of the General Purposes Committee, which comprises the whole of the members of the Council, the report of the borough engineer (Mr. R F. Campbell) on electric tramways construction, equipment, and operation was adopted. The work is to be carried out in such sections as the Tramways Committee may decide, and the Town Clerk has been authorised to make application for the necessary borrowing powers, and take all such steps as may be required for the purpose of carrying out this resolution. The scheme contemplates the adaptation to electric haulage of the entire tramway system of the borough—about 30 miles—and will necessitate the outlay of further capital to the extent of nearly £100,000, but promises, according to the estimate of Mr. Campbell, a very large annual profit. Mr. Campbell estimates the cost of equipping the Lindley, Edgerton, and Outlane section completely, having in view the adoption of the Longroyd Bridge destructor site for a generating station, and allowing £6,000 for 10 double-deck cars with 2-h.p motor trucks, at £30,127, against the borough electrical engineer's estimate of £30,500, without cars, which, at £6 000, would bring the estimate up to £37,500. He estimates the cost of working the section by his scheme at £7,467, and the revenue at £9,000 for a year of 310 days, which would give a surplus profit for the section of £1,533 a year. To equip the whole tramway service he estimates £99,605 would be required. Adding this to the total capital expenditure on the existing tramways, £139,705, it would make the gross capital expenditure £239,310. He estimates the receipts from 45 cars at £4. 10s. a day for 310 days at £62,775, the present receipts with steam traction being £30 870, and the total expenses at £30,000, leaving a profit of £32,755, from which £10,431 would have to be paid for interest and sinking fund, and the net profit at £22,344, after including in the expenses £5,143 for depreciation, £437 for compensation, and £795 for parliamentary charges. Mr. Campbell recommends the overhead trolley system of electric traction, but instead of suspending the wires on poles and brackets he favours the span-wire system, which is open to competitive tendering, free from the patent rights claimed over the bracket system.

Islington.—At the last meeting of the Guardians a report was received from the Highgate-hill Infirmary Committee enclosing reports on electric lighting by Mr. J. Enright, electrical engineer, and from the electricity department of the Islington Vestry. Mr. Enright reported that for the lighting of the infirmary they would require the equivalent of 2,300 16-c.p. lamps. As, however, not more than two-thirds of the 2,300 would be in use at one time, they would have to provide current for 1,700 16-c.p. lamps, for which purpose an engine of 190 b.h.p., with a dynamo of corresponding output, would suffice. As during great part of both night and day only a very small number of lights would be required, it was clearly not economical to run a large engine for so few lamps, therefore it would be well to use a storage battery in connection with a smaller engine. The best plant for the purpose would be

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an engine of 135 b.h.p., with a storage battery of about 1,000 ampere-hours. The estimate of plant is: engine and dynamo. £1,050; engine and dynamo, £1,050; erecting engines, etc., £130; cables, £200; battery, £650; contingencies, £100—total, £3,180. The yearly charges would be: interest on £3,420 at 2¾ per cent., £94. 1s.; depreciation, sinking fund at 3 per cent., £103. 12s.; wages, etc., £160; oil, waste and sundries, £100—total, £456. 13s. Each 16-c.p. lamp will require about 36 units per year, and accordingly 2,500 will acquire a total of 99,000; dividing £456. 13s. by this number 1·21d was got, or slightly less than 1¼d. per unit. There is no allowance for coal in the estimate. He considered ½d. per unit a liberal allowance to make for coal, which brings the total price up to 1¾d. The plant could also be used to run the laundry machines; it would lessen the expenditure by being able to transmit energy by a flexible conductor instead of having to cut away and disfigure walls and ceilings by setting belts and shafting. Ventilating fans and lifts might also be worked electrically. The greater use of the plant would lower the price per unit, since the engine if used for lighting only would stand idle for nearly 18 hours out of the 24. If in public supply electric stations use could be found for the work the engines could do during the 24 hours, electric energy could be had for one-quarter of the present price. The total estimate was £5,920. The Electricity Committee of the Vestry are prepared to supply the light at a uniform charge of 4d. per unit, subject to a two years' agreement. After a long debate the recommendation of the committee for the Board to generate their own electricity was carried.

Light Railways.—The Light Railway Commissioners have held an enquiry into the proposal to construct a light railway from Lincoln to Barton-on-Humber. The scheme for promoting a light railway from Reveeby to Boston, a distance of 12 miles, is being considered by the Sibsey Rural District Council. The Railway Commissioners will recommend the issue of an order for the construction of an electric light railway from Edmonton to the boundary of Enfield. The Board of Trade have confirmed an order authorising the construction of light railways in the county of Essex between Barking Town and the Beckton Gasworks. With regard to the light railway between Craigie Terrace and Broughty Ferry, the Town Council have written to the promoters that unless all the provisions of the agreement were embodied in the order in one form or another the order must be abandoned forthwith, in terms of the undertaking to that effect contained in the agreement. At a recent meeting of the First District Committee of the Inverness County Council a report was submitted by Mr. Robert Black, C.E., road surveyor, upon the proposed light railway between Inverness and Lochend, stating that the proposed light railway would interfere injuriously with the road. The District Committee agreed to refer the report to the Light Railway Commissioners. The Colwyn Bay Urban District Council have carried a resolution to the effect that, having approved of the light railway scheme as now before the Board of Trade, and having entered into an agreement with reference thereto, the Council instructs its legal representative to see the terms of such agreement are carried out, and to generally support the confirmation of the order provided the interests of the Council and of the ratepayers are safeguarded. The Light Railway Commissioners have now sanctioned the Leeds and Bradford tramway scheme, and by agreement a clause is to be inserted in the concession whereby the power to construct and work the line between the Bradford terminus at Thornbury and the Leeds boundary at Stanningley, will be invested in the Bradford Corporation. The total length of the line will be two miles, and it is to consist of a single track with passing places. The London County Council will oppose the Finchley, Hendon, and District, the Hampstead, Finchley, and Edgware, and the Highgate, Finchley, and Wood Green Light Railway Orders. The Parliamentary Committee of the London County Council have had under consideration the proposed Crystal Palace Light Railways Order, under which it is sought to authorise the construction of a series of 10 railways, with a total length of over nine miles, and they have recommended that the scheme should be opposed by the Council. Strenuous opposition will also be offered by local authorities in the districts affected, and numerous letters have been received objecting to the proposal. The Light Railway Commissioners have held an enquiry into the Trent Valley and North Lindsey light railway schemes. With regard to the scheme for constructing a line from Blyton to Frodingham, and known as the Trent Valley scheme, the Commissioners said the order would be submitted to the Board of Trade for sanction. The North Lindsey Railway is intended to serve the districts of Scunthorpe, Roxby, Winterton, Thealby, West Halton, Whitton, Alkborough, and Winteringham. The Earl of Jersey, at the conclusion, said the Commissioners would be glad to recommend to the Board of Trade to sanction the scheme. The Aberdeen authorities are discussing the proposed light railway to Newburgh. The London and South-Western Railway Company have been memorialised to consider the advisability of constructing an extension of proposed West Somerset light railway from Bridgwater to Watchet, and thence, *vid* the West Somerset mineral line, to Exeter.

PROVISIONAL PATENTS, 1899.

FEBRUARY 20.

3735. An improved method of and apparatus for utilising the waste gases and heat from electric furnaces. Wilhelm Borchers, 78, Fleet-street, London. (Complete specification.)

3704. Improvements in and appertaining to electric street tramways. Richard Riley, Thomas Winstanley, and Samuel Riley, 12, Turley-street, Cheetham, Manchester.

3734. Improved process for electric smelting or reducing. Wilhelm Borchers, 78, Fleet-street, London. (Complete specification.)

3736. Improvements in secondary batteries. Joseph Skwirsky, 8, Quality-court, Chancery-lane, London. (Complete specification.)

3742. A combined thermo-electric or electro-thermal lamp. Alfred Charles Brown, 129, Algernon-road, Lewisham-road, London.

3746. An improved electric switch. Walter John Murphy, 19, Holborn-viaduct, London.

3754. An improvement in electrical wall plugs. Philip Frederick William Simon, Herbert Henry Berry, and Charles Rayner, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

3762. Improvements in wireless telegraphy through water. Richard Joseph Crowley and A. C. Oakes, 7, Martin's-lane, Cannon-street, London.

3773. An improved dynamometer for use in laying submarine cables. Walter John Murphy, 19, Holborn-viaduct, London.

3774. Improvements in galvanometers and the like. Lancelot Hall Newton, Robert Rutson Fowler Neville, Sydney Percival Newton, and Edward Tew, 31, King-street, Baker-street, London. (Complete specification.)

3784. Improvements in electric safety appliances. Franklin Hodgkins Badger and William John Plews, 47, Lincoln's-inn-fields, London.

FEBRUARY 21.

3836. A new or improved process for roasting or calcining mineral substances by electrical currents, especially adapted to the manufacture of Portland and like cements. Reginald John Wallis-Jones and Harold William Couzens, 73, St. Stephen's-road, Upton Park, London.

3861. Improvements in telegraph and telephone cables. Théophile Carles, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

3869. Coin controlled and registering telephone apparatus. Robert Dickie Cranston and Sylvester Marcellus Williams, 60, Queen Victoria-street, London. (Complete specification.)

FEBRUARY 22.

3893. Improvements in electrical signalling apparatus. The Anchor Electric Company and Edwin Freund, 39, Victoria street, Westminster, London.

3899. "The Oxford watch lamp," an improvement in electric cycle lamps. John Frederic Pierce, 45, Broad-street, Oxford.

3904. Improvements in telephone exchange switches for use in public central stations, large institutions, police service, and the like. Albert Edward Slater, Imperial-chambers, Albert-street, Derby.

3910. Improvements in starting alternating single-phase electromotors and in apparatus therefor. Rankin Kennedy, 89, Gathorne-terrace, Leeds.

3936. Electric bell for velocipedes. Alexander Bodenheimer, 275B, Holloway road, London.

3943. Improved means for establishing connection between underground electric circuits and electromotors of vehicles. Joseph Henry Betterley, 44, Clapham-road, London.

3947. Improvements in apparatus for applying electric currents of high frequency to telegraphy. Théophile Carles, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

FEBRUARY 23.

3999. Improvements in electric traction for tramcars and the like. John Milnes, 55, Market-street, Manchester.

4001. Improvements in and relating to starting switches and resistances for electric motors. Edward Neville Bray, 81, St. George's-place, Glasgow.

4007. Improvements in electrically-controlled switches. Rookes Evelyn Bell Crompton and Edmund Arthur Norman Pochin, 55, Chancery-lane, London.

4027. Improvements in automatic electric warning signals for railways and the like. Joseph Henry Hollyer, Rashwood House, Droitwich.

4046. Improvements in or connected with electric motors and generators and other electric apparatus and instruments. Valère Alfred Fynn, 55, Chancery-lane, London.

4059. Improvements in incandescent electric lamps. Theophilus Davies Farrall, 322, High Holborn, London.

4065. Improvements in electrical switches. Veritys, Limited, and Louis John Steele, 11, Burlington-chambers, New-street, Birmingham.

4068. A new and useful method of manufacturing electric resistances. Samuel Sydney Bromhead, 171, Queen Victoria-street, London. (W. C. Heraeus, Germany.) (Complete specification.)

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FEBRUARY 24.

4078. A new or improved machine tool, particularly applicable for refacing or turning commutators of electric generators and the like. David Honeywood, Grove Works, Harleyford-road, Vauxhall, London.

4082. Improvements in accumulators and storage cells, portable and stationary. Frederick Homer Stone, 30, Richmond-road, Oxford.

4088. An improved lampholder for incandescent electric lamps. William Lynes, 2, Wilton-road, Sparkhill, Birmingham.

4119. Improvements in the mode and means for operating the poles or masts of electrical cars or vehicles for tramways. Walter Rutherford, 77, Colmore-row, Birmingham. (Complete specification.)

4121. Improvements in miners' safety lamps and in means for electrically igniting the same. William Best, 33, Chancery-lane, London.

4122. Improvements in or connected with induction coils, especially applicable for use in mines. William Best, 33, Chancery-lane, London.

4123. Improvements in electric glow and arc lamps. Sidney George Brown, Van Buren, Poole-road, Bournemouth.

4124. An improvement in electric stoves. Herbert John Dowsing, Birkbeck Bank-chambers, Southampton buildings, Chancery-lane, London.

4158. Improvements in transformers for continuous electric currents. Alfred Wydts and Gustave Weissmann, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Aug. 4, 1898, being date of application in France.)

FEBRUARY 25.

4190. Improvements in electrically-propelled vehicles. Robert Frederick Hall, 24, Temple-row, Birmingham.

4210. Improvements in and connected with electrical traction. William Kingeland, 33, Chancery-lane, London.

4224. An electrical recording instrument. William Humphrey Wheatley, 40, Chancery-lane, London. (H. R. Lockhart and R. O. King, ————.)

4231. Improvements in arc lamps. Walter Claude Johnson and Adolph Wunderlich, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

4232. Improvements in electromotor road vehicles. La Société Geoffroy et Delore, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Aug. 29, 1898, being date of application in France.)

4244. Improvements in or in connection with primary electric batteries. Haydn Thies Harrison, 46, Lincoln's-inn-fields, London.

SPECIFICATIONS PUBLISHED.

1897.

3831.* Electric batteries. Adams. (Amended.)

1898.

2428. Electrical transformer for currents of high potential and variable frequency. Wydts and Rochefort.

3431. Anodes for electrolytic operations. Beach.

3850. Holders for electric glow lamps. Geipel, Lange, and Sattrick.

4588. Method of and means for holding the bases of electrical fittings within boxes or upon other surfaces. Bathurst.

5064. Non-synchronous electric motors. Belfield. (Lamme.)

5177. Dynamo-electric machines. Sayers and Mavor and Coulson, Limited.

6990. Electrical measuring instruments. Weston.

7751. Lifts worked by electricity with hydraulic braking apparatus. La Société Guyenet et de Mocomble. (Date applied for under International Convention, Nov. 12, 1897.)

15496. Electrical time switches. Browne and Martineau.

18754. Electric tramways and railways on the conduit system. Love.

23529. Method and system for generating and distributing electric energy. The British Thomson-Houston Company, Limited. (Green.)

23530. Method and apparatus for generating and distributing electric energy. The British Thomson-Houston Company, Limited. (Green.)

23531. Method and apparatus for generating and distributing electric energy. The British Thomson-Houston Company, Limited. (Green.)

24747. Electric sparking devices, more particularly for igniting devices of motors operated by explosive mixtures. Houpied and Girard. (Date applied for under International Convention, June 13, 1898.)

26153. Telephonic microphone apparatus for electric signalling. Siemens Bros. and Co., Limited. (Siemens und Halske Aktien Gesellschaft.)

26629. Current collectors for electric traction. Penning-Dupuis.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1899.	Corresponding week 1898.	Increase or decrease.	Total receipts for half-year. 1899.	1898.
		£	£	£	£	£
Birmingham Tramway	Feb. 25	3 823	3,333	+ 490	30,028	27 936
Blackpool and Fleetwood Tramroad	,, 25	207	—	—	1,267	—
Bradford City Trams	,, 5	145	—	—	6,733‡	—
Bristol Tramways and Carriage Co.	,, 24	2,589	2,290	+ 299	—	—
City and South London Railway	,, 26	1,102	1,065	+ 37	9 997	9,631
Dover Tramways	,, 25	142	100	+ 42	1,043	848
Dublin U.T., elec. cars	,, 24	956	637†	+ 319	6,557	5,559†
Dublin S.D. Electric Tramways	,, 24	648	350	+ 298	4,786	3,178
Halifax Corporation Tramways	,, 22	324	—	—	9,126*	—
Liverpool Overhead Railway	,, 26	1,280	1,300	− 20	11,624	12,130
South Staffordshire Tramways	,, 25	624	551	+ 73	4,714	4,696

* Since June 29, 1898. † Including horse cars. ‡ Since July, 1898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	23-24 xd
Bournemouth and Poole Electric Supply, Limited, Ord.	10	13-13½
—— 4½ per cent. Cum. Pref	10	10½-11½
British Electric Traction, Limited, Ordinary, Nos. 1-80,000	10	16½-17½
—— 6 p. c. Cm. Pf., 80,001-40,000 (all paid)	10	13½-13¾
—— 5 per cent. Perpetual Debenture Stock	100	125-127
Brush Electrical Engineering, Limited, Ordinary	2	2-2½
—— Non. Cum., 6 per cent. Pref.	2	2½-2⅝ xd
—— 4½ per cent. Debenture Stock	100	110-114 xd
—— 4½ per cent. 2nd Debenture Stock	100	101-104
Callender's Cable Company, Debentures	100	114-117
—— Ordinary	5	12½-13½
Central London Railway, Ordinary	10	9½-10½
——	8	7⅞-8¼
—— Pref. Half-Shares	8	3¾-4
——	5	4¼-4½
Charing Cross and Strand	5	11½-12¾
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	8½-9½
—— 4½ per cent. Debentures	100	114-116
City of London, Ordinary	10	19½-20½
—— ,, 90,001-100,000	10	19-20
—— 6 per cent. Cumulative Pref.	10	15-16
—— 5 per cent. Debenture Stock	100	124-129
City and South London Railway, Consolidated Ordinary	100	71-73
—— Ordinary	3	4⅜-5¼
—— 4 per cent. Debenture Stock	100	135-135
—— 5 per cent. Pref. Shares	10	14½-15½
—— ,, ,, '96	10	14-15
County of London and Brush Prov. Elec. Light Co., Ord.	10	12½-13½
—— ,, ,, No. 80,001-40,000	10	12½-13½
—— 6 per cent. Cum. Pref.	10	14½-15½
Crompton and Co.	3	3⅛-3⅜
—— 5 per cent. Debentures	—	98-101
Crystal Palace District, Ordinary 5 per cent. Stock	100	130-135 xd
—— Preference 5 per cent. Stock	100	140-145 xd
Edison and Swan United Ordinary	3	2¼-2⅜ xd
—— 5 per cent. Debentures	5	4-5 xd
—— 4 per cent. Deb. Stock, Red.	100	98-100
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5½-5⅝
Electric Construction, Limited	2	2½-2⅝
—— 7 per cent. Cumulative Pref.	2	2-2½
—— 4 per cent. Perp. 1st Mort. Deb.	100	103-106
W. T. Henley's Telegraph Works, Ordinary	10	26½-27½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	113-116
House-to-House Company, Ordinary	5	9-10
—— 7 per cent. Preference	5	9½-10½
Imperial Tramways, Limited	6	22½-24½
India Rubber, Gutta Percha, and Telegraph Works	10	22-23 xd
—— 4 per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	13-14 xd
London Electric Supply, Ordinary	3	3½-4
—— 6 per cent. Pref.	5	6½-7
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	104-106
Metropolitan Electric Supply, Limited, Ord., No. 1-62,500	10	16½-17½
—— ,, ,, No. 62,501-85,000	4	13½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-121
National Telephone, Ordinary	5	5⅜-5½ xd
—— 6 per cent. Cum. First Pref.	10	14-16 xd
—— 6 per cent. Cum. Second Pref.	10	14-16 xd
—— 5 per cent. Non. Cum. Third Pref.	5	5½-5⅝ xd
—— 2½ per cent. Deb. Stock, Red.	100	100-102
Notting Hill Electric Lighting Company, Limited	10	16½-17½
Oriental, Limited, 1879	1	1-1⅛
—— £5 Shares	5	7½-7⅝
—— £4½ Shares, New	4½	6½-6⅝
Oriental Telephone and Electric Company	1	⅞-1
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6¾-7¼
Royal Electrical Company of Montreal	·4	180-180
—— 4½ per cent. First Shares Mortgage Debentures	100	107-109
South London Electric Supply, Ordinary	3	3⅛-3⅜
St. James's and Pall Mall, Limited, Ordinary	5	16½-17½
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	40-44
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	100	109-112
Westminster Electric Supply, Ordinary	5	15½-16½ d

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NOTES.

A New Honour.—The latest honour done to the electrical profession in the United States is that of placing a portrait of Prof. S. F. B. Morse on the greenback side of the new two-dollar silver certificates.

"Science Abstracts."—We have received an intimation to the effect that the editorial offices of *Science Abstracts* have been transferred from 66, Victoria-street to 82, Victoria-street (Grosvenor Mansions), S.W.

Signalling to Lightships.—At a recent meeting of the Deal Corporation a resolution was passed in favour of petitioning the Trinity Board to establish permanent connection by means of wireless telegraphy with the lightships on the Goodwin Sands.

Book Received.—Prof. G. Lippmann has published a timely volume entitled "Unités Electriques Absolues" ("Absolute Electric Units"), and the work is based upon lectures to the students at the Sorbonne. It is published by G. Carré et Cie., 3, Rue Racine, Paris, and the price is 10fr.

Ozone.—In a recent issue our contemporary, the *Lancet*, referred favourably to the ozoniser introduced by Mr. Lamprey, and we understand that the apparatus has been tried in other directions than medical. Thus it is claimed that for horticultural purposes it will be found of considerable service, and that many, if not most of the pests of the greenhouse can be easily exterminated by its use.

Electric Motors versus Steam-Engines.—It is stated by the *Electrical World* of New York that the use of electric motors in Philadelphia is already making itself felt. Thus, in the annual report of the Bureau of Engines and Boilers in that city, the chief of the department states that out of a total of 3,579 boilers under the supervision of that bureau, there are 625 which are temporarily out of use, the chief reason being that electric power is gradually being substituted for steam power.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on Monday afternoon, Sir James Crichton-Browne (treasurer and vice-president) presiding. The special thanks of the members were returned to Sir Andrew Noble for his donation of £100 and to Mr. Edward Kraftmeier for his donation of £52. 10s. to the Fund for the Promotion of Experimental Research at Low Temperatures. The Duke of Northumberland was elected president of the Royal Institution in the place of his father.

Automatic Telephony. — The Direct Telephone Exchange Corporation has just issued an illustrated description of its system, which we referred to in our issue of May 6 last. We believe that Mr. A. R. Bennett has reported on the result of a tour of inspection in the United States and elsewhere on this system, and it seems that his conclusion is that although the instruments and switches are doubtless susceptible of some improvement in some of their details, the principle of the system is correct, and has been worked out in a way capable of meeting the everyday requirements and wear and tear of busy exchanges.

Telegraphs to Klondyke.—It is stated that the Dominion Government of Canada has decided to complete a telegraph line to the Yukon goldfields. This should come as bad news to the telegraph company recently promoted in this country, which claims to have the monopoly of all telegraphic connections to the Klondyke district. We think the Edinburgh stockbroker who was able to obtain the ordinary shares of this company for his clients as a special favour will now find that they are rather difficult to dispose of. The Government telegraph line is to be pushed forward at all speed, commencing with the section between Lake Bennett and Dawson City.

Electric Lighting in the East.—We understand from *Indian Engineering* that any detailed scheme that may be submitted to the Mandalay Municipal Committee for lighting the town with electricity will, provided it does not entail increased expenditure for such lighting, be considered by that committee. We also gather from the same source that a concession has been asked for introducing electric lighting into Karachi. The concessionees say that their final report may be expected within a period of two years. All we can say is that if it is to take all that time to elaborate a scheme for electric lighting, we doubt whether the work will be ever done at all.

Gravitation.—There is an ingrained idea in the minds of all modern people, with the exception of a few "dry-as-dusts" who go outside the beaten tracks for information, to take for granted that America was discovered by Columbus and that universal gravitation was discovered by Newton. It is probable that a wiser man than our modern philosopher, he who said "there is nothing new under the sun," is correct also as regards these two assumptions, for it is practically certain that America had been discovered before the time of Columbus, and that Newtonian philosophy had been formulated by earlier writers. But, even if this is so, it does not detract from the value of the work of either Columbus or Newton, for they discovered anew, and gave their discoveries as a commencement of the development of modern progress.

Pacific Cable.—At a meeting of the British Empire League, held on Monday last, with the Duke of Devonshire in the chair, resolutions were passed in favour of a British Pacific cable. The first resolution was to the effect that the council were pleased to note that the Australian Colonies and New Zealand were offering to guarantee an increased proportion of the cost of an all-British cable, and expressed satisfaction that the Dominion of Canada is willing to share the remaining proportion equally with the mother country. The second resolution was as follows: "That in view of the undoubted value of the Pacific cable to the empire, and of its probably profitable result as a commercial enterprise, the council expresses a hope that every effort will be made to overcome any obstacles that may delay the co-operation of the mother country in the undertaking."

Marconi's Lecture.—It was announced at the Institution of Electrical Engineers last week that the Council would try to arrange for this lecture to be repeated, owing to the fact that a very large number of members and friends failed to gain admission to the building. We are now informed by the secretary that Mr. Marconi has kindly promised, at the request of the Council, to repeat his lecture and demonstration on Thursday, March 16, in the theatre of the examination hall on the Victoria-embankment, adjoining Waterloo Bridge. Up to 7.45 p.m. admission will be only by ticket, to be obtained by members on application to the secretary. We notice that ladies are to be admitted to the lecture, and that in the event of the space being too small for those applying, the right to bring a friend may be somewhat restricted. An early application is requested in order that final arrangements may be made.

Is Electricity an Article?—The vexed question of what is electricity has been causing trouble in the Bilston Police Court. The case in which it arose was brought by the factory inspector against the Bilston District Council,

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because the Council had not posted a copy of the Factory Act in the market hall. It seems that a portion of this hall is used for the generation of electric light, and the contention of the prosecution was that the hall was a factory because electricity was manufactured by way of trade for the purpose of gain. This was denied, the defence being that the building was not used for the purpose stated, and that it could not be a factory, because electricity was not an article as defined by the Act. In subsequent arguments the stipendiary was asked to define whether electricity was an article, and he adjourned the hearing for the purpose of obtaining information on the subject. In whatever way the case may be decided, we think the Council is unwise to have defended.

Durban and Electric Traction.—Durban is to be shortly endowed with an electric traction installation. We understand from the *British and South African Export Gazette* that two officials from that busy and progressive centre are at present on a visit to this country and America, studying existing electric traction installations, and their report cannot fail to be of considerable value to the borough authorities of Durban. The commencement of the work is expected to take place in June, and it is intended to take in hand first the important section from the Point to the end of Musgrave-road, the completion of which is expected to be realised within two years from the beginning of the works. The working of the completed installation is expected to realise economies sufficient to justify the reduction of the electric lighting charges. One effect which is expected to result is the reduction of the patronage accorded to the ricksha industry. The "boys," however, may find fresh fields of usefulness in less up-to-date towns than Natal's only seaport.

The Guest Conduit Electric Railway.—A description of a sealed conduit electric railway design, by Mr. J. H. Guest, of New York, appears in a recent issue of the *Electrical Engineer* published in that city. Mr. Guest has aimed at simplicity in construction, but we fancy certain practical points in his system will be difficult to design satisfactorily. Like some of the older English sealed conduit systems, Mr. Guest uses a magnet to make the electrical connections in the sealed conduit. For this purpose an electromagnet is used, which collects the electricity from the iron studs projecting from the non-magnetic cover of the conduit. The magnetic attraction obtained between two adjacent studs, which are only 18in. apart, actuates a switch closing the electric circuits. When the circuit has been made, a series coil of a few turns tends to keep the circuit complete until the car leaves the stud. The details given in our contemporary appear to be taken from a patent specification, and will have to be altered most radically if the system is to be put into practical work.

Power Distribution.—It will be remembered that last year a committee reported in favour of a Bill for power distribution over a very large area. It may be also remembered that this General Power Distributing Company's Bill was hung up last session and carried over until this year. The second reading was set down for Friday last, with the result that there was a majority of 32 against it. We hardly expected the Bill to pass, although the committee's report was in its favour. This was because a number of vested interests were attacked, or seemed to be attacked, and a very general opposition to it arose among those whose sole object at the present time appears to be in favour of indiscriminate municipalisation. Mr. Stuart Wortley (Sheffield) led the opposition to the second reading, while Mr. Davenport (Cheshire, Macclesfield) supported it. A somewhat desultory discussion ended in a motion for the adjournment of the House, and the division lists at first showed an equality of votes for and against. Mr. Gedge (Walsall), however, claimed to be counted in the "No" lobby, so that the vote against adjournment in the end was 150 to 149. The final majority against the Bill in its present form was 32.

Lighthouse Apparatus.—The paper read last week on "Improvements in Dioptric Apparatus for Lighthouses," by Mr. W. T. Douglas, M.I.C.E., and Mr. J. A. Purves, B.Sc., before the Institution of Civil Engineers, will repay careful study by those interested in the important problem of lighthouse signalling. The paper was devoted to a description of the advantages secured in practice by the feux-éclairs, or "lightning lights," introduced by Mr. Bourdelles in 1890, and to an investigation of the financial aspect of improvements effected, from which it appeared that a more efficient and characteristic light was obtained at a greatly reduced cost. The authors raised the interesting question that there was a waste of light when it was allowed to rest on the eye longer than the time necessary. Elaborate experimental investigation had been made, notably by Charpentier, to determine the exact time which an intense ray of light falling on the retina required for full perception. This time was set down at between 0·08 of a second and 0·125 of a second. A mean between these periods was accepted for working purposes, and the French lighthouse service accordingly fixed the standard duration of a flash at one-tenth of a second. In future, therefore, this law would determine the maximum effect of an optical apparatus, and any "wire drawing" of the flash beyond these limits would mean want of economy and a diminution of the efficiency of the light. In both systems it was equally easy to produce group-flashing lights by the simple expedient of breaking up the faces of the panels.

Standard Frequencies.—At the last meeting of the Institution of Electrical Engineers, Prof. J. Perry announced from the chair that the committee appointed to consider the question of uniformity in electrical engineering practice had come to definite conclusions on the vexed question of a standard frequency for alternate-current working. The committee has collected information, and has ascertained the opinions of a number of manufacturers and of consulting engineers on the Continent and in America, as well as in this country. It is unanimous in recommending the adoption, for general purposes, of a frequency of 50 periods per second, as on the whole the best suited to ordinary cases of mixed distribution of alternating-currents for incandescent lamp, arc-lamp, and power supply. For the exceptional purpose of transmission of power on the large scale, it recommends the standard frequency of 25 periods per second. It also suggests for the exceptional cases of house-to-house transformer supply, as preferred in districts where the houses are scattered, a standard frequency of 100 periods per second. We think that the committee would have shown itself more than in touch with the profession generally if it had left out the saving clause allowing a frequency of 100 periods per second in certain districts. The very few cases in which, with a well-organised and well-supported electric lighting undertaking, a house-to-house transformer system is really advantageous, renders it useless, in our opinion, to start a special class to gain a slight efficiency in the transformers. Even then, if motors are to be considered at all, it would be better to adhere to the frequency of 50 complete periods per second.

Motor-Vehicle Design.—Mr. T. H. Parker's paper on "Some New Features in Motor-Vehicle Design," was read before the Liverpool Self-Propelled Traffic Association on the last day of February. As the paper is very incomplete

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unless full illustrations are given, we are unable at present to reproduce more than the following extracts. In the first part of the paper Mr. Parker details the steps by which he has improved the design of some motor-vehicles with which he has been associated. The conclusions, as exemplified in his recent cars, are somewhat as follow: the use of two motors to drive the two hind wheels, each being independently geared; the use of chain gear for the second reduction in the gearing; and the use of shunt motors. Mr. Parker's system of regulation consists in dividing the accumulators up into a number of parallel circuits when starting, and of using the two motors in series across all the cells for the middle speed. At full speed the two motors are connected in parallel. He advises the use of 40 accumulators, so that they can be charged in series on a 110-volt circuit. In the steering gear Mr. Parker arranges to move both the hind and front wheels, so that only a smaller angular displacement with respect to the car body is required. With regard to shunt motors, it must be admitted that on the whole a good braking effort could be obtained by charging the batteries on down grades; but we hardly credit the statement that, "in case of need, it was found possible to bring the car to a stand from full speed ahead in 3ft. on a 10 per cent. gradient without the use of the brake or reversing the motors, which was an impossibility with the series motors." The shunt motor will not act as a brake unless the car is running, and hence could not be used to bring it to a standstill.

A Direct-Connected Electric Pump.—Mr. Carl Eickemeyer has designed an electric pump of somewhat novel form, which is illustrated and described in a recent issue of our New York namesake. In this pump the electric motor is placed underneath the pump cylinders, which are again vertical beneath the valve-chambers. The reduction of speed and the change from a circular to a reciprocating motion is obtained by means of a worm and wheel. A crank on the wheel shaft drives by means of a connecting rod the piston of the pump. To prevent any jar caused by a water-hammer action being transmitted to the mechanism, the inventor has devised relief springs which are carried on the worm shaft. These permit of an axial motion of the worm without disturbing the armature. In fact, the arrangement allows of the gear acting as a rack and wheel gear in cases of sudden load. Automatic electric devices are provided for governing this motor so that it may adjust itself to sudden changes of load. The motor is of the Manchester type, and has a somewhat novel feature in connection with the winding of the field coil. These coils are shunt wound in such a way that the outer portions of the coils are approximately one-half the thickness or horizontal width of the inside portions of the coils. This allows the flattening of the coils on the inside to get the motor as thin as is desirable, and at the same time makes the outside wires of the outer side of the coils effective, which would otherwise be ineffective, in producing magnetic lines of force in the field core. The series regulating coils are made rectangular without bend, and directly magnetise or demagnetise the armature, as the case may be. It seems to us that there is practically little advantage in this method of winding coils, and it is very liable to cause insulation troubles. The theory of the efficacy of the outside wires is quite wrong. The most risky feature in the design of the plant as a whole seems to us to be the placing of the electrical devices directly under the pump cylinders. Any leakage due to faulty glands or covers are likely to cause trouble.

Surging Alternate Currents.—The hunting action which sometimes is set up between two or more alternators working in parallel is exceedingly difficult to explain, and sometimes difficult to prevent. The way a load on such a plant sometimes surges from one side to the other has been the cause of not a few of our central-station breakdowns. Our contemporary the *Electrical World* points out that the disturbance is generally started, and is always seriously affected, by any irregularities in the driving power or engine torque. For this reason it is closely dependent upon the variations of the torque of steam-engines as the crank passes through its double cycle of minimum and maximum effort per rotation. By the beats of the ammeters in the circuits of synchronous machines taking power from steam-driven systems the number of turns of the engines can readily be counted, often even if the latter have two or more cranks, or there are several of them in multiple. Engines, therefore, for driving alternators in parallel must be much more carefully designed than for driving railway generators in parallel. The uniformity of rotation is so important that recent specifications have called for a maximum variation of the angular position from the mean position of absolute uniformity of rotation of a small fraction of 1deg. This requires extremely heavy flywheels. From the fact that the pumping is in time with the engine strokes, many have obtained the idea that it does not exist with turbine-driven plants, but unfortunately it does, and often to a distressing extent. The surging action is also accompanied by changes in the magnetic fields, and hence solid pole-pieces, or pole-pieces containing short-circuited copper bars, as are often used in France, provide one means of checking the great transference of energy from one machine to the other. In the same way an increase in the self-induction of the armature of an alternator tends to make it more liable to set up the current surges. In selecting a machine to be free from this trouble, those possessing good regulating properties should be preferred.

Secret Commissions.—The report of a special committee of the London Chamber of Commerce on "secret commissions" has reached us this week, and we regret to say that we can endorse a large number of the statements contained in it. The committee point out how disastrously these secret commissions affect the welfare of the various industries in the country. They also explain how difficult it is to get evidence which will lead to convictions in such cases. In the report the legal aspect of the question is very well gone into, and a number of cases in which damages have been recovered from givers and receivers of secret commissions are reported in abstract. In the appendix, cases in which the committee have had evidence of direct bribery are given. In one case an electrical and mechanical engineer in the North of England wrote as follows: "I have come in contact with several cases most prejudicial to the healthy development of trade generally, chiefly among the London engineers, who specify for particular makes of articles, and that everything shall be to their approval, in order to be able to press the contractor for money. Then there are consulting engineers of the highest standing and above all suspicion, but in whose offices there are men who, unknown to their employers, receive indirectly or directly commissions, and who levy blackmail on the contractors." We are sure that although the letter was written in good faith, the custom is not at all common amongst London consulting engineers, and also that it is the surest way of procuring the consulting engineer's downfall. In other cases which are quoted later on in the appendix, the question of corporation bribery is touched upon, and here we regret to say we are afraid a true bill must be returned. Even then it is more often a question of

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the representatives of low-class municipalities asking for commission, than that these commissions are offered by the actual manufacturer. We are afraid that the holding of a public meeting will have practically no effect in preventing the secret commissions. Besides, how this prevention can be done without infringing the rights of the individual, it is very difficult to see.

The Cause of Breakdowns.—The overhead line between the Niagara Falls and Buffalo has recently been troubled with a number of short-circuits, which at first were a source of perplexity to those in charge of the line. We learn from the *Electrical World*, of New York, that some enterprising boys have the trouble laid at their door. Thus, last autumn, a guard wire broke, and one end fell over the line wires, making an intermittent cross as it swung in the wind. This started an arc between two parallel wires, with a potential difference of about 11,000 volts, which was blown by the wind for several hundred feet along the line before it broke. It was a pretty exhibition of fireworks, and some boys who saw it wanted to see more. So at convenient times, when no one else was about, they threw miscellaneous pieces of wire, barrel hoops, etc., on the wires and watched the fun. Generally the arcs would break before any great damage was done to the line, but it was hard on the switches and circuit breakers. Three of the young men have been caught, and the line is being closely watched to prevent any more such mischief. At the Niagara Falls end arrangements have been made by which, when the circuit breakers are thrown by a short-circuit on the line, the wires may be connected to a set of lower-potential fuses, on which the short-circuit may be burned off, without danger of establishing an arc that will be maintained across the gap between the line wires. Curiously enough, as the *Electrical World* points out, the worst short-circuit was caused by a large stick of wood, which was thrown upon the wires, and allowed a small current to pass, which, with the high E.M.F., generated enough heat in the wood to carbonise it and start an arc, which burned one line wire in two. The same effect was observed, with less serious consequences, when a small branch from a tree near the line, which was being felled to remove a possible danger in the next gale, flew upon the wires and started an arc, which travelled before the wind about 300ft. along the line. One reason that the cause of the trouble of the past four months was so long hidden is that the comparatively small wires, hoops, etc., that were thrown on the line were nearly, if not quite, destroyed by the current.

Civil Engineers' Students' Dinner.—The Newcastle-on-Tyne Association of Students of the Association of Civil Engineers held their annual dinner on Saturday last, when Mr. J. R. Baterden, the president of the local association, occupied the chair. Mr. W. H. Preece, the president of the parent institution, was one of the guests, and was supported by a number of other prominent civil engineers. Principal Gurney, in proposing the toast of "The Institution of Civil Engineers," referred to the great aid the institution afforded to the professional man. The Civil Engineers was indebted to the work of the allied sciences, and there was practically no discovery made in which some good was not derived by the profession as a whole. Mr. W. H Preece, in reply, referred to the great gratification felt by the parent institution at the prosperity of these local students' associations in different parts of the United Kingdom. The great tendency in engineering at the present day was towards specialisation, and he referred to the value of such an institution as the one to which they belonged, for it afforded a ready means of all branches of their profession to freely intermingle. Moreover, by belonging to it a kind of brotherhood was formed, and facilities provided for securing a readier introduction for strangers abroad. He seriously deprecated the action of trades unions, which he thought were doing the greatest possible harm by destroying the sympathy which ought to exist between employers and employed. Unfortunately, this was not the worst feature of those organisations, for they alienated from workmen that enthusiasm without which success was almost impossible. Mr. Preece then briefly alluded to the great engineering works situated on the Tyne, and to the great improvement in high-speed vessels developed by a Newcastle man, the Hon. C. A. Parsons. He was glad to hear that considerable progress was being made with the new boats of the "Turbinia" class, and that our navy was shortly to receive some of these high-speed torpedo destroyers. Mr. Barker, the engineer to the Cambridge Electric Lighting Company, proposed the toast of "The Local Association." In doing so he spoke as one of its founders, and as its first organising secretary. The Chairman, in reply, said that their association was third among the five branches of the institution, and that it was doing a most successful work in the district.

Physical Society.—We have received from the Physical Society a proof of the first portion of the address delivered by their new president, Prof. Oliver Lodge, on the 10th of last month. In it especial attention is called to the remarkable way in which in modern times the pursuit of science tends in the direction of rapid and immediate application. In Newton's time, remarked Prof. Lodge, pure science was altogether aloof from practice. He did not suppose that the gravitational theory of astronomy had any effect on his Majesty's coins at the Mint, nor did the prismatic sifting of white light lead at that time to any chemical applications of spectrum analysis. Even as late as Faraday's day the induction of currents by motion and magnetism exercised no appreciable effect on commerce and industry. Nowadays, Fourier's theorem is applied by Lord Kelvin to work an Atlantic cable; Hopkinson's researches on the magnetic circuit (an idea that has revolutionised the practical treatment of magnetism) result at once in improvements in the dynamo; and Hertz's experimental detection of Maxwell's waves seems likely to result before long in a new system of wireless telegraphy. Prof. Lodge raised the question as to the cause of this keen interest in the practical application felt in varying degrees by nearly all modern physicists. Amongst these causes he enumerated the example and inspiration of Lord Kelvin, and the improvement in education in recent years. In spite of this improvement, Prof. Lodge considered that the progress in education is lamentably slow, and he pointed out that the teachers are not wholly free from blame in respect to the dislike which many boys feel for the most elementary mathematics, and for problems which may be made exhilarating when properly presented. He also showed that a thorough training in any branch of knowledge stimulated and enlarged the faculties for the intelligent appreciation of many other branches. Prof. Lodge proceeded to detail the progress of experimental science during the past year, and referred first to the developments of Prof. Zeeman's important discovery. Alluding to Prof. G. F. Fitzgerald's prophecy that circularly-polarised light sent through an absorbing medium would constitute a magnet, he remarked that many attempts had been made from Faraday downwards to excite magnetisation by means of light, to detect a real and not an imaginary "magnetisation of a ray of light," but all the experimenters hitherto had failed to realise the necessity of an absorbent medium. The effect was bound to be small, and of course it might not be there

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after all; but Prof. Lodge understood it was being looked for, and had, at any rate, been on rational grounds predicted. The last part of the address dealt with the question of opacity in the most general sense.

Prof. Oliver J. Lodge.—A complimentary dinner was given in Liverpool on Saturday evening to Prof. Oliver J. Lodge, B.Sc., F.R.S., in recognition of his having received the Rumford medal, which is awarded every other year by the Royal Society for the most important discoveries in heat and light. The Lord Mayor of Liverpool was in the chair, and the company included a distinguished gathering of scientific men, including Prof. Sir W. Crookes, Sir John T. Brunner, Bart., M.P., Prof. Rücker, Prof. Fitzgerald, Principal Glazebrook, Prof. Hele Shaw, and Mr. A. Bromley Holmes. After dinner and the usual loyal toasts, the Lord Mayor proposed the health of "Our Guest." He said they were there to do honour to one whom the foremost minds of the country had honoured, and by whom Prof. Lodge was held in the highest esteem and respect. The city of Liverpool was greatly indebted to him for the good work he had done in connection with the Liverpool University College since his appointment in 1881, while those who had come under the guidance and instruction of their guest all testified to his courtesy and kindness and to the clearness and completeness of what he afforded them. But, apart from that, original experimental work had brought great distinction to Prof. Lodge. In conclusion, the Lord Mayor alluded to the necessity of erecting and endowing a physical laboratory at University College, and expressed a hope that before long one worthy of Prof. Lodge would be provided. In reply, Prof. Lodge expressed his gratitude to the Lord Mayor for his speech, the final remarks of which he proceeded to emphasise as to the need of a large physical laboratory. The gathering that night was a remarkable proof of the amount of good feeling and appreciation shown by scientific men for the magnificent act of the Lord Mayor in doing honour to science, for the honour was really done to the Rumford medal of the Royal Society. The chief magistrate of Liverpool recognised in the Royal Society the fountain of all purely scientific honour in this country, and he also recognised the biennial award of the Rumford medal as an event of national—nay, even sometimes of international importance, because it was often given to foreigners, and in this way promoted friendly feeling among the workers in science in different parts of the world. It was undoubtedly a great honour to receive the Rumford medal, and he was astonished when he got the intimation that by some concatenation of circumstances it had been awarded to him. Later in the evening Principal Glazebrook announced that the new physical laboratory should cost from £30,000 to £40,000. He added that he had been promised £10,000 from a gentleman whose name was not to be disclosed, and that Sir John Brunner had just intimated his intention of giving £5,000, while another gentleman present had promised £2,500 provided three others could be found who would each contribute a like amount. So that there is a fair chance of the new laboratory being shortly put in hand.

Institution of Junior Engineers.—At a meeting of this institution held at the Westminster Palace Hotel on Friday last, Mr. Basil Joy presiding, a paper on "Carbon-Consuming Batteries and their Possibilities" was read by Mr. W. R. Cooper, B.Sc., M.A., M.I.J.E. There was a large attendance. The saving which might be effected in the cost of production of electrical energy by the use of a carbon-consuming battery was first discussed. The absolute mean efficiency of a steam plant, generating electrical energy for general supply purposes, might be taken as low as 6 per cent. as deduced from experiments by the late Mr. Willans, whereas the corresponding figure for a battery working under the same conditions was about 73 per cent. Assuming that a Board of Trade unit could be generated and distributed by the combustion of 10lb. of coal, and that the cost per unit was 3·3d. with coal at 20s. per ton, then the efficiency of a battery rendered it possible to effect a saving of 30 per cent. of the cost per unit, provided that coke could be voltaically oxidised to CO_2, and that the electrolyte and the plate opposed to the carbon did not introduce additional expense. The cost of renewing the electrolyte and negative plates, however, might counteract the gain due to efficiency. It was also necessary to remember that the cost per unit depended upon maintenance, and that the price at which electrical energy could be supplied depended upon capital expenditure. For the consumer to derive much benefit from a carbon-consuming battery, a reduction in the capital expenditure as well as in the coal bill must be effected. The author next considered the various difficulties in attempting to solve the problem of the direct production of electricity from carbon; they were due to (1) the insoluble nature of carbon; (2) the scarcity of electrolytes among carbon compounds; (3) the inability of carbon to act as an ion in such organic compounds as are electrolytes; (4) the electro-negative character of carbon. In the place of the oxidation of carbon, that of CO might be attempted; but the possible E.M.F. from such a reaction was lower than that theoretically obtainable from the oxidation of carbon. There was also a difficulty in finding electrolytes in which CO acted as an ion. Suggestions for various forms of carbon-consuming cells were then reviewed. Grove's ordinary gas cell, in which the hydrogen might be replaced by CO, was of no commercial value, because the current obtainable appeared to depend upon the rate of occlusion of the gases by the platinum. The cell brought out by Borchers with a view to the utilisation of CO had not proved successful; the E.M.F. was, in fact, not due to the oxidation of CO, but to the solution of the copper which was used as one of the plates. The problem had been attacked by Reed in a manner which was suggestive, but without much practical result. This investigator aimed at a cell having indestructible electrodes, and an electrolyte by means of which the carbon was oxidised, but which was regenerated by the action of the cell itself. The indirect production of electrical energy from carbon by the use of H_2S and SO_2 was ingenious, but no practical outcome could be obtained by the interaction of two liquids, because true voltaic action does not take place in that way. The utilisation of free carbon, combined with electrolytic solutions, had been attempted by Case and by Coehn. The Jacques cell was an example of one in which in a fused electrolyte was employed. Owing to the many defects which were inherent in this form of cell, its efficiency was low; it also appeared extremely doubtful whether the electrical energy obtained was due to the voltaic consumption of carbon at all. Another cell of the same class was Blumenberg's, in which the same objectionable features were to be found as in the case of the Jacques cell. Some interesting experiments were successfully shown in illustration of the paper, and in the discussion which ensued, Mr. H. B. Varley, Mr. W. B. Clarke, Mr. R. F. Krall, Mr. C. Lean, and Mr. A W. Marshall took part. A vote of thanks having been accorded the author, the proceedings concluded with the announcement of the visit on the 25th inst. to the testing station of the British Fire Prevention Committee. At the meeting on April 14, a paper on "Piles and Pile-Driving" will be read by Mr. H. C. Reid, M.I.J.E., of Chatham.

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CANTERBURY ELECTRIC LIGHT WORKS.

W. W. Mason, Alderman and Deputy Mayor.—The consistent advocacy of Alderman Mason has perhaps been the primary cause of Canterbury getting the electric light. The photograph given herewith was taken when the worthy alderman was mayor.

ALDERMAN W. W. MASON.

In business Alderman Mason is a jeweller and silversmith, but, like many another friend of humanity, he has given of his time and talents for the good of his fellow-citizens. For 15 years he has been a member of the Town Council, and has always taken a keen interest in the progress of electricity, and in face of great opposition has been enabled to gain the realisation of his views in the opening of the central station to-day. Mr. Alderman Mason is the chairman of the Lighting Committee.

The halo of romance around the cathedral city is so strong that it shines conspicuously amongst our ancient cities from the time of the Romans to the present day. Few, however, are conversant enough with its history to know that there is fairly strong evidence to suggest that Canterbury was once a seaport, and situated upon an estuary of the sea. Most people think of Canterbury as the resting-place of Augustin, the home of Thomas à Becket, the site of the shrine to which the pilgrims of Chaucer wended their way. The glories of Canterbury ended when Henry VIII. began its spoliation, which continued in grim earnestness till the Puritans smashed the stained glass, destroyed the sculpture and carving, and turned the cathedral into a stable. Yet it remains a city of ancient churches, a city full of old associations, whose narrow, meandering streets, whose gates and mouldering walls stir the imagination, and rouse a whirlwind of thought, in which cowled monk and armed warrior strive in vain for the mastery. Still more recent sounds of strife are brought within ken when one enters the pillared nave, and learns that among the tattered emblems upon the wall hang the only colours of England that entered Sebastopol, the scene of the final tragedies of our last great European war. Stand—as we have stood—by the side of him who carried these colours, look adown the long vista of history backwards to the time of St. Augustin, think over the glories of our national achievements, our sins, our follies, our losses, and our successes, which must vividly lead to the conclusion that even now we are no unworthy sons of these ancient sires.

Municipal Activity.

In the earlier years of municipal life there was a good deal of the "let be" and "don't worry" views, and we thus find the city dependent for improvements on the public spirit of individuals rather than on the action of the city representatives. "Thus it was two traders of Canterbury who built in 1400 the first private bridge over the river; and in 1485 a mercer from London, William Pratt, constructed the first main drain under the Old Street to carry off the rain-water into the river." It was the "evil report" of the pilgrims in 1474 that led to the roads being "pitched with boulders and Folkestone stone." Even in those days the municipality was a borrower, and various sums were so obtained, generally, however, to fête the king or the queen who happened to be passing through. It is somewhat of a jump from the fifteenth to the nineteenth century, from the time of no bridges, no sewerage, no paving, no public lights, to the present, when neither of these is lacking, and when an earlier is to give place to the latest system of lighting. Lanthorns, candles, oil and gas lamps now give place to the most perfect and most beautiful of all—the electric lamp.

History of the Electric Light.

The electric lighting of Canterbury has taken a long time to come about. The supply of gas and water in this city is in the hands of one company, who 10 years ago promoted a Bill for the further extension of their plant and powers, including power to supply electrical energy. The City Fathers, however, thought that the company was going a bit too far, with the result that the electric lighting powers sought by the gas and water company were refused. Hardly, however, had the Corporation disposed of this application than the Brush Company gave them notice of their intention to apply for a provisional order, with the usual result, that the Town Council got its own order, which received the Royal assent on June 11, 1891. The Brush Company, not to be left out in the cold, immediately began negotiations with the Corporation for a transfer of its powers, and finally an agreement was arrived at, but for some reason which we have not been able to discover the agreement was not signed. The next step was made by an enterprising citizen, Mr. Councillor Lukey, who in remodelling the ancient County Hotel lighted it throughout by electricity, generating the current upon the premises. So satisfactory did the sample appear that the Council took into consideration the advisability of giving the whole of the citizens the opportunity of lighting their houses electrically, and finally, in September, 1895, the Council appointed Mr. Robert Hammond, M.I.C.E, to report on the subject. An Electric Lighting Committee was formed, and Alderman Mason, who from the first has been the enthusiastic friend of the new illuminant, was appointed the chairman. In due course the report made its appearance, and, as may be expected, Mr. Hammond strongly urged the advisability of the Corporation taking up the work of electric lighting, and prognosticated a profitable future for the undertaking in view of the number of low-roofed shops and premises abounding in the old city. In addition, Mr. Hammond urged that a refuse destructor should be erected. In this connection we cull a sentence from his report: "I think there will be an opportunity of utilising in Canterbury what is at the present time a waste and, I might venture to add, a dangerous product. I refer to the city refuse, which has hitherto been dealt with in a laborious and costly way. It is, as you know, at present carted to the sewage-disposal works. On the way it turns one of the fairest lanes in England, much frequented by citizens and neighbours, into a polluted place. At its destination it has been heaped into a mound forming an eyesore to the passing railway travellers. The natural and proper method of disposal of the refuse of dustbins is by cremation, and if the Corporation adopt this method it would be an economical plan to combine the dust-destructor works with those for electric lighting." After a good deal of discussion, Mr. Hammond's report was adopted, and an application made to the Local Government Board for sanction to obtain a loan of £20,000 to carry out the first works.

The opponents of the scheme, however, though temporarily thwarted, organised a very strong opposition to the scheme, with the result that on one pretext or another it was delayed for a whole year, and the Local Government Board enquiry did not occur until May, 1897. It proved a most excited one, the solicitors of the gas company having promoted a memorial against the electric lighting, and the opposition being conducted by Queen's counsel and by leading solicitors in the town. However, all was of no avail, and finally the Local Government Board granted the loan, and Mr. Hammond was allowed to get to work and in due course to issue his specification, which saw the light in November, 1897. The tenders were duly received and the work distributed as follows:

Buildings and foundations—A. J. Brewster, Canterbury.
Boiler-house plant: two 30ft. by 7ft. Lancashire boilers and accessories, mechanical stokers, feed pump, injector, economiser, electric motor, weighing machine, etc.—Robert Taylor and Son, Marsden, Yorks.

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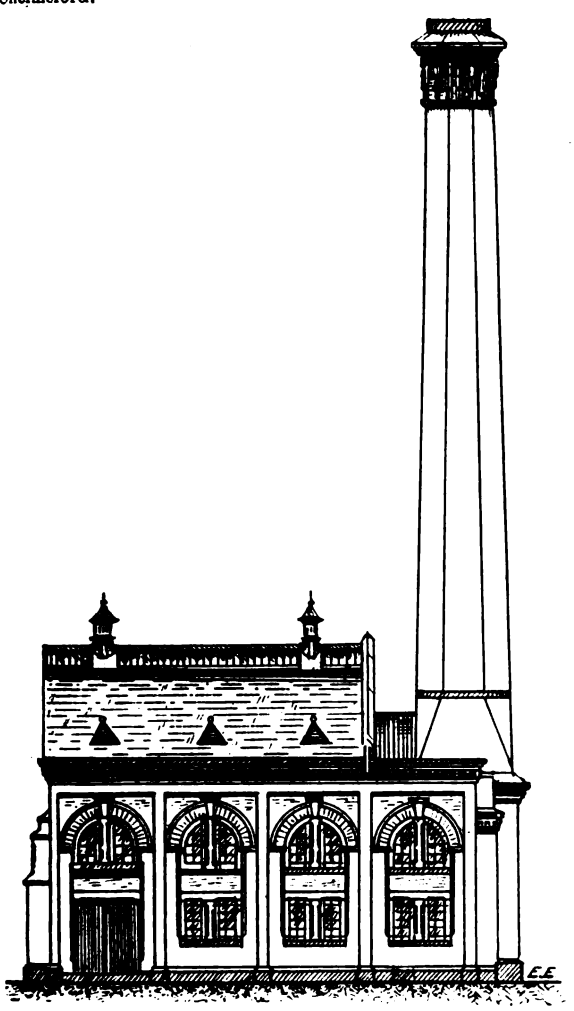
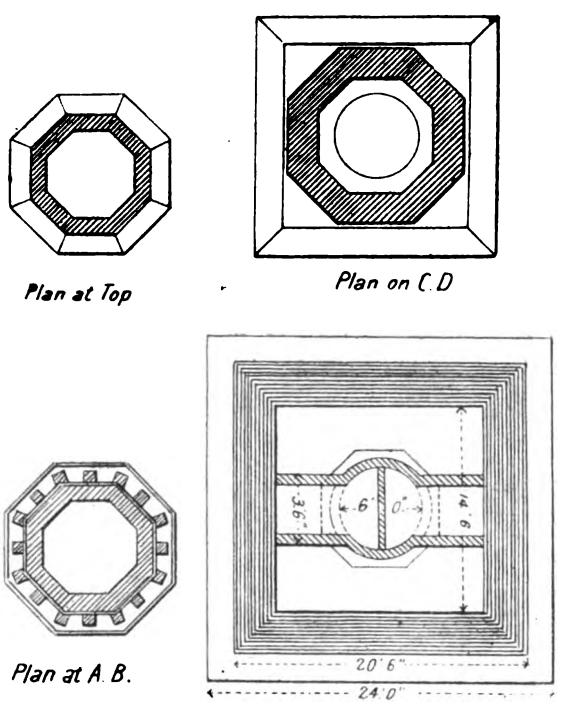
Engine house plant: two high-speed continuous-current 75-kw. steam dynamos and booster, condensing apparatus, pipe work and valves, pumps, suction tank and storage tank, etc.—India Rubber, Gutta Percha, and Telegraph Works Company, Limited.
Overhead travelling crane—James Spencer and Co., Wednesbury.
Switchboards and instruments—Crompton and Co., Limited, Chelmsford.



Canterbury Electricity Works—Front Elevation.

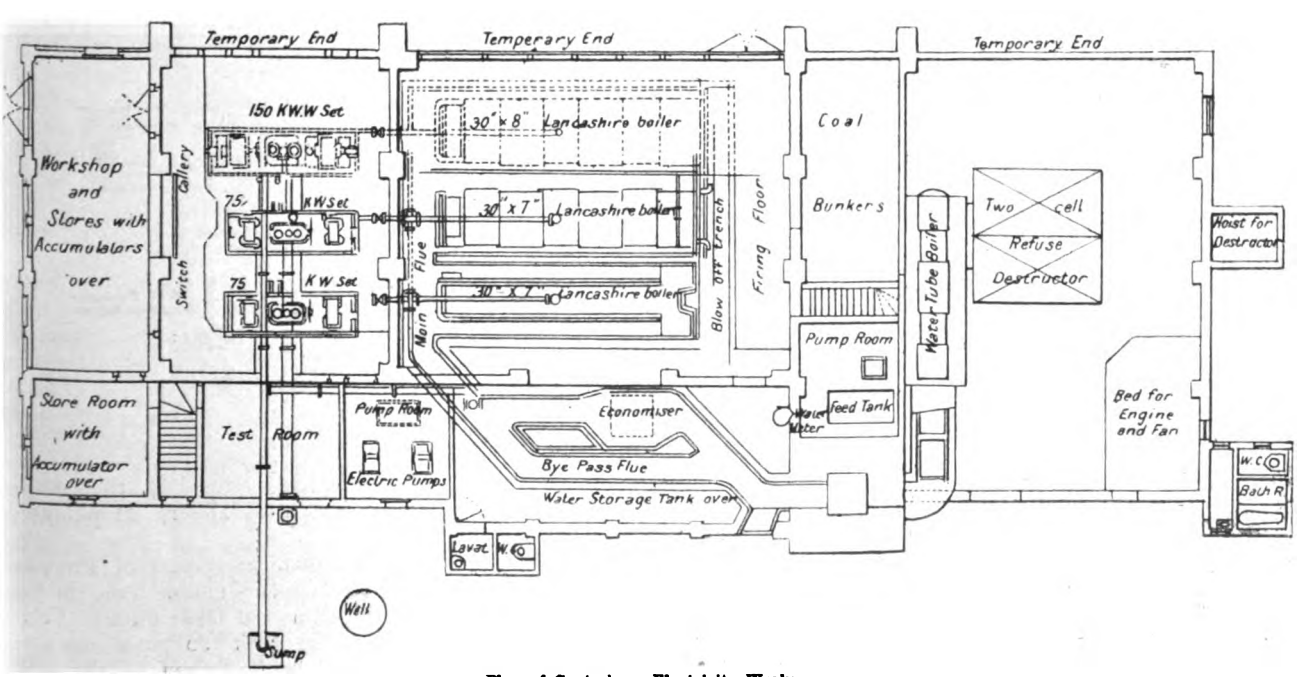
Battery of accumulators—Chloride Electrical Storage Syndicate Limited, Manchester.
Mains: insulated cables and trenching—Western Electric Co.
Public lamps: arc and incandescent lamps, posts, and brackets—Crompton and Co., Chelmsford.
Meters—S Z. de Ferranti, Limited.

feeders being taken from the works to suitable centres in the city. During the course of laying the mains, the Corporation issued a circular to consumers expressing their willingness to carry the supply mains into consumers' premises free, provided that the request for connection was made while the trench in front of the premises was opened. The offer was very freely accepted, and during the laying of the mains 136 premises were connected up, thus putting the works in the magnificent position of starting with over 100 customers on the first night of supply. Indeed, the



Chimney Sections, Canterbury Electricity Works.
C D, 40ft. from ground line. A B, 12ft. from top.

capacity of one of the sets of plant is fully taxed to supply the pioneer customers, with the result that the Corporation have instructed Mr. Hammond to draw up a specification for an extension involving a further expenditure of £12,000, and, in a recent issue of this journal, tenders for the additional plant were invited. A portion of the new work consists in laying mains in the cathedral precincts, and we hope it will not be long before the venerable cathedral will have introduced into it the only light which should be



Plan of Canterbury Electricity Works.

The system adopted was the low-pressure three-wire system, with a voltage between the outers of 440 volts, permitted in these ancient edifices, it being well known that gas has a most deleterious effect upon the stonework,

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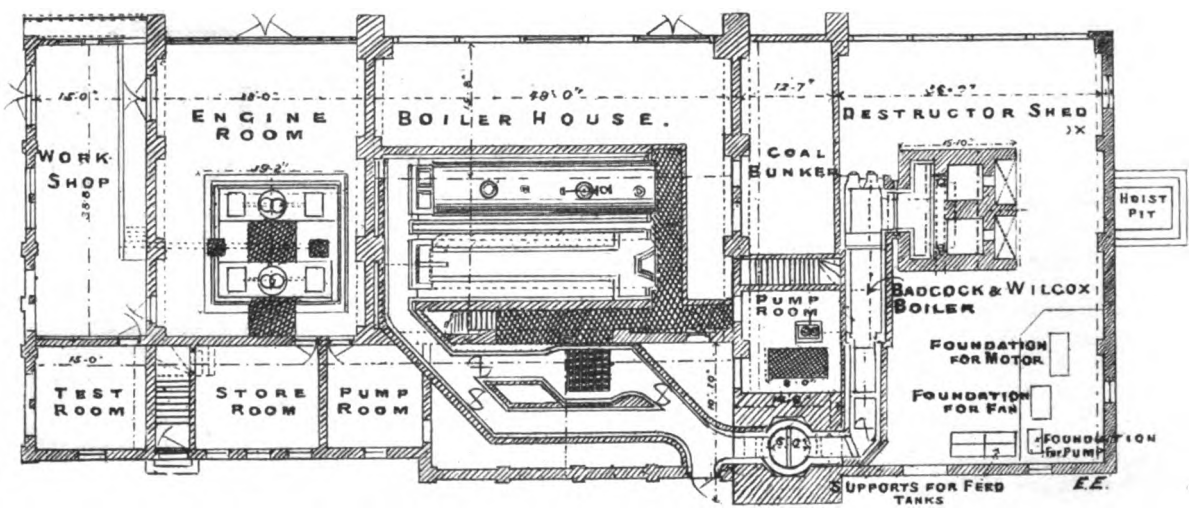
as evidenced by the stone dust which is to be found in all gas-lighted churches.

Site and Buildings.

The buildings are fairly centrally situated in the Northgate district of the city, the site being determined by these considerations: (1) being central for the various points of distribution; (2) suitability of foundation; (3) proximity of water for condensing purposes; (4) proximity to railway stations. The last-named has had to be somewhat sacrificed to the other considerations named. The battle of the sites was, as usual, keenly fought, but ultimately a suitable site about two acres in extent was secured adjacent to the River Stour, central in position, and with excellent road accommodation. On this site it is intended by the Corporation to erect Corporation stables and stores; and on land adjoining, which has been also acquired, dwellings for the Corporation workmen, so that when complete there will be a well-equipped municipal depôt. The buildings are the joint design of the consulting engineer (Mr. Robt. Hammond) and of the city surveyor (Mr. A. H. Campbell), who has been actively associated throughout the whole of the works with Mr. Hammond. They are of substantial fireproof construction, brick walls, and iron roofs, the floorings being constructed of fireproof granolithic composition.

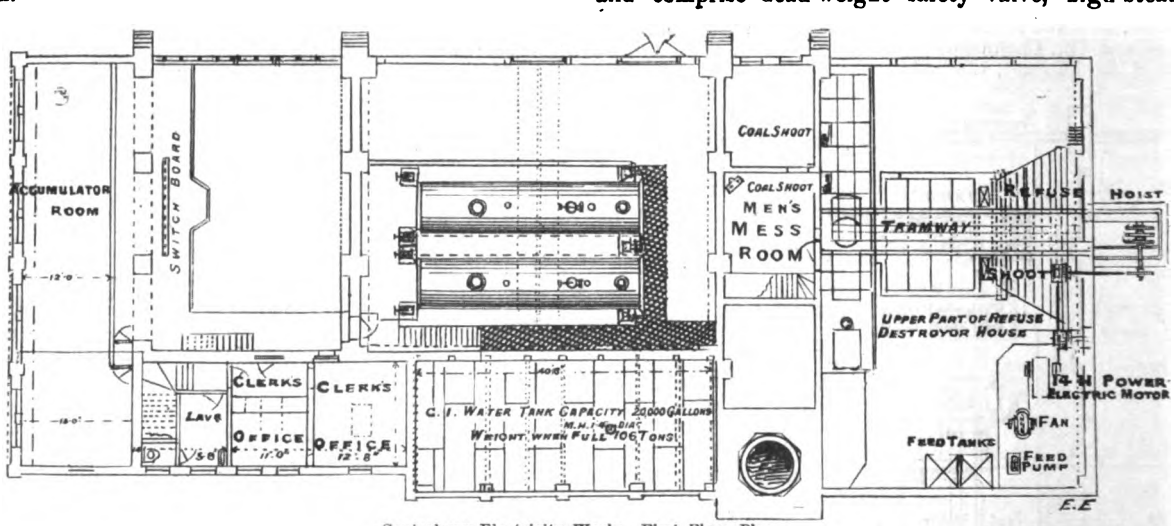


Canterbury Electricity Works—Ground Floor Plan.

buildings as now erected are remarkable for their compact and complete arrangements, those who have inspected the buildings remarking upon their thoroughly convenient plan. The chimney, which forms a feature and is elegant in its lines and proportions, was erected by Mr. G. E. Tournay, of Canterbury. The contract price for the buildings, foundations, and chimney was about £5,000.

Boiler-House Plant.

The steam-raising plant consists of two Lancashire boilers, each 30ft. long by 7ft. diameter, designed for a working pressure of 140lb. per square inch. The bulk of the boiler mountings are by Messrs. Charles Winn and Co., and comprise dead-weight safety valve, high-steam and



Canterbury Electricity Works—First Floor Plan.

In plan, the buildings comprise three main sections—viz., engine-house, boiler-house, and refuse-destructor house—all so designed that extensions of any one or all can be readily effected by simply removing the temporary corrugated iron end and enlarging the buildings as required. Around the engine-house are grouped the workshop, test-room, store-room, and pump-room, whilst overhead these surroundings, and forming an upper floor, are the accumulator-room, offices for engineer and clerks, lavatories, switch gallery, etc. The boiler-house measures 48ft. by 40ft., and is surrounded by the economiser chamber, pump-room, coal-

low-water valve, junction valves, etc., but the water-gauges and blow-off valves are of Messrs. Hopkinson's manufacture.

The furnaces are fed by mechanical stokers of Proctor's manufacture, driven by an electric motor fixed in the economiser chamber. A Cameron feed pump, Sirius injector, and Green's economiser of 96 pipes complete the equipment, the last named being driven by the same motor as the stokers. The whole of the boiler-house plant was supplied by Messrs. Robert Taylor and Sons, of Marsden, Yorks.

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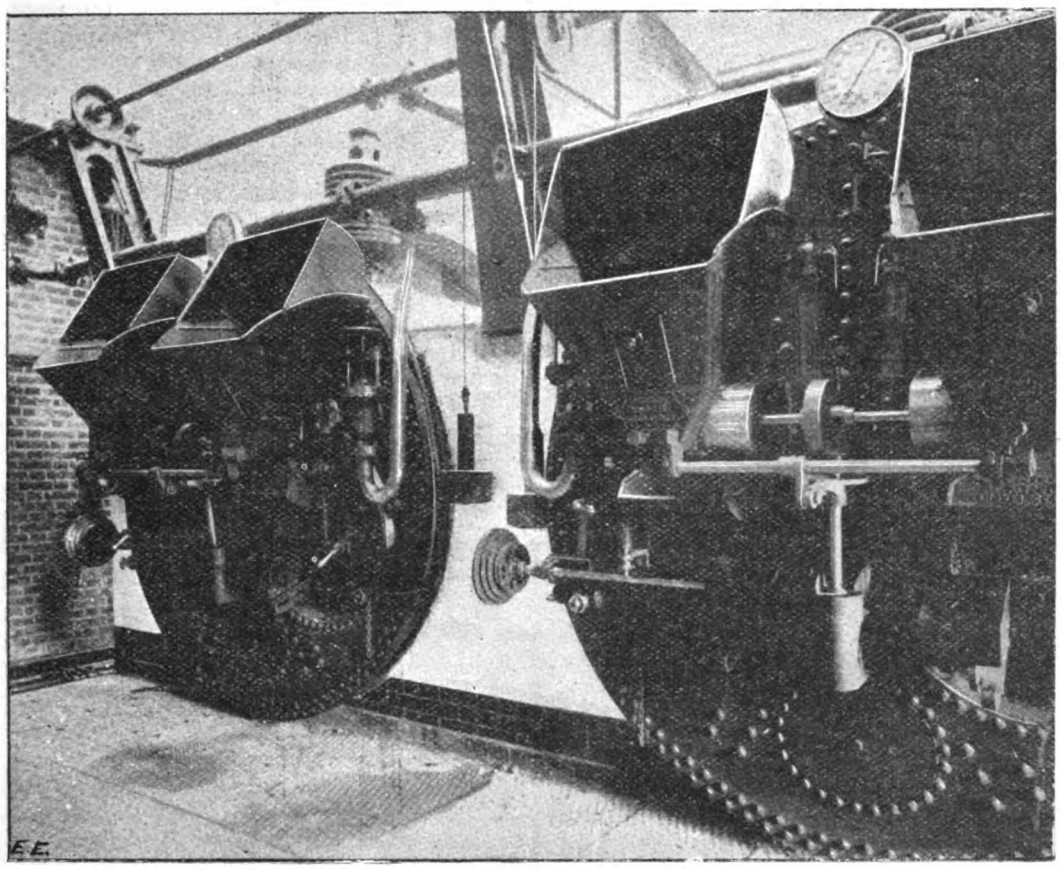
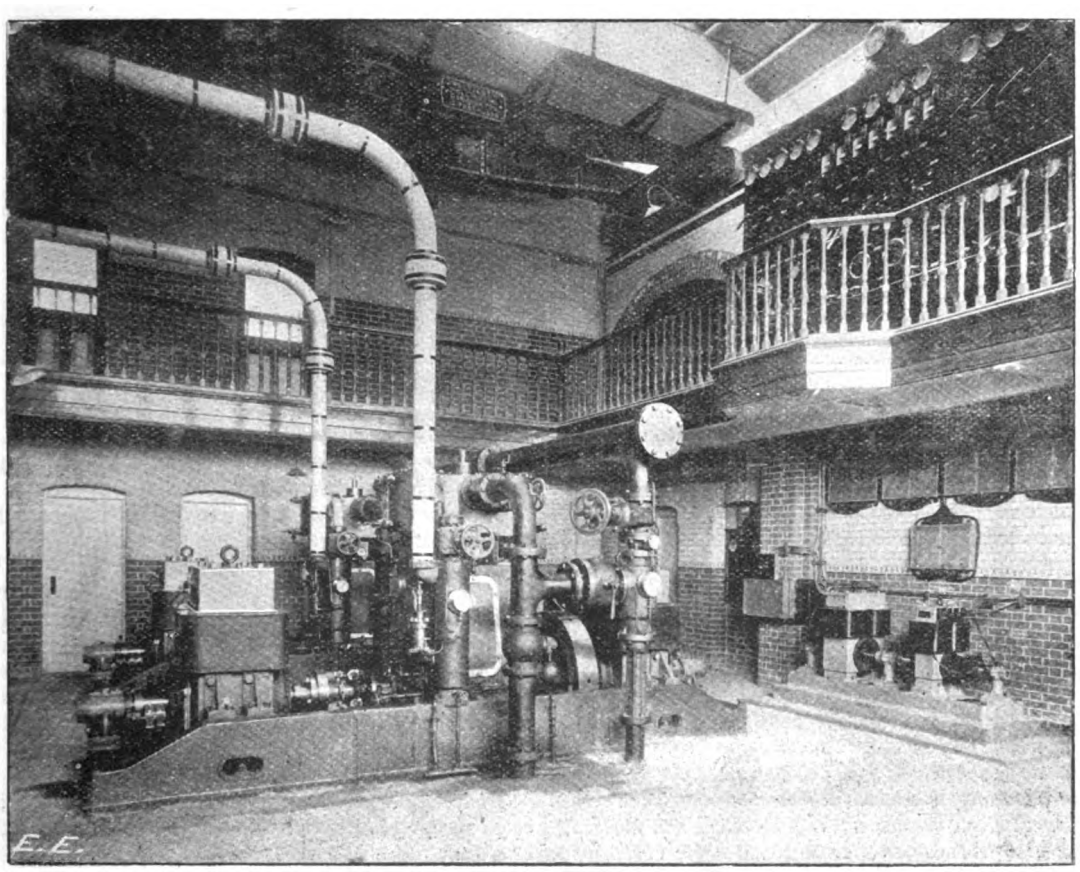
Engine-Room Plant.

The present generating plant consists of two Belliss-Silvertown high-speed direct-current sets, composed of a standard Belliss two-crank compound engine, with two Silvertown single horseshoe undertype dynamos fixed one at each end of the crankshaft. Each plant is capable of giving an output of 75 kw. at a pressure of 220 to 250 volts as an ordinary continuous load, but designed to work up to 84 kw. if required. The working steam pressure will be 125lb. per square inch at the engine stop-valve when condensing, or 140lb. non-condensing. Each set is fitted with a Korting condenser capable of maintaining a vacuum of 26in. when the engines are working at full load. The condenser is fitted with a non-return valve to prevent



View of Boiler-House—Canterbury Electricity Works.



View of Dynamo-Room—Canterbury Electricity Works.

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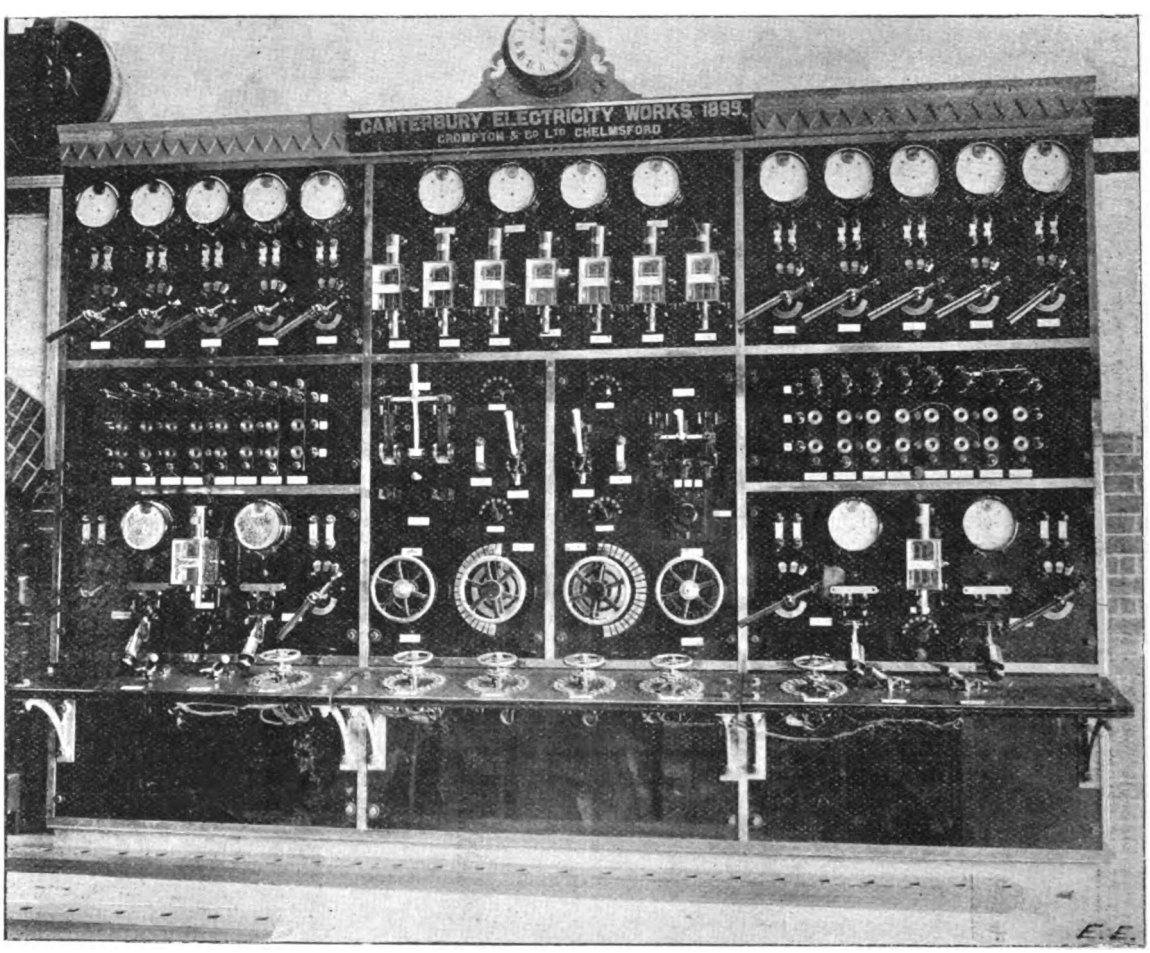
water backing up into the cylinder, and there is also a Blake and Knowles automatic valve fixed on the branch pipe leading to the atmosphere. By an ingenious arrangement of levers, an air-cock on the condenser is interlocked with the water-valve in such fashion that the air-cock must be opened, and the vacuum broken in consequence, as soon as the water-valve is partly closed. By this means the full head of water on the condenser is ensured. The steam range is comprised entirely of lap-welded steel pipes. From each boiler there is a 5in. branch leading into a cast-iron tee-piece, which also forms a drain pocket, being fitted with steam-traps for leading away any water that may condense in the pipes. These tees are connected by a 6in. steel pipe, fitted with a Hopkinson parallel slide valve with outside screws, and from them are led the 4in. steel branches to the engine separators, each branch being furnished with a stop valve, which can be manipulated from the engine-room floor level. The steam after leaving the engines is exhausted either direct into the atmosphere or into the condenser already described. The atmospheric exhaust pipe and the discharge pipe from the condenser are laid side by side under the engines, passing through separate tunnels in the concrete foundations, and are continued thence in straight lines to the outside of the buildings. Here the atmospheric pipe takes an upward turn, rising to a height of 10ft. above the roof, and the discharge pipe terminates in a brick sump, from whence the condensed steam and water are returned to the river. The high and low pressure drain pipes from the engines follow the same course.



Switchboard, Canterbury Electricity Works.

The water for boiler feed and for condensing purposes is pumped from a sump outside the building by means of two electrically-driven centrifugal pumps, each capable of lifting 5,000 gallons per hour, the total lift being about 30ft. The pumps are by Messrs. Evans, of Wolverhampton, and are driven by Silvertown motors. Both pumps deliver into a cast-iron water storage tank of a capacity of 20,000 gallons, a float and index being provided for showing in the engine-room the height of water in the tank. The storage tank is supported on girders over the economiser chamber, for which it serves as the roof. The town's water supply can also be pressed into the service if required, a 3in. connection having been made to the storage tank, with valve outside the pump chamber. The water supply to the condensers is carried overhead across the engine-room, and with the exception of the steam branches this is the only overhead pipe in this part of the works. The feed water is drawn from a small underground tank connected to the larger tank by a 3in. pipe passing through a Kennedy meter. The water-level in the feed tank is kept at a constant level by means of a ball valve. There is a separate connection from the town's water-main to the feed tank. The exhaust steam from the feed pump is utilised to raise the temperature of the feed water, a flat condensing coil being fixed in the feed-water tank for this purpose. The lower end of this coil is connected to the base of the overflow pipe. The condensed steam finds its way through this pipe to the drains, and any vapour that may remain is carried away up the chimney, the overflow pipe being extended vertically with this object in view, and having a branch formed in the side to serve as the overflow from the tank. The feed pump has two deliveries, and from it to the boilers there is a complete double range of feed pipes, one for hot feed and the other for cold. These feed pipes are 3in. cast-iron pipes, and are fitted with Hopkinson valves. The cold feed passes direct from the pump-room to the boiler-house, being connected by a $2\frac{1}{2}$in. copper branch to a check valve on each boiler. The hot feed passes from the pump-room to the economiser and thence returns to the boiler-house, and is there connected by similar copper branches to check valves on each boiler. The injector can also deliver water into either the hot or cold feed range.

In addition to the steam dynamos there is a variable-ratio motor-generator intended for use as a booster when charging the batteries from the omnibus bar. The generator side is designed for a working current of 90 amperes with a variable pressure of from 20 to 100 volts, the motor being driven at a pressure of from 220 to 250 volts.

The whole of the engine-house plant and pipework has

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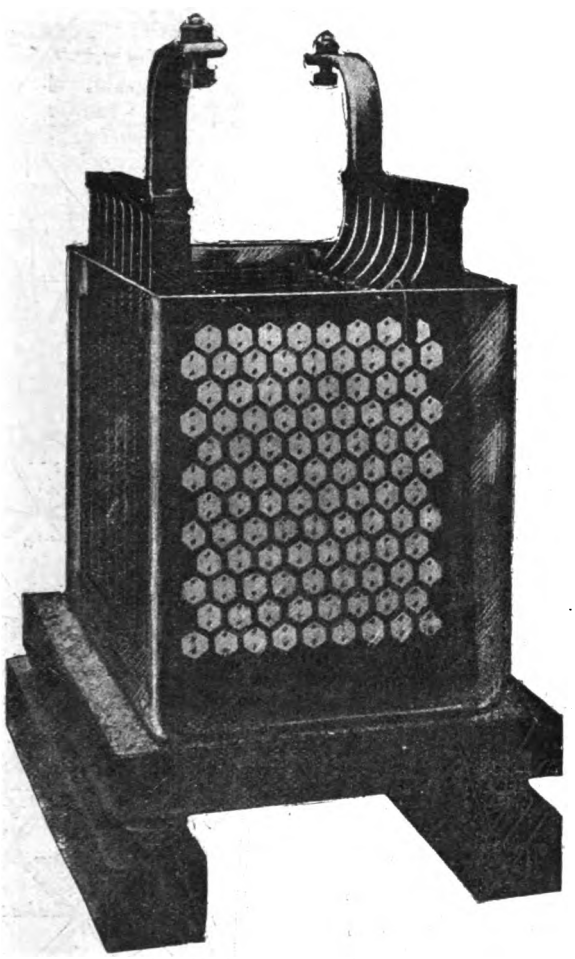
been erected by the India Rubber Company. An overhead travelling crane capable of lifting up to 10 tons (made by James Spencer and Co., of Wednesbury) spans the engine-house.

Switch Gear.

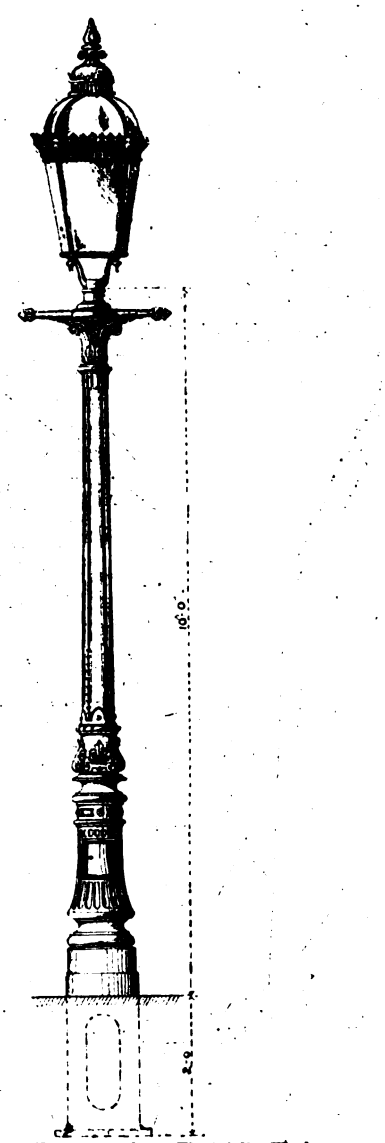
The whole of the work in connection with the switchboard and regulating gear has been carried out by Messrs. Crompton and Co., London and Chelmsford, to the engineer's specification and requirements. The board is divided into three sections—the positive on the right, the battery and middle wire in the centre, and the negative on the left. It is arranged for dealing with the four dynamos, arranged two on either side of the three-wire system, two batteries of accumulators, with arrangements for charging the inner cells by the motor-transformer, also for five feeder mains, with the necessary instruments and plug bars. The side sections are divided horizontally into three panels, devoted to dynamos, plug bars, and feeder circuits respectively, reckoning from the bottom panel. In circuit with each dynamo is placed an ammeter, and a combined duplex switch and fuse, the switch being arranged with a special sparking piece in order that its main contacts may not suffer damage should there be any current passing when the switch



Chloride Company's "R" Type Cell.

is operated. There is also an adjustable minimum cut-out of the well-known Crompton type. There is a common voltmeter in the centre of the panel for the two dynamos. The centre slate contains the plug bars, which are of massive construction, and are so arranged that either dynamo or battery may be connected on to any one of the five feeders or on to the works circuit. The top panel contains the five duplex switches and fuses and ammeters for the feeders. The negative side of the board is exactly similar to the positive side described above. A sloping slate shelf at a convenient height runs the entire length of the board, and on it are mounted the shunt-breaking switches and also the regulating switches for the dynamos. The two centre switches are in circuit with the motor-generator, the starting switch for this being placed on the wall of the engine-room close to the motor-generator itself.

The centre section, as stated above, contains the battery gear, which consists of a charging switch, the contacts of this being on the board, and a 30-way discharge switch. The handle and indicator only for the latter are on the board, the switch itself being bolted to the battery-room wall, and operated from the front of the board by a long spindle. This arrangement saves a large number of cables being carried across the space at the back of the board, and consequently the connections at the back of the board are very much simplified. The double-pole switch shown on the right-hand panel is for the dynamo of the motor-transformer, and the double-pole throw-over switch on the left-hand panel is for throwing the motor side of the transformer on to the other side of the circuit for balancing purposes. The two single-pole switches shown on either panel are emergency switches in the battery circuit. The top panel contains the voltmeters for reading the pilot, omnibus, feeder, battery, and motor-transformer volts, the switches



Arc Lamp Pillar, Canterbury Electricity Works.

for these voltmeters being placed within easy reach on the lower panels. At the top of the board are placed the two battery ammeters, the middle wire, and also the ammeter for reading the charging current of the motor-transformer. All ammeters on the board are of the shunted type (manufactured by Crompton and Co.), the shunts being placed at the back of the board, the voltmeters being of the well-known Kelvin type, manufactured by Messrs. Jas. White. The whole board is contained in a wrought-iron frame, the slates being held in position by bolts passing through ebonite bushes. A neat brass strip is screwed on to the front of the framework in order to hide the joints. The accompanying illustration gives an excellent view of the board and gear.

Accumulators.

The accumulators were supplied by the Chloride Electrical Storage Syndicate, Limited, the cells being the well-known "R" type, now used so extensively in electricity supply

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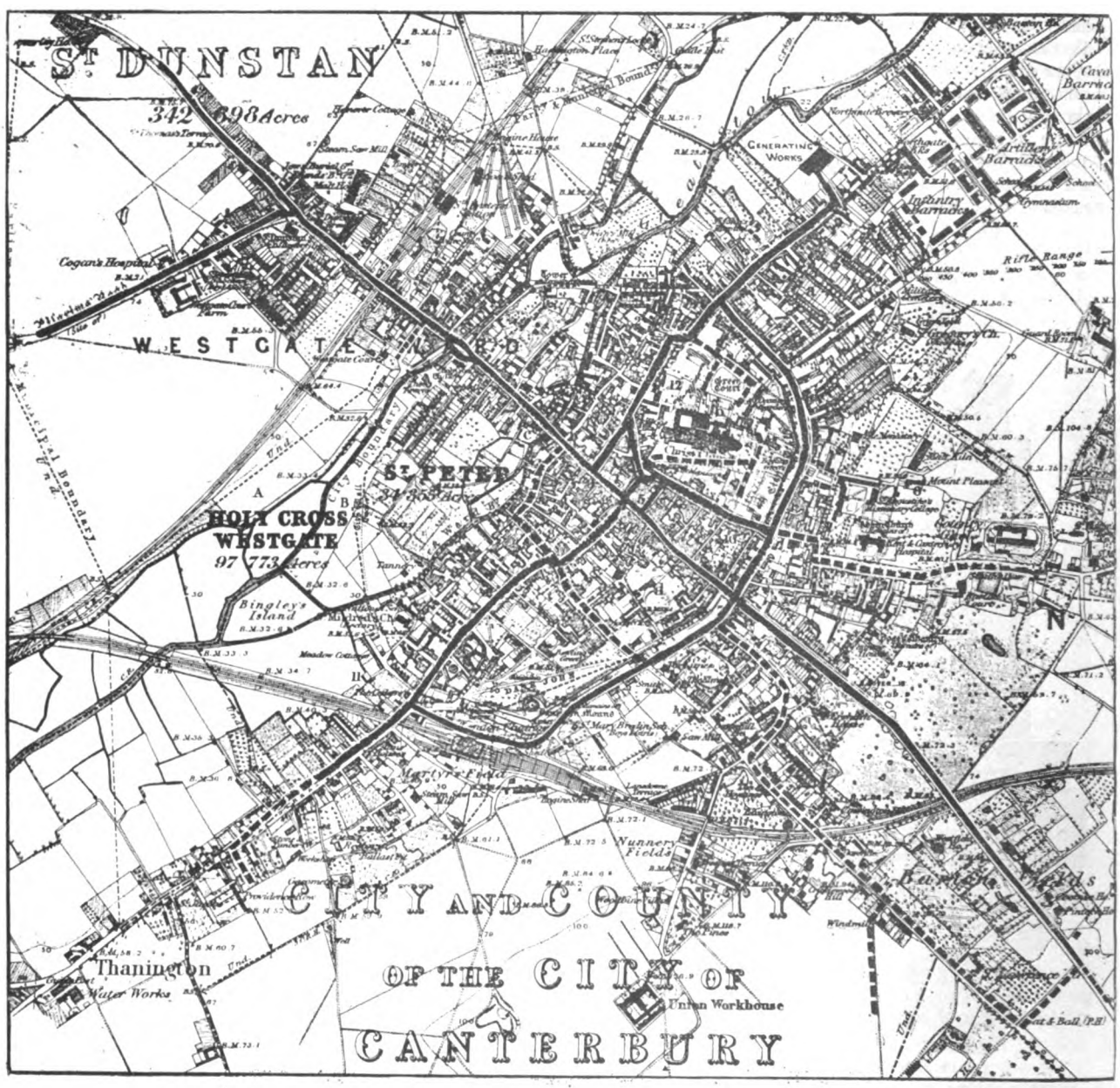
stations. They are constructed upon a combination of mechanical and chemical principles, combining the advantages of the Planté and Faure types of plates; lightness, durability, large capacity, and high rate of discharge, being special feature. The complete battery consists of 280 cells in glass boxes, having a capacity of 630 ampere-hours, and is capable of maintaining a discharge continuously for 10 hours with a terminal E.M.F. of 500 volts. It is, however, only intended to charge 240 cells at the start, the remainder being held in reserve and for spares, and added as required. The cells rest on wooden trays supported on glass insulators, and are suitably arranged on stands for easy inspection. The stands are of pitch pine, and all



MAP OF MAINS — EXISTING MAINS ——— EXTENSIONS IN HAND - - - - -

factured at their North Woolwich factory. They are of the triple-concentric lead-covered and armoured type laid direct in the ground. The middle or neutral wire of the system is placed on the outer of the cable. The insulation between the inner and outer conductors is composed of paper and jute, the remaining insulation of jute only, the whole being impregnated with their insulating compound and covered with lead $\frac{1}{8}$in. thick. The lead-covered cable is then served with hessian tapes and armoured with two steel ribbons, each ·040in. thick, laid on spirally so as to break joint, and finally served again with two hessian tapes. The distributing network, consisting of ·125 square inch and ·1 square inch triple-concentric cables, is so arranged

horizontal parts are protected from acid sprays by sheet lead bent along the edges in the form of an inverted "U." The connections from the cells to the switchboard are made with lead-covered cable. The battery is charged direct from the omnibus bars, a somewhat novel feature of the arrangement being the position of the regulator cells, which are not fixed on the extremities, as is usual, but in the centre of the battery on either side of the middle wire. The object of this arrangement is to enable all the regulator cells to be charged by one booster at the same time that the main battery is being charged.

Underground Mains.

This important part of the work has been carried out by the Western Electric Company, the cables being manu-

that it embraces the whole of the principal streets, making a total length of 5½ miles. This network is fed at five points by triple-concentric feeder cables, brought direct from the works to specially-designed boxes, together with the necessary pilot wires. Wherever possible, the pilot wires have been made up, forming six-core and nine-core cable. Disconnecting boxes of the three-way and two-way type have been fixed at various points in brick pits, so that any section or sections can be fed from any of the five feeder cables if necessary. The house connections are made to the mains by means of the Western Electric Company's house service box of the split type, filled solid with insulating compound, and the end of the service cable is finished off in a newly-designed single-pole fuse-box. The same company undertook the

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connection of consumers' wires to mains, the fixing of meters, and the connection of cables in the works to meter-board and switchboard.

Public Lamps.

Some may cavil at the introduction into the ancient streets of Canterbury of such modern articles as arc lamps, but at present they are used sparingly, there being only a dozen fixed in the most prominent situations. The committee, however, have adopted the extremely good principle of substituting electric incandescent lamps for gas lamps on the whole course of the mains. With regard to the arc lamps, there are altogether 13 of them to be erected, nine being in series, and running on the outer conductors, the adjustable resistance and switch gear of this series being placed in the lighting station. The remaining four lamps are run off one side of the system only, the switchboard being placed in the police station. The lamps are of the well-known Crompton-Pochin type, burning 17 hours and taking 10 amperes. The pillars are manufactured by Messrs. James Allen, sen., and Son, of Glasgow, and have two brackets for incandescent lamps on them, which will be switched on when the arcs are extinguished. The existing gas lamps will be replaced by 16-c.p. lamps, mounted in Fredereau lenses, supplied by Messrs. A. and E. Cohen. The incandescent lamp pillars are of handsome design, the present number on order being 170. Several of the side streets will be lighted by lenses attached to brackets. The exact design of these, however, has not been settled upon. The incandescent lighting will be switched on from six centres, the switches and fuses being placed in ornamental cast-iron switch pillars. Half the pillars are being cast by Messrs. James Allen and Sons, and the other half by Messrs. MacKenzie Bros., of Edinburgh. The whole of the street-lighting work has been carried out by Messrs. Crompton and Co.

The price fixed by the Corporation for the supply of current is: for private lighting, 6d. per unit; and for power and heat, 3d. per unit.

The great success that has attended the pioneer lighting is, we trust, an augury of the continued success of the undertaking, which certainly starts under better auspices than any other municipal undertaking of its size in the kingdom.

Extensions.

The specification already referred to was issued a fortnight ago, and embraced the following plant: one Lancashire boiler, 30ft. by 8ft., combined with mechanical stokers, etc.; one high-speed 150-kw. steam dynamo and accessories; necessary steam, exhaust, water pipes, etc.; condenser, centrifugal pump, motor, and switch gear; addition to switchboard; addition to mains. Had the scheme not been so bitterly opposed in its early stages the City Council would no doubt have been emboldened to put in rather larger plant than that to which they had limited Mr. Hammond, a fact which they now deplore, as there would have been a saving of money as well as space had the more generous plan been adopted. Representatives of other local authorities should take a lesson.

THE CITY OF LONDON ELECTRIC LIGHTING COMPANY'S WORKS AT BANKSIDE.

(Continued from page 265.)

The two largest alternators of the station were supplied by Messrs. Ferranti, Limited, and their general arrangement is indicated in Fig. 6. Each alternator is capable of giving a nominal output of 1,500 kw., but the makers inform us that on emergencies 2,000 kw. may safely be taken from the machine. The engines driving the alternators are also of Ferranti make, and run at 150 revolutions per minute. They are vertical compound engines with the high-pressure line of cylinders arranged on one side of the flywheel, and the low-pressure on the other. The view in Fig. 6 is taken from the high-pressure side. In this engine great attention has been paid to steam economy, but we were unable to obtain exact figures at the time of our visit. A complete system of forced lubrication is used to convey oil to all parts of the engine. Of the alternator itself there is little new to be added. Except in point of size, the machine is similar to a large number of others now working in different parts of the United Kingdom. These sets are the largest at present working in this country, and are also, we believe, larger than any machines used for electric lighting only in America. The way in which the switch gear works was described in our previous number, but we are now able to give illustrations of the switchboards. Thus Fig. 7 represents the machine side of one of the main Ferranti switchboards. On this board every machine in the half of the station controlled by it has its own individual line of fuses, main and synchronising switch, ammeter, and synchronising connections. The two middle lines in each board provide inter-connection between the north and south switchboards. Besides this method of inter-connection, the two 1,500-kw. alternators have panels on each board, so that they can aid either half of the station without having the whole machinery in parallel. The omnibus bar seen at the top of the switchboard is continued round the rectangle of masonry, into which the slate supporting the switch gear is built. On the opposite side of this masonry is placed the feeder board, on which connections from the omnibus bar to the individual feeders are made. The vertical lines of instruments on that side are practically the same as on the alternator switchboard, except that no synchronising arrangements are wanted. The arrangement is an exceedingly neat and convenient one, and the system of locking up the switch gear of any one feeder in the off position gives a ready means of protecting the workmen when repairs have to be made. The small space taken by this switch gear is especially noticeable. In fact, the exciting switchboard and board for varying the excitation of the alternators, seen in Fig. 8, take up actually more space than the switchboards used to control the main high-tension currents. A provision is made on each of the feeder boards for 24 feeders, and as there are only 22 sub-stations in the City, this allows for a duplicate feeder to practically every station. The arrangements on the exciter board and field regulating board do not call for special mention. A number of instruments in use are those originally provided for the purpose, but in other cases new and improved arrangements have been erected on the fireproof framework supporting the gear.

The condensing plant now installed is not sufficient to work the whole of the station, but at light loads the engines in use can all be supplied with condensing water. The plant for this purpose is placed on the ground floor of the building, facing the River Thames. A view of this pumping station is shown in Fig. 9. There are in this two steam-driven centrifugal pumps, such as is seen on the right hand of the illustration, each capable of supplying condensed water to between 10,000 h.p. and 12,000 h.p. The smaller electrically-driven pump for light-load working is seen on the left hand of the illustration. Two motors are used, in order that the pump can be worked economically at widely varying loads. The condensing water is drawn by the centrifugal pumps from the Thames, for which purpose two suction pipes are provided. The height of lift varies, of course, with the tide, and at low tide the mercury gauge frequently indicates 26in. The water is delivered from the Thames into a novel form of strainer, which has been found to be absolutely necessary in order that the thick Thames water may not choke the tubes of the surface condensers. This consists of a large cylinder, inside which a wheel with projecting radial arms revolves. These arms are machined to make a fairly tight joint with the inside of the case. This case is divided up into two segmental divisions extending, roughly, over, say, 120deg. The remaining 60deg. separates one compartment from the other. The space between the radial arms of the revolving wheel contain in the recess a filter gauge. The water from the river is then passed through one of the 120deg. segments, and in its passage any particles likely to obstruct the condensers are caught on the gauze. The delivery from the condensers returns through the other broad segment, going, of course, in an opposite direction. As the wheel is revolved, the *débris* collected on the face of the gauze is carried round from the suction

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to the delivery side, and the water so returning removes and carries with it all the matter so caught. In this way the filter is kept clean. The power required to drive the separator is obtained from a small electric motor by reduction gearing. The main delivery and discharge pipes of the condensers are 26in., and a second set of pipes of the same size are now in position, and will be connected up shortly. As regards the power required to circulate this condensed

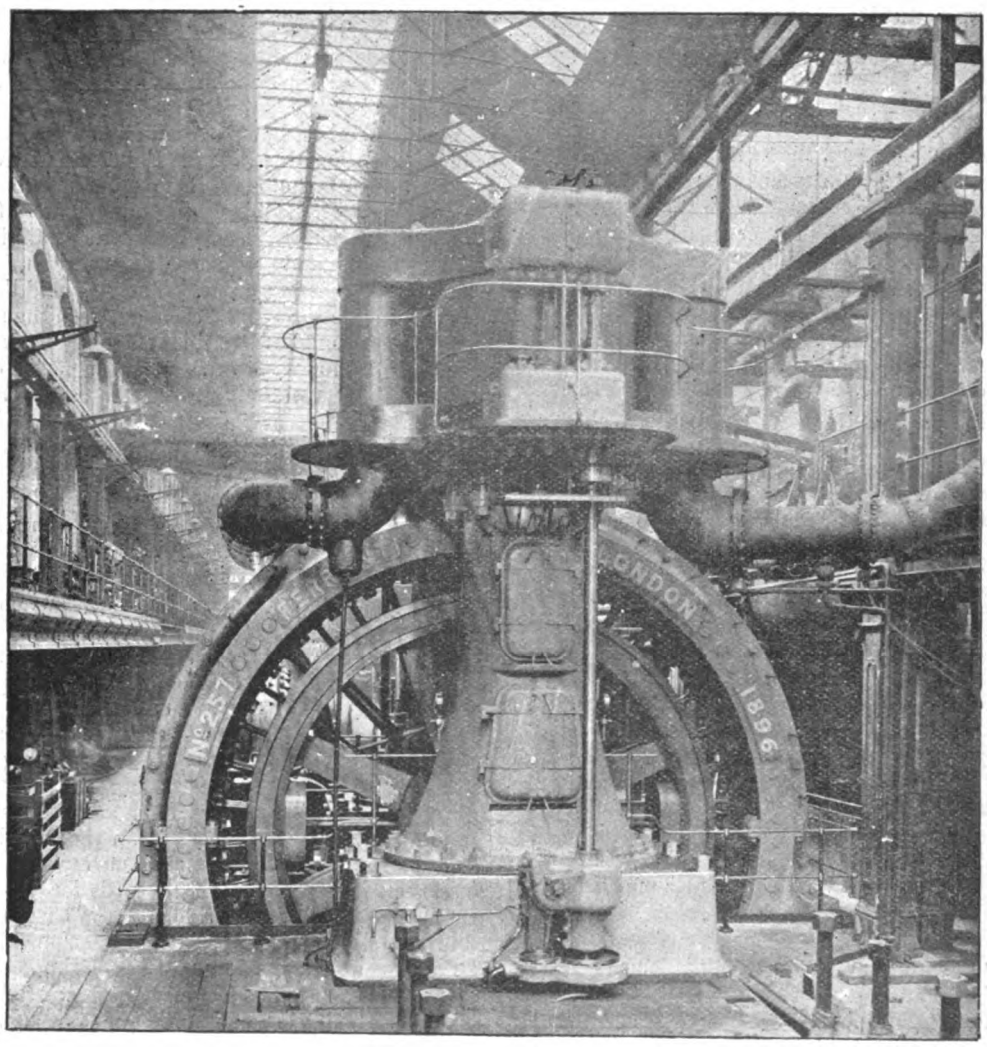

FIG. 6.—One of the Ferranti 1,500-kw. Steam Alternators, as placed in position at Bankside.

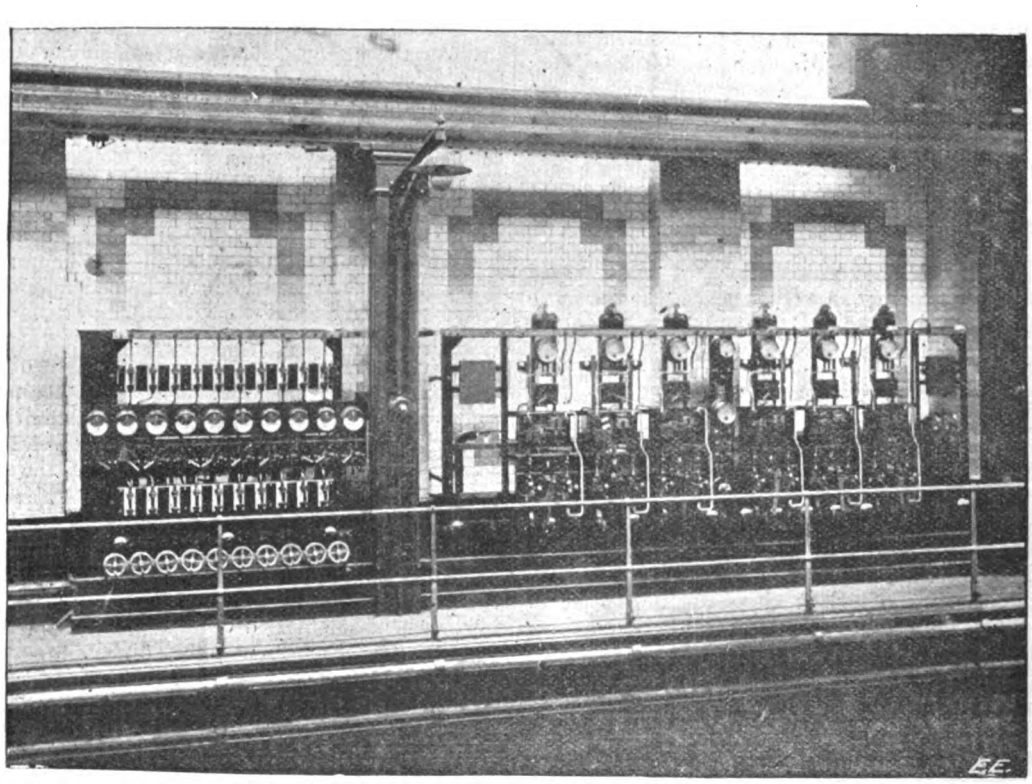

FIG. 8.—An Exciter Switchboard and Switchboards for Regulating the Alternator Exciting Circuits.

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water, it must be remembered that the whole system acts as a siphon. Trouble occurred at first at low tides, owing to the air getting into the upper part of the siphon. This difficulty has been overcome by making a connection from this point to the air-pumps, which can be regulated by hand at times when the water in the Thames is very low. Independent condensers are used for the engines, and the company are making some of these condensers for engines still requiring them in their own workshops.

(To be continued.)

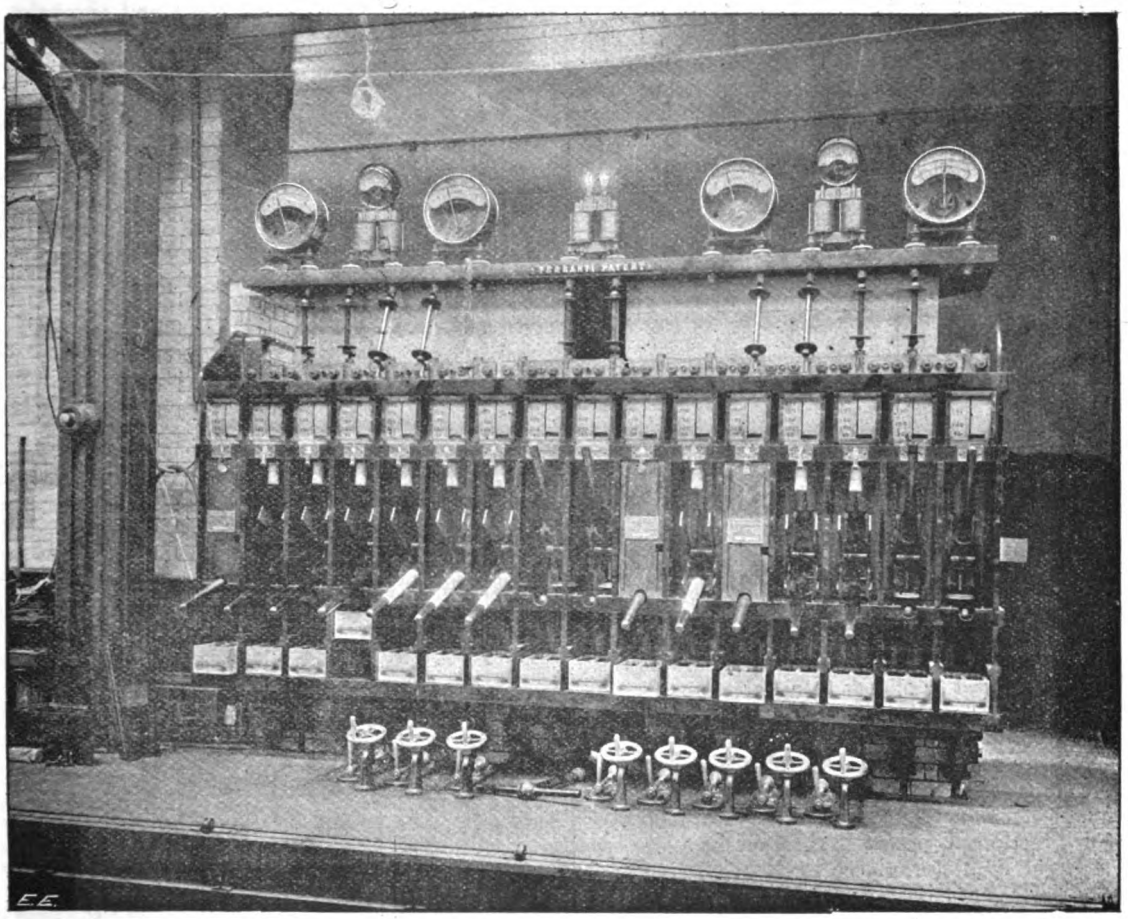

FIG. 7.—One of the Ferranti Switchboards used for Controlling the Alternators at Bankside.

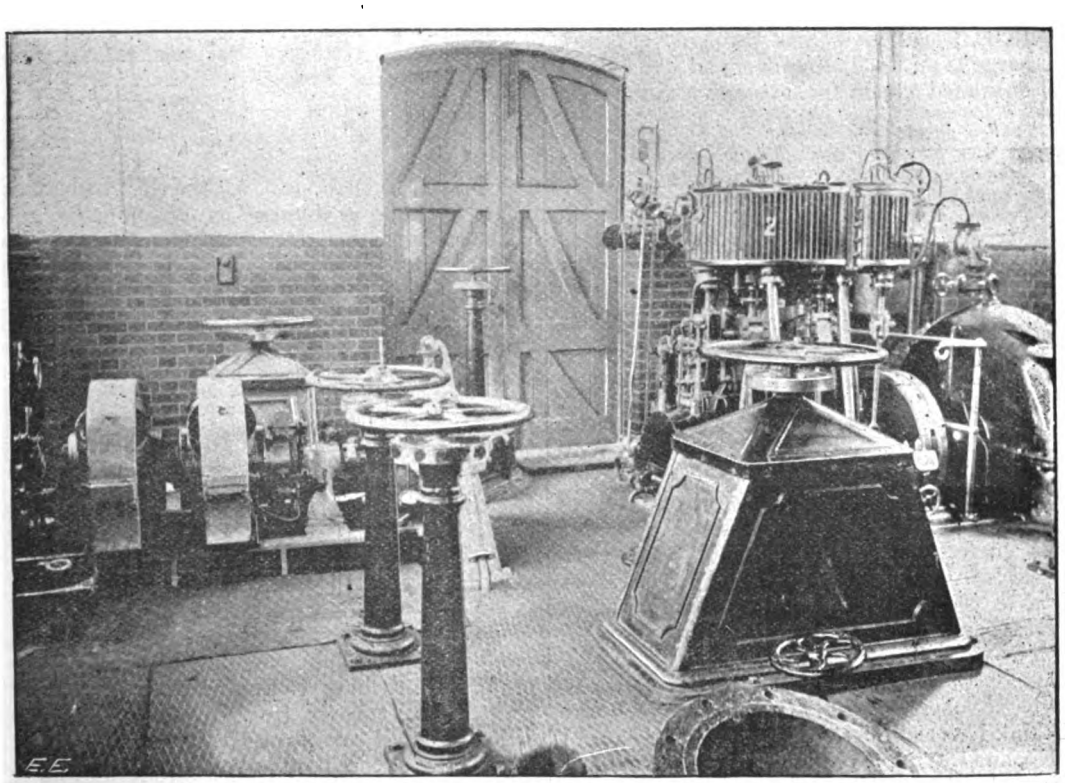

FIG. 9.—View in the Pump-Room at Bankside.

INSTITUTION OF ELECTRICAL ENGINEERS.

Wireless Telegraphy.

BY G. MARCONI, MEMBER.

"Wireless telegraphy," or telegraphy through space without connecting wires, is a subject which has attracted considerable attention since the results of the first experiments I carried out in this country became known. It is not my intention this evening to give my views on or

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discuss the theory of the system with which I have carried out so many experiments, and by means of which I have worked various installations, but I hope to put before you some exact information of what has been done by myself and my assistants during the last 12 months, and also some reliable data as to the means employed to obtain such results. Much has been published on the subject, I must say with varying accuracy, and there can hardly be anyone here altogether ignorant of the general characteristics of the system. Before I go into this subject further, I wish to state that any success I have met with in the practical application of wireless telegraphy has been in a large measure due to the efficient co-operation which has been rendered by my assistants. I think it will not be out of place if I give a brief description of the apparatus.

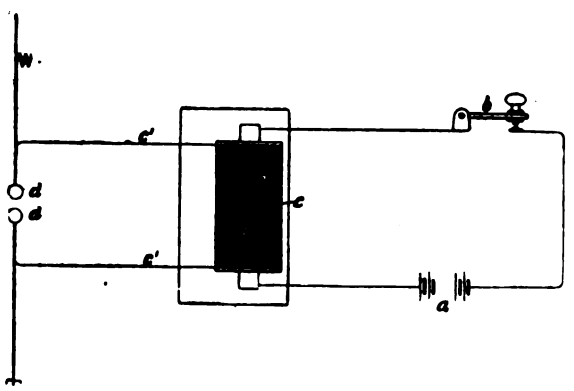

FIG. 1.

Transmitter.—When long distances are to be bridged over and it is not necessary that the signals should be sent in one definite direction, I employ as transmitter an arrangement as shown in Fig. 1, in which two small spheres connected to the terminals of the secondary winding of an induction coil, *c*, are connected, one to earth and the other to a vertical conductor, *w*, which I will call the aerial conductor. Should it be necessary to direct a beam of rays in one given direction, I prefer to use an arrangement similar to a Righi oscillator placed in the focal line of a suitable cylindrical parabolic reflector, *f* (Fig. 5). The transmitter works as follows: when the key, *b*, is pressed, the current of the battery is allowed to actuate the spark coil, *c*, which charges the spheres of the Righi oscillator or the vertical wire, *w*, which discharges through the spark gap. This discharge is an oscillating one, and the system of spheres and insulated conductor becomes a radiator of

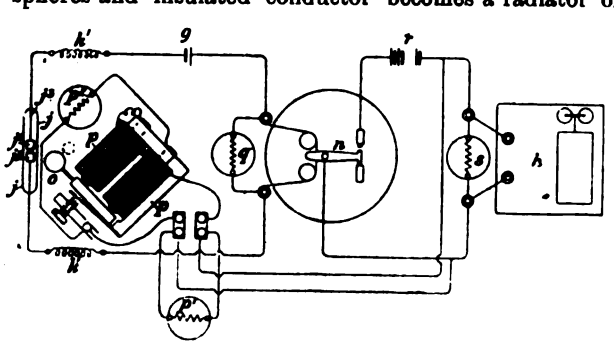

FIG. 2.

electric waves. It is easy to understand how, by pressing the key for long or short intervals, it is possible to emit a long or short succession of waves, which, when they influence the receiver, reproduce on it a long or short effect, according to their duration, in this way reproducing the Morse or other signals transmitted from the sending station.

Receiver.—One of the principal parts in my receiver is the sensitive tube or coherer or radio conductor, which was discovered—I think I am right in saying—by Prof. Calzecchi Onesti, of Fermo, and was improved by Branly and modified by Prof. Lodge and others. The only form of coherer I have found to be trustworthy and reliable for long-distance work is one designed by myself as shown in Fig. 2. It consists of a small glass tube, 4cm. long, into which two metal pole-pieces, j^1 j^2, are tightly fitted. They are separated from each other by a small gap, which is partly filled with a mixture of nickel and silver filings. This coherer forms part of a circuit containing the local cell and a sensitive telegraph relay actuating another circuit, which circuit works a trembler, *p*, or decoherer and a recording instrument, *h*. In its normal condition the resistance of the filings in the tube, *j*, is infinite, or at least very great, but when the filings are influenced by electric waves or surgings, cohesion instantly takes place, and the tube becomes

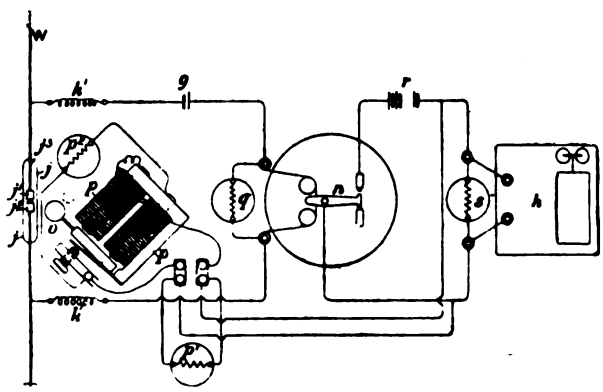

FIG. 3.

a comparatively good conductor, its resistance falling to between 100 and 500 ohms. This allows the current from the local cell, *g*, to actuate the relay, *n*. One end of the tube is connected to earth and the other to a vertical conductor, similar to that of the transmitter (Fig. 1); or if reflectors are used a short strip of copper is connected to each end (Fig. 4). The length of these strips of copper must be carefully determined, as good results cannot be obtained unless they happen to be of the proper length, which will cause them to be in tune or sympathy with the

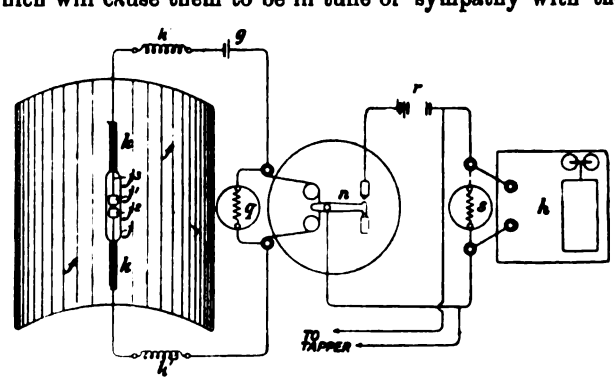

FIG. 4.

transmitted oscillations. All the electromagnetic apparatus in the receiver is shunted by non-inductive resistances in such a manner that there may be no sparking at contacts and no sudden perturbations or jerks caused by the local battery current near the coherer. I find that the relay tapper and telegraphic instrument, if not properly shunted,

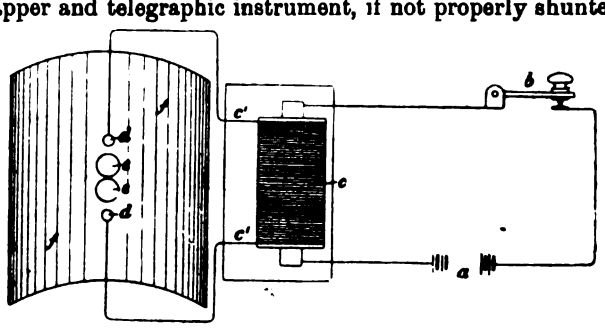

FIG. 5.

produce disturbing effects, the result of which is to prevent the coherer from regaining its sensitive condition after the receipt of electrical oscillations. No such trouble is experienced when suitable shunts are used, and I attribute to their action in very great measure the success which has been attained with this system. Small choking coils, *k' k'*, are introduced between the coherer and the relay. They compel the oscillating current due to the electric waves to traverse the coherer rather than

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waste its energy in the alternative path afforded by the relay. The oscillations induced on the strips, *k k*, or aerial conductor, *w*, which acts as resonator by the radiation from the oscillator affect the sensitive tube. This effect on the tube consists, as we have said, in a great increase of its conductivity, thus completing the circuit and allowing the current from the cell to actuate the relay. The relay in its turn causes a larger battery, *r*, to pass a current through the tapper or interrupter, *p*, and also through the electromagnets of the recording instrument, *h*. The tapper or trembler is so adjusted as to tap the tube and shake the filings in it. If in the instant during which these various actions take place the electrical oscillations had died out in the resonator, the shake or tap given to the tube by the hammer, *o*, would have restored it to its normal high-resistance condition, and the Morse instrument or recorder would have marked a dot on the tape, but if the oscillations continue at very brief intervals, the required conductivity of the tube, *j*, is destroyed only for an instant by the tap of the trembler, and immediately re-established by the electrical surgings, and therefore the relay tapper and telegraph instrument are again actuated, and so on until the oscillations from the radiator have ceased. The practical result is that the receiver is actuated for a time equal to that during which the key is pressed at the transmitting station.

(To be continued.)

Discussion.

Prof. Fleming said their hearty congratulations were due to Mr. Marconi for the magnificent success which had attended him in making his important experiments, and he thought the lecturer had also earned a debt of gratitude for the lucid paper he had read giving the results of his very interesting researches. Mr. Marconi was in complete possession of his subject, and everything he had done was so much in advance of that which anyone else had achieved that they could only follow after him by asking one or two questions. In the course of other observations, Prof. Fleming remarked that by far the most interesting matter associated with Mr. Marconi's experiments was the use of the long vertical wire, because he thought it was this which had enabled him to arrive at his successful results The speaker said he had himself experimented a good deal last summer with horizontal and vertical wires of the same length. One could get effects at a distance from vertical wires which one could not do from horizontal wires. Mr. Marconi also connected one terminal of the coherer and of the spark balls to the earth. It was an interesting question to consider what part the earth played—whether they must look upon it as a perfect conductor, or whether they must look upon the receiver and transmitter as entirely disconnected, with the earth acting as an insulator. The paper was so full of suggestive matter that one could ask a number of questions. He concluded by again offering Mr. Marconi their most sincere congratulations on what he had been able to achieve.

Dr. Erskine Murray, as one who had assisted Mr. Marconi some little time ago in making his experiments at Bournemouth, said on his first going to that town and seeing the action of the telegraph he was as much surprised as those in that building doubtless were to find the extreme ordinariness of the thing. Certainly, the increased distance with a vertical wire seemed an interesting point. A somewhat simple illustration might be made with a frictional electric machine. As they knew, electricity generated by a frictional machine collected round projections on a conductor, where the tension was very much greater than elsewhere; therefore the force passing near the points was greater than it would be at any part of the conductor. With wireless telegraphy we had the earth one large conductor, and then there was this vertical wire, whose force when charged increased the higher we got, pretty much in proportion to the distance from the earth. In other words, the electrical tension depended upon the square of the surface density, and they would therefore see that the action at the top of the wire would be more or less proportional to that square.

Mr. Evershed said he had done some work in connection with wireless telegraphy, but had not made a single experiment with the Hertzian waves. It therefore followed that he could not discuss Mr. Marconi's paper. He wanted to read it first. Ever since he had heard of the lecturer's work, however, he had been hoping the members of that Institution would be afforded an opportunity of hearing him describe it. That hope he was quite sure was shared by everyone in the building. Before listening to Mr. Marconi, several questions had suggested themselves to his mind, such as the amount of power used, the law as to the connection between the vertical wire and the distance to which a message could be transmitted, also the length of the vertical wire, and other points. But everyone of these questions, it seemed to him, had been anticipated. He noticed that the law as to the length of vertical wire and the distance to which it was possible to signal was an exceedingly simple one, and he proceeded to draw attention to the analogy which existed between that law and the one associated with his own wireless telegraph. Before sitting down, he would just refer to one other matter—telegraphing to lightships. He had been working at that subject for many years. One proposal was tried, submitted to a Royal Commission, but was a total failure, and he wanted now to be one of the first to sincerely congratulate Mr. Marconi on having succeeded.

Mr. H. W. Sullivan said he would like to ask Mr. Marconi if his system required a perfect earth—*i.e.*, an earth of little or no resistance? They had seen in the diagrams and had been told that great improvement was effected in the signals by having an earth at both ends—one on the transmitter and one on the receiver. He thought this an important matter. He thought that if Mr. Marconi had successfully solved the difficulty, as seemed to be the case, of connecting with lightships and lighthouses, had conferred a great and lasting benefit upon the world.

Mr. W. P. Granville observed that it was difficult to enter upon a discussion of the paper just then. One felt very much more inclined to congratulate Mr. Marconi on the energy and skill with which he had conducted his experiments that evening. One or two questions had occurred to him. First, in regard to the vertical wire. Was that wire measured from the sea-level? For instance, at Alum Bay was the wire erected on a hill 100ft. or 200ft. high? And so at Bournemouth. Did the height of the wire above the sea level make any material difference?

Captain Brett, R.E., remarked that a good deal of interest seemed to attach to the earth connection. He did not want to anticipate Mr. Marconi's answer on this point, but he (Captain Brett) happened to have been some time ago present at experiments, and at his request Mr. Marconi disconnected the earth connection of the receiver, with the result that the signals came just as before. So that it would appear under those conditions, where there was an open space, that the earth connection of the receiver was not of necessity for the working of the apparatus. But what he wanted to ask was whether Mr. Marconi had followed up the experiment of disconnecting with earth to any extent in order to ascertain whether at greater distances, as at Poole and Alum Bay, messages could be received? This would throw light upon the question as to whether earth conduction formed a part in the transmission, or whether the transmission was effected by pure ether waves generating from the vertical wire. He fancied that the result at South Foreland came as a surprise even to Mr. Marconi himself.

Captain Vivian (deputy master, Trinity House), on being invited to speak, said he was totally unprepared to say anything on the subject, but he congratulated Mr. Marconi on the important results he had obtained and upon the abnormal gathering and reception he had had there that night. He could confirm every word that had been said in regard to the lightships, in connection with which experiments had been going on for some time. There had been no hitch whatever. Having said this, he would not presume to discuss the question of electricity.

Captain Kennedy, R.E., after referring to the time when Mr. Marconi came to England under the guidance of Mr. Preece and Mr. Gavey, and to the experiments which took place, but which he was unable to take part in, at Weston, Salisbury Plain and the Isle of Wight, went on to say that in a paper he read a year ago at the United Service Institution he dealt with the subject of wireless telegraphy. In the field some difficulty might be found with the vertical wire, but no trouble was found in carrying about a balloon such as he described, and the diameter of which was only about 4ft. One advantage about these balloons and also kites was that all difficulties in regard to installations were dispensed with. The length of wire used with one kite was, however, two miles. It was too long to use. Still, said Captain Kennedy amid some laughter, they got some wonderful atmospheric effects, and very painful too. About a year ago he was about the only true believer in Mr. Marconi. He, however, excepted Captain Brett and Captain Jarvis. Most people thought Mr. Marconi a genius. Some did not think so kindly of him. In the Press he was accused of every crime to be thought of; worst of all, remarked the speaker, he was accused of being an Italian.

The **Chairman** remarked that Mr. Gavey had promised to reopen the discussion on Thursday, March 9, when Mr. Marconi would do his best to attend and reply.

The proceedings then terminated.

At last night's meeting of the Institution the following were the candidates balloted for:

Member.—W. C. Clatworthy, 29, Lily-avenue, Newcastle-on-Tyne.

Associate Members.—A. W. Money, 24, Ravenscourt-garden Hammersmith, W.; A. W. Thomas, 7, Penrith-road, Keswick.

Foreign Member.—Prof. J. Epstein, Messrs. W. Lahmeyer and Co., Höchsterstrasse 45, Frankfort-on-Maine.

Associates.—G. Finch, 31, Embankment-chambers, Charing Cross; A. S. Hampton, 25, Killermont-street, Glasgow; E. Loam, Faraday House, Charing Cross-road, W.C.; R. S. Mansel, The George Gotch Amalgamated Gold Mining Company, Johannesburg, S.A.R.; C. H. Phillips, 33, Poplar-grove, West Kensington, W.; A. Stewart, 65, St. Andrew's-road, Pollokshields, Glasgow; W. J. Unwin-Sowter, 25, Alacross Villas, Ealing, W.; C. T. J. Young, Pietermaritzburg, Natal, South Africa.

Students.—J. P. Bradshaw, Faraday House, Charing Cross-road W.C.; W. Bradshaw, Faraday House, Charing Cross-road, W.C. G. H. Van Corback, 5, Ardgowan-terrace, Glasgow; C. Kidner 101, Toothill-road, Loughborough; H. L. Percy, Faraday House Charing Cross-road, W.C.; C. W. Salt, "Thorncliffe," Kingswood-road, Moseley, Birmingham; W. A. Toppin, 187, Chipping house-road, Sheffield; A. A. Watkins, Faraday House, Charing Cross-road, W.C.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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PURCHASE, CONFISCATION, OR COMPETITION.

The Government proposals relating to the telephones are now known, and have been hailed with delight by all parties. This unanimity of sentiment is somewhat startling, and requires careful investigation before admitting its correctness. It is seldom that we find ourselves on the same side as the National Telephone Company, but we certainly think that it is being hardly treated. Indeed, when the admirable Government exponent of the measures to be adopted lays stress upon the morality of the action, attention is naturally turned towards the morality of the thing. We have long since stated that the honest procedure is purchase. The difficulty seems to be one of amount. The Telephone Company states a much larger price than the Government advisers deem advisable, but surely there ought to be some method of coming to terms. We believe the Government plan as described by Mr. Hanbury to indicate an entirely new departure, and one of the most far-reaching for evil that has ever been heard of in the history of legislation. It is but a few days since the Government granted a joint committee to consider the limits of municipalisation, and within a week it propounds a scheme the carrying out of which means the employment of public money in competition with private capital. The Government has nobody but itself to blame for the existing state of things, but that is no reason why it should adopt the most objectionable form of remedy that can possibly be conceived. There can be no mistake as regards our position. We have never supported the policy of the National Telephone Company. Indeed, so far as we know, no other technical journal has so persistently opposed its high-handedness, dearness, and inefficiency as this, yet we cannot stand aside without emphatic protest against the proposed action of the Government. Get rid of the National Telephone Company by all means, but do it honestly. Give an efficient and cheap service, but do not preach the morality of an immoral action. For years past we have strenuously urged that telephony was legally interpreted as telegraphy, and so part and parcel of the monopoly of the State. Owing to the invertebrate character of the various Governments, private enterprise was allowed to exploit telephony, and this exploitation has conclusively proved two things. The first of these is that telephonic messages are mainly local—that is, the telephone messages within population areas are mainly confined to those areas; secondly, that a small percentage of the messages go from area to area and demand trunk connections of areas. Because of these ascertained facts, General Webber has put forward the view that telephonic organisation ought naturally to be of a double character—the Government controlling the trunk and the municipalities the local areas. On the other hand, our contention has been rather in favour of wholly Government control, because few local areas are coterminous with municipal boundaries, so that the troubles of inter-municipal agreement come into play. It is all very well to say that there

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is usually one authority of preponderating influence within the local area, but frequently the smaller bodies resent any interference with their affairs by their more powerful neighbour; and we contend, further, that neither the State nor the municipality should act as traders. If telegraphy, including telephony, is a State monopoly, the work should be done—or as nearly as possible done—at cost price. This is exactly what the Government proposes to do. It will charge a small annual rental to defray the interest upon the cost of installation, and a small sum per message to defray cost of transmission. Coming in in the year of grace 1899, the Government is in a vastly better position to do the work more economically than were the exploiting private adventurers. The latter had to experiment and buy their experience. Hence the increased cost of the earlier work. This in fairness might be allowed, but any question of terms of purchase might well ignore the watering of capital, owing to amalgamation shufflings and the purchase of rival concerns in order to corner the market. The Government will make a vital mistake if it competes with private capital in the way indicated. It will for ever render private capital chary of embarking in any concern of general utility, and it will destroy all confidence in Government supporting the constitution of the country when a momentary burst of popularity may be gained by doing the contrary. We again state that the cry of approval of the spoliation policy which these suggestions have gained should make the Government consider before it is too late the tendency of the foreshadowed legislation.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

SIMPLE SIGNALLING THROUGH A SINGLE WIRE.

SIR,—I know that telegraphic signals are sent by a single wire, *but with earth return*, and I did not use the latter. If the coherer acted simply as a resistance, then the deflection on the galvanometer would have been constant whether the coil was worked or not; but this was not the case. To begin with, the resistance of the coherer was infinite, and therefore there was no deflection on galvanometer; then when the switch closed the circuit through coil and battery at the transmitting end, there was a deflection of 15deg., and this was constant until the coherer was tapped, when it fell again to zero. This was repeated many times. Switching-on the coil gave the signal or deflection, and tapping the coherer removed it, and the above 15deg. is the mean of a great number of readings. I think this is sufficient to prove that the coherer acted otherwise than as a resistance, and if the transmission was not by Hertzian waves, what was it that altered the resistance of the coherer from infinity to only one or two ohms, when nothing had been touched at the receiving end of the line?—Yours, etc.,

J. GILHAM.

PREMIER ELECTRIC LAMP SYNDICATE.

We were invited on Monday last to inspect the factory of the Premier Electric Lamp Syndicate, Huyton Quarry, near Liverpool, at which the incandescent lamps made of carbide of silicon are being manufactured. The filaments of the ordinary incandescent lamps are now made, as a rule, of pure carbon. Generally speaking, the purer and harder the carbon is, the higher temperature the filament will stand without rapid deterioration. As is well known to all students of the general principles of lighting, the higher the temperature of a source of light, the more efficient that source of light is. In other words, the proportion of light rays to the heat rays given out increases with the temperature. The filament used by the syndicate is said to stand a higher temperature than a carbon filament, and hence the claim for a higher efficiency is likely to be realised in practice. The filament, as manufactured at the factory at Huyton Quarry, consists of a chemical combination between carbon and silicon, coated with silicon and carbon by means of a modification of the usual flashing process. The first part of the process of manufacture consists in the treatment of cellulose in successive operations with sulphuric acid of varying concentration, or with both sulphuric and phosphoric acids, by which means a gelatinous semi-liquid substance is obtained, with which silicon, in the form of a fine amorphous powder, is incorporated by mechanical mixture. This amorphous silicon is prepared by a special process invented by Herr Langhans, the ordinary silicon powder sold as amorphous not being at all suitable for the purpose. This semi-liquid mass of cellulose and silicon, after being freed from air bubbles by rapid rotation in a centrifugal machine, is pressed or "squirted" through a fine aperture, from which it issues in the form of a continuous thread, which, passing through alcohol into water, hardens in the way common to all cellulose processes. The thread so produced is washed and wound up on frames to dry, after which it is ready for the carbonising furnace. The process of carbonising does not differ from that usually employed, except that, in order to protect the silicon from any nitrogen which may be present, the forms on which the squirted thread is wound are surrounded by a mixture of carbon powder and rutile (titanic acid), and the highest temperature attainable must be held for a sufficient time for the silicon and the carbon formed from the cellulose to combine. In the baking process it is found to be exceedingly important that the temperature to which the filaments are subjected should be slowly increased. In this way it is usual that at least 17 hours should be taken in bringing the temperature up to that finally required, after which a three hours' baking is sufficient. If the initial stage is hurried, the filaments become irregular in shape, and although this does not impair their light-giving property, the lamp does not look so well. After removal from the furnace, the filaments are flashed in a vapour of silicon and carbon. The process is carried out somewhat in the same way as the usual carbon flashing, except that the hydrocarbon liquid used also contains a certain amount of amorphous silicon. The liquid is raised by exhaustion until it completely surrounds the filament in the vessel, so that a coating of the liquid mixture is held on the filament. The liquid is then lowered and the current turned on to the filament. This vaporises the silicon as well as the hydrocarbon, and a uniform deposit of grey carbide of silicon is obtained on the filament The next process is the mounting of the lamp, and in this respect much the usual procedure is followed. We notice, however, that the filaments were more brittle than the carbon filaments, and hence a larger proportion are likely to be broken during the mounting operations. A small tube is formed at the end of the platinum wire, into the end of which the filament is slipped. It is then cemented in by a carbon mixture, which solidifies on baking. When we visited the works we saw a number of lamps running on a life test which had been at work for over 400 hours, and they quite showed the validity of the claim, that with the new filament the lamp does not blacken with time. The makers claim for this lamp an efficiency of 2·8 watts per candle when new, and that the increase only causes a rise of 3·1 watts per candle with 600 hours' run. This means, of course, a great reduction in the consumer's lighting bill if these lamps are used, and we only regret that the present factory is altogether too small to admit of these being turned out in sufficient quantities to supply even a limited demand. The syndicate is further considering

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the advisability of extending their financial capabilities in order that a factory equal to turning out at least 2,000,000 lamps may be equipped. We understand that this would mean a transference of the right to manufacture these lamps to a new company. Mr. E. A. Medley is in charge of the factory, and personally conducts a large number of the processes of manufacture.

THE BRITISH INSULATED WIRE COMPANY'S STAFF DINNER.

The annual staff dinner of the above company was held at the Adelphi Hotel, Liverpool, on Friday last, when the company took the opportunity of entertaining a number of engineering friends. Thus a corridor carriage was put on the 2.15 train from Euston, in which the London contingent had full opportunities for anticipating some of the pleasures of the evening's function. The dinner itself was well served, the guests being interspersed amongst the staff. One good feature consisted in breaking up the usual group of representatives of the technical Press. The chair was taken by Mr. W. Marriner Brigg, the chairman of the British Insulated Wire Company, and he was supported at the high table by the following gentlemen: Mr. E. Manville, Mr. A. H. Walton, Mr. S. V. Clirehugh, Mr. J. Lobley, Mr. E. M. Lacey, Mr. Jacob Atherton, Mr. J. J. Steinitz, Mr. G. P. A. Schultz, Mr. H. Dickinson, Mr. E. Ashton, Mr. J. A. Bell, Mr. G. H. Nisbett, Mr. J. H. Barker, Mr. S. Clegg, Mr. C. D. Taite, Mr. H. L. P. Boot, Mr. F. A Nixon, and Mr. C. L Vesey Brown. The other tables were presided over respectively by Mr. J. B. Atherton, Mr. S. Z. de Ferranti, Mr. E. K. Muspratt, J.P., Alderman T. Snape, J.P., and Mr. J. A. Pearson.

After the usual loyal toasts, which in this case was preceded by the permission to smoke, Mr. E. K. Muspratt proposed the toast of "The Electrical Industry." He expressed himself as appalled by the magnitude of the subject before him, and explained that his shortcomings as an exponent of it was further enhanced by the fact that he had had the same toast allotted to him at last year's dinner. He was pleased to see how well the practical engineers and scientific men were working together to further the industry. As regards the relative position of England with respect to other countries, he was glad to see that we were pulling up the leeway, but he deprecated the action of certain consulting engineers in preventing standardisation in electrical matters. He thought that the endeavour to get an individuality in specifications must be deprecated, and that more of the detail work should be left to the contractor. There was no doubt but that the Americans owed their position in the electrical markets to their methods of standardisation. Mr. Muspratt also referred to the work of Dr. Lodge and Signor Marconi with the object of dispensing with electric conductors, and humorously suggested that the cable maker was doomed.

Mr. S. Z. DE FERRANTI, in reply, said that in America they were able to reproduce articles very cheaply in spite of their high rates of wages. Their prominence over this country in such matters was largely due to our labour system. It was not that an Englishman was not able to do as much work as an American. In fact, English workmen were very highly valued in the States, and a man going over soon settled down to the altered methods and showed his superiority. In the same way, now that England was really making great strides in electrical matters, he had no doubt but that the work turned out would be second to none. As regards the standardisation troubles, the best consulting engineers did not put obstacles in the way of uniformity. What he thought should be done was for the consulting men to specify the results they desired, and then to leave to the contractor the responsibility of so arranging details that the desired end might be attained. Great attention should be devoted to the selection of the best scheme from a financial point of view. He also argued that the industry was not sufficiently far advanced to dispense with experimental work, especially with tramways, where there was absolutely no need for further experiments.

Mr. Alderman T. SNAPE proposed the toast of "The Visitors," and deprecated the use of the overhead trolley for the tramways in Liverpool when conduit systems were available.

Mr. E. MANVILLE, in reply, thanked the company on behalf of the visitors for the hospitality enjoyed by them. He pointed out that, whereas it was comparatively easy to supervise the station plant, the mains of an electric lighting undertaking were practically inaccessible for supervision, and that it was a great credit to our cable manufacturers that so few faults occurred in the distribution system. The great uniformity obtainable in cables of the British Insulated Wire Company's make was exceedingly creditable to all the staff.

The other toasts were "The Directors," proposed by Mr. G. H. NISBETT and responded to by the CHAIRMAN; and "The Chairman," proposed by Mr. JACOB ATHERTON. After these both Mr. J. B. Atherton and his brother were made the subjects of extra toasts, and the proceedings were thus lengthened out into the small hours of the morning. An excellent musical programme was interspersed with the speeches.

FORTHCOMING EVENTS.

FRIDAY, MARCH 10.

Royal Institution.—At 9 p.m., "Measuring Extreme Temperatures," by Prof. H. L. Callendar, M.A., F.R.S.

SATURDAY, MARCH 11.

Royal Institution.—At 3 p.m., "The Mechanical Properties of Bodies," lecture by Lord Rayleigh, M.A., D.C.L., LL.D., F.R.S. Fifth lecture of series of six.

Institution of Junior Engineers.—At 7 p.m., Conversazione at Westminster Palace Hotel.

MONDAY, MARCH 13.

Society of Arts.—At 8 p.m., "Cycle Construction and Design," by Mr. Archibald Sharp, A.M.I.C.E.

TUESDAY, MARCH 14.

Institution of Civil Engineers.—At 8 p.m., "Water-Tube Boilers for Marine Engines," by Mr. J. T. Milton. "Recent Trials of the Machinery of Warships," by Sir John Durston, K.C.B., R.N., M.I.C.E., and Mr. H. J. Oram, R.N., M.I.C.E.

Liverpool Self-Propelled Traffic Association.—At Royal Institution, Liverpool, at 8 p.m., "Further Developments in Steam Motor Vehicles for Heavy Traffic," by Messrs. D. H. Simpson and W. L. Bodman.

WEDNESDAY, MARCH 15.

Institution of Electrical Engineers.—Students' meeting at 7.30 p.m., "The Application of Electric Motors to Printing Presses," by Mr. E. V. Young.

Society of Arts.—At 8 p.m., "Liquid Fuel," by Sir Marcus Samuel.

THURSDAY, MARCH 16.

Institution of Electrical Engineers.—At Exeter Hall, at 8 p.m., repetition of Mr. Marconi's lecture on "Wireless Telegraphy."

Institution of Civil Engineers.—At 2.30 p.m., students' visit to the generating station of the South London Electric Supply Corporation. Train from Victoria (L. C. and D. Railway) to Loughborough Junction at 1.55 p.m.

FRIDAY, MARCH 17.

Royal Institution.—At 9 p.m., "The Electric Fish of the Nile," by Prof. Francis Gotch, M.A., F.R.S.

SATURDAY, MARCH 18.

Royal Institution.—At 3 p.m., "The Mechanical Properties of Bodies," by Lord Rayleigh, M.A., D.C.L., LL.D., F.R.S. Sixth lecture of the series.

Institution of Electrical Engineers.—At 11 a.m., students' visit to the Langdon-Davies Electric Motor Company's works at 101, Southwark-street, S.E.

QUESTIONS AND ANSWERS.

QUESTIONS.

147. What are the advantages of lagging boilers, steam-pipes, etc.? Give tests.—T. J. A.

148. In selecting a site for a generating station, what are the chief points to be considered?—A. B.

ANSWERS.

Question No. 141A.—What effect would the general introduction of an incandescent lamp taking 1½ watts per candle-power have on the financial prospects of central supply stations?

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Best Answer to No. 141A (*awarded* 10*s.*).—The general effect of the successful introduction of a 1½-watt lamp having the same life as the present four-watt lamp would be to cheapen the electric light by from 50 to 70 per cent. This would, no doubt, lead to an enormously increased demand for the light, which would be obtainable in most towns in England at a price equivalent to gas at about 1*s.* 3*d.* a thousand. This condition of affairs would be extremely favourable to a new company who could design their station and mains for the altered conditions of things, but the *immediate* effect on those stations already working would not be quite so beneficial. Inasmuch as the effects of such a lamp would have to be faced by a large number of existing companies, we shall consider the question chiefly from the point of view of a station already supplying a large number of consumers with electric light. The question then arises as to whether such a lamp, if invented, would be generally adopted in a comparatively short time. Experience has shown that a large class of consumers are not content to change their lamps more often than once a year, though using most of them three or four hours a night. The public have, in fact, but a small appreciation of a gradual diminution in their light, and to induce such people to change their lamps for the new ones would in most cases require a very persuasive agent. Assuming the lamps all replaced, the effect would be to increase the capacity of the station plant by 200 to 300 per cent.—in other words, more than half the plant would be thrown idle for a time. This would mean a corresponding diminution in the coal bill, and less maintenance and repairs. Clerical and management expenses would not be affected, and the former would increase with the advent of new customers. Cost of meters, fixing, repairs, and testing would increase in a similar manner, and all outside work would show an advance. The largest item of increase would be mains as these were extended to serve the whole area, and although the copper per lamp would be reduced, the copper per unit sold would not be materially lessened. The difficulty of the first cost of wiring premises would remain. Of course this would be cheapened by allowing the use of smaller wires, but in small installations, where the size is governed almost entirely by considerations of mechanical strength, the difference would not be appreciable. This difficulty will probably be met by the introduction of free wiring syndicates, or by municipal bodies themselves doing the work for a small additional charge per unit sold. The ultimate benefits, however, would quite compensate for any temporary disadvantage. The fact of the light being more widely used would increase the load factor, owing to the diversity factor in the demands of the different classes of consumers. In fact, instead of the load curve dropping sharply after 8 p.m., it would continue up till about 10 p.m. on account of the large private house load, which must ultimately be the chief source of profit to the supply company. Another very paying load would be the street-lighting, which would, no doubt, be wrested from the gas company—unless, indeed, they materially reduced their price, which is possible. Finally, the writer thinks that something a good deal better than the Nernst lamp in its present form will be necessary to affect to any great extent the electric lighting industry.—E. M.

Answer to No. 141A (*awarded* 5*s.*).—The incandescent lamp as now manufactured takes from three to four watts per candle-power, and more after the lamp has been burning some time, so that four watts can be considered about correct. The introduction of a lamp of only 1½ watts per candle would at once reduce the consumption of current to one-third (to be exact, $\frac{1}{2\cdot7}$) of what it formerly was. This means a similar reduction in revenue, and not only this, but the supply stations would be over-capitalised. They would have twice as much generating plant as would be required for the load, and twice as much copper in the mains as would be needful. The interest on this capital would be a heavy item, quite out of proportion with the income. Compared with the number of units sold, the cost of repairs and maintenance of the generating machinery would be heavy, for although half the plant would be laying idle it would still need attention and occasional running to keep it in order. Management expenses, salaries, and wages would compare less favourably than before, since only the indoor staff could be reduced, and that not to any great extent, while the work of the distribution department and clerical staff would be likely to increase, if anything. It will be argued that with the cost of electricity so greatly reduced (electricity at 6*d.* per unit would be equal to gas, light for light, at 1*s.* 8*d.* per 1,000 cubic feet), the demand for electric light would increase enormously, that there would be a rush of new consumers, and that those already connected to the system would make more use of the light than formerly. But the connection of new consumers takes time. Services and, frequently, new mains have to be laid, the consumers' premises have to be wired, and the first cost of this—which has always been a great deterrent to the adoption of the electric light—would be no less than before. As for old consumers, it is doubtful whether their use of the light would increase to any great extent. They might burn their lamps for longer periods, thereby improving the station load factor; but it is hardly likely, even though the thing is cheap, that consumers would do all all they could to bring their accounts up to previous figures for the sake of the supply corporations. At least, this seems to have been the case with several supply stations where a substantial reduction in the price per unit has been made, their published accounts showing smaller profits, notwithstanding the larger number of units sold and the reduction in total costs per unit, this being especially so with the smaller concerns.

It is probable, therefore, that the greater efficiency of the new lamp would occasion a loss, or something nearly approaching it, on the first year's working after its introduction; in fact, most stations would be running under conditions similar to those of their first year of working with loads far below their respective capacities, and the capital charges and expenses of distribution heavy compared with the number of units sold. The following figures show the probable result at the end of one year's working under the new conditions. They have been obtained from published accounts. The first column shows the financial position with a generation of 322,000 units, and the second column when the generation has been reduced by a little more than one-half by the adoption of the new lamp. These latter figures are worked out on the basis of the accounts of the same station two years previously, with increased capital for the necessary mains, extensions, and additions to the items for meter rents and total costs to suit the new conditions:

Capital expended	£49 000	£54 000
Revenue from electricity supply	5,367	2,467
,, ,, meter rents	155	200
Total revenue	5,522	2,667
Total costs	2,340	1,600
Gross profit	3,180	1,067
Interest on loans	1,230	1,350
Amount set aside for depreciation	900	—
Financial result	Surplus, 1,050	Deficit, 297
Number of units sold	322,000	148,000
Price charged	4d.	4d.

This is, of course, only the immediate result of such a change; the ultimate one could not possibly be anything but good, and the second year's balance-sheet would probably show much larger profits than any previous one In fact, no change could have a more beneficial effect on the financial results of electricity supply undertakings than the one suggested here—viz., the general introduction of a lamp of much greater efficiency.—F. T. H.

Question No. 142.—How would the above lamp affect the design of a system of electric light mains?

Best Answer to No. 142 (*awarded* 10*s.*).—The general use of a lamp taking 1½ watts per candle-power would, in the first place, enormously simplify the design of a system of mains, since it would be possible to rely on at least 90 per cent. of the houses in almost every street using the light, consequently the demand could be nicely estimated, and the whole system laid out on such a basis with a tolerable certainty of its being loaded up in a year or two.

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This would dispense with the necessity, at present existing, of either burying a large amount of capital for a number of years, or of expensive alterations and additions to the distributors, as the number of consumers increased. It would be extremely convenient to lay mains on both sides of the streets, and this would be commercially possible if the custom of 90 per cent. of the inhabitants was assured, as the saving in length of service wires and labour of laying same would more than compensate for the extra first cost of two trenches. The fact of the network being much more uniformly and heavily loaded, and also interconnected through almost every street, would allow of much smaller neutral wires in the distributors, and it would be quite feasible to dispense with the neutral in all but two or three of the feeders. This arises from the fact that the difference of pressure on the two sides of a three-wire system is always less for the same out-of-balance current when the district is heavily loaded than when lightly loaded, in conjunction with the fact that the maximum out-of-balance current likely to arise when supplying 500 consumers is no greater than when only supplying 100, provided proper care is exercised in balancing the installations.—E. M.

Answer to No. 142 (*awarded* 5*s.*).—The effect of the adoption of such a lamp being to greatly increase the number of consumers, the distributing mains will have to be tapped at many more points than they are at present. The well-distributed load thus obtained will favour all those mathematical systems which indicate a theoretical saving of copper for a given maximum potential drop. Hence, for example, five-wire systems will be preferred to three-wire systems, and numerous distributing centres and sub-stations will be necessary. The most popular system will be perhaps to have ring distributing mains fed from distributing centres by numerous feeder mains, the distributing centres being themselves possibly on ring distributors. If we can count on a well-distributed demand over a large area as certainly as we can on the general adoption of an economical lamp, then the superiority of these systems can easily be demonstrated. Again, those systems of laying mains which permit of them being easily and cheaply tapped will have a great advantage over those systems which make the mains more inaccessible. Also, the standard of insulation resistance of the mains would have to be raised, owing to the increase in the size of the network per kilowatt of output.—J. C. R.

THE GOVERNMENT TELEPHONE POLICY.

On Monday last the House of Commons went into committee on the financial resolution on which to found a Bill dealing with telephonic communication. The following account of the proceedings is taken from the report in the *Times*:

Mr. Hanbury said: The resolution which I have to move is in two parts, to adapt it to the two clauses of the short Bill which is to be founded upon it. The first portion of the resolution is to enable the Post Office to extend its means of telephonic communication by the extension of exchanges. I think the committee will agree with me that the very first question which we have to ask ourselves is whether the Post Office is perfectly free to undertake this task. I say free, not merely technically but morally free—free not only in law, but in equity, honour, and good faith. If it is so free there is public property of the taxpayers which we have to protect, a property which ought to be developed in order to bring the telephonic communication of this country up to the level of what it is in other countries. At the present moment we in England are very much behindhand in this respect. In Norway and Sweden we find that there is one telephone line for every 145 of the population; in Switzerland one for every 170; in Denmark one for 210; in Germany one for 450; and in the United Kingdom one for 636. The committee last year was entirely unanimous against the claim put forward by the National Telephone Company. They claimed the right to go everywhere in the United Kingdom, and they also claimed the right to refuse to go anywhere—to have, in fact, rights without any corresponding duties. They claimed that they could go into these areas, and that, they being there, there should be no competition with them, and that even if the local authorities refused to give them wayleave, that was not their fault but the fault of the municipalities, and they were still entitled to be there without competition. The Government is naturally most anxious to be perfectly fair to the National Telephone Company. It would be mere folly not to recognise fully—and most unjust not to recognise fully—the work that the company has done to develop telephonic communication in this country. We want to be fair to the company, but our fairness must rest rather upon established facts than upon any preposterous pretensions such as the company put forth. I believe in that respect the company has been its own worst enemy. What are the established facts? In the first place, the company is working under the old license of 1884, granted in the very height of public competition, and directly after Mr. Fawcett changed the Government policy, and decided that he would grant licenses everywhere and to everybody that applied for them. The company's is the only existing license at the present moment which is not a purely local license, and enables the company practically to set up areas everywhere. In addition, the company has privileges attaching to the old license—that is to say, it has now become a monopoly, but that, in spite of that fact, it has got all the privileges which are denied even to the smallest local monopoly of gas and water. It has a right to refuse services, there is no limit upon its maximum, and it is entitled to give preferences, and it does use that power. The clause which stands in the license of 1884 is a very stringent one, and it provides that nothing shall prejudice or affect the right of the Postmaster-General from time to time to establish, maintain, and work any such system or systems of communication or his right to make agreements or grant licenses. That being so, what has happened since? The company has bought up all other existing licenses; it has, in fact, done its best to defeat the policy of competition. But is that any reason for competition forthwith ceasing? It does not in any way prevent the Postmaster-General from exercising his full right to grant new licenses. But something else has happened. A new agreement was signed in 1896, which retains the old clause of the license of 1884. That clause was alluded to in the Treasury minute of 1892, the Fergusson draft of 1892, the Morley draft of 1894, and the Norfolk agreement of 1896. These negotiations took four years, and they were based entirely upon the Treasury minute which declared the new policy of the Government. What is that Treasury minute? There are reservations contained in it in the strongest terms, so strong that, when articles appeared in the *Times* newspaper declaring the position of the company, the strange compliment was paid to this Treasury minute of leaving out the one important clause in connection with this question reserving the right of competition. That minute reserves in the strongest terms the right of competition, and leaves no ground to complain of any breach of contract or want of good faith on the part of the Postmaster-General. We were told constantly before the committee that there was some understanding and some undertaking at the back of this public agreement. All I can say is that when the agreement of 1896 was signed neither the Postmaster-General nor anyone at the Treasury knew of any such understanding or undertaking. We had before us on that committee two ex-Chancellors of the Exchequer and two ex-Postmasters-General, and they all denied that they had given any such assurance or entered into any such understanding. But confidential letters were produced on the last day of the committee sittings, which showed that private negotiations had been going on, and that the National Telephone Company had tried to get this understanding, but the Post Office very properly declined to agree to any such undertaking. Then we have what really clinches the matter—the statement of Mr. Forbes himself before the committee. In his evidence Mr. Forbes stated that the Post Office were absolutely free in all the negotiations, and that there never was the slightest suggestion directly or indirectly of any such cession on the part of the Post Office. Looking at the question apart from the evidence, I ask, would it not be monstrous in a public agreement of this kind, which was the only written agreement which the public could see, that there should be at the back of it, on the part of Ministers or of any Department, any undertaking to the effect that that agreement did not mean the whole of what it said? But Mr. Forbes abandoned altogether any idea of any such understanding of this kind when the whole purport was made plain to him. It is only fair to say with regard to Mr. Forbes that his voice is always the voice of a very simple person indeed, almost like the simple shepherd in Arcady; but the hands are the hands of a very able chairman of a company in the City; and so before us he took a different line. He said, with some fairness, "I am not bound by a mere written agreement such as bind ordinary men of business; the moral law alone is the thing for me." From that point of view he enlarged with a certain suave satisfaction on the great moral obligations of the assumed partnership between him and the Post Office, and the mutual delights which follow from a system of brotherly co-operation. One objection to a picture of that kind is this, while our agreement is perfectly full, precise, and clear, the moral law, which depends on too simple-minded an interpreter, is apt to vary with the individual requirements of the interpreter, and sometimes with the varying conscience of one individual himself. That undoubtedly has been the case here. Take the case, for instance, of co-operation. Co-operation is a very pretty word, and no doubt it was mentioned in the Treasury minute—that is to say, we were to put them in connection, as a rule, on our trunk lines—and no doubt there was a great similarity of interests between the two. But it never went to the extent of indicating that we were never in any circumstance to compete with them. Mr. Forbes's interpretation of co-operation, however, was that we were never to compete with him: we were to co-operate with him in all his exchanges; but when the Post Office has an exchange of its own the National Telephone Company is to compete with it tooth and nail, and is to refuse to put itself in connection with its partner, with whom elsewhere it is anxious to be on such friendly terms. A further case was raised, and it was this: "Oh, but, after all, the main point is this—we abandon the

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trunk lines." That plea is put forward as if this again was an instance of self-sacrificing, brotherly affection, as if it were a purely unrequited gift. But what are the facts of the case? At the present moment the trunk system and the messages sent along it represent only 3 per cent. of the whole. We bought and paid for the trunk wires and gave an ample price for them. We not only bought them at the original cost price, but added 10 per cent. in addition, which represents, I think, a very adequate recompense to the company. With regard to the lines taken over, they were after all much the least important of the existing trunk lines, because they were mainly the shorter trunk lines, where competition was possible and less expensive to lay, and the Government might have licensed another company to start trunk lines against them. Since we have taken over the trunk lines it has become a different matter. We have had to lay long and expensive lines, and, of course, the cost has been very considerable. But there is another thing. It is not as if the National Telephone Company had lost the use of or the benefit of the trunk lines, but ever since they had been taken over by the State the use of the trunk lines has practically been monopolised by the subscribers of the National Telephone Company themselves. We gave them further advantages. We undertook that no more general licenses extending over the whole country should be issued, and, as a matter of fact, no more licenses have been issued to companies. The trunk system has been largely extended, and we established a submarine cable between this country and Ireland, which threw the whole of Ireland open and gave them very important wayleaves under our agreement of 1896. These are very tangible advantages, which anyone would find even with a refined and superfine moral philosophy difficult entirely to explain away. I hope I have shown to the satisfaction of the committee that we are free, both legally and morally, to compete. But are we free to refuse to compete? About that I am not so sure. There are two questions that have to be answered. We have to ask ourselves, in the first place, Is the service efficient? And in the second place, Is the service sufficient? To both of these questions the committee unanimously gave a negative reply. On what does the efficiency of a service like this mainly depend? It mainly depends, of course, on wayleaves, and wayleaves undoubtedly this company has not got, and will not be able to get in future to the extent it wishes. Why is this? It has applied to Parliament time after time, but Parliament is not going to override the local authorities, to impose everywhere and in every locality in the country a company on these local authorities without their permission. So, backed up by Parliament, the municipalities are refusing to grant these wayleaves, and if they are not granted you cannot have this efficient service. What is the position of the company with regard to the existing wires? It has got 143,000 miles of wire. Out of this number no fewer than 120,000 miles, on the admission of the manager of the company himself, are on sufferance and terminable at very short notice—at the utmost in 12 months. Is it tolerable that the great telephone system, so important to the trade of the country, should exist any longer on sufferance? What do these wayleaves mean? There are three kinds. In the first place, there is the laying of the wires between the various exchanges of the company in the same area. These are absolutely secured to them by the written agreement with the Post Office. But there are other two kinds which are of greater importance. There is the wire which connects the subscriber with the exchange. That means, of course, that as the number of subscribers increases the company is constantly taking up the streets. It is against that that the municipalities protest, I think very naturally; and if a company is not allowed to take up streets for the purpose of connecting its exchanges with the subscribers, as far as any advantage given to the subscribers, the system falls to the ground. There is this further difficulty. What is called the single-wire system prevails in places like Glasgow, and is largely used over the rest of the United Kingdom; but it is impossible that the single wire system should be an effective or efficient system. The Treasury minute prescribed that no company hereafter licensed should have anything but the double-wire or the metallic circuit system. It is absolutely essential, in order to lay the double circuit, to take up the streets again, and the municipalities refuse to grant such permission. The result is that in places like Glasgow, where the single-wire system is in use, the service is an inefficient one. But then you have this fact, that the Post Office is under no obligation whatever to put them into communication even with its trunk wires. As between post offices and exchanges the agreement of 1896 distinctly states that the Post Office is under no obligation whatever to do anything of the kind, that the company must provide its own wayleaves between post offices and exchanges; and those wayleaves are being refused by the municipalities. I am bound to say it is reasonable in a case of that kind that the Post Office, although under no obligation, should meet the wishes of the company, and it is, as a matter of fact, using its powers to connect the company's exchanges with its own trunk wires. I pass to the sufficiency of the service. Here, again, I do not think any blame can be laid on municipalities; it is entirely due to the license originally granted to the company itself. Under that license the company has got most unusual powers. It can pick and choose the localities it will serve. It may, for instance, choose one locality and refuse to serve another. Naturally, of course, it chooses the more profitable areas and leaves the least profitable areas for the Government to undertake. But more serious, I think, than this choice of localities is the fact that even in the same locality it has the right while it gives telephonic communication to one man to refuse it to his neighbour. Between two tradesmen engaged in the same trade and in keen competition this is a power which ought not to be in the hands of any private company. Similarly it has the right to levy different rates from different localities and even from different persons within the same locality. Then, again, we have the further fact that the company have no intention whatever of extending their system after 1904. If that is to be the case and the license expires in 1911 it is absolutely necessary that some other competitors should come into the field to supply the void between 1904 and 1911. There is another important fact in connection with this want of sufficiency of the service, and that arises out of some very important evidence given by Mr. Gaine himself. I was astonished that he should have given such evidence. Let me describe to the House the present system of subscription to the service of the company. I will illustrate it by the parallel case of telegraphs. If the Post Office were to say that nobody should send a telegraph message who did not subscribe £10 or £15 a year and that nobody should receive such a message unless he also subscribed the same amount, and that, having paid that subscription, they might send as many messages as they liked—that is the system of the company at the present moment. I say that is an absurd system, and it has the effect of limiting its advantages to rich subscribers. Mr. Gaine himself very frankly admitted it was an absurd system. Indeed, Mr. Gaine said the company was so anxious to go back to the system of tolls that they wanted to try it in Sheffield. Mr. Gaine held a public meeting in Sheffield. He stated to the people that he was anxious to go back from the subscription system, and he was mobbed by the rich subscribers, and he thought he had very little chance of leaving Sheffield alive. The company's service is naturally limited to a small class of rich subscribers. It is not right that a service of communication of this kind so essential to the trade of the country should be so limited. Therefore we have got to introduce competitors who will, in the first place, be assured of their wayleaves; and, in the second place, will be perfectly free to introduce a system which will popularise telephonic communication. It is for this reason, therefore, that we are bringing in this Bill. This resolution proposes to ask for two millions of money to develop telephonic communication on the part of the Post Office. The first place to which our operations will extend will be London itself. Of course we shall have over a large amount of money for the work of the smaller municipalities. I do not say that is the final sum we shall spend, but it will carry us on for a considerable time. I have been considerably abused for a statement I made that for 2½ millions we could replace the whole of the wires of the National Telephone Company. That statement of mine was confirmed by Mr. Gaine before the committee. With private wires we have got nothing whatever to do, as they are outside the monopoly of the Postmaster-General. We have to deal entirely with public wires, and of these Mr. Gaine said there were only 96,000. I was astonished to hear there were so few. Mr. Gaine told us that the cost to the company of these wires had been on the average £40 a wire—96,000 wires multiplied by 40 gives £3,800,000. If you deduct from that £1,250,000 of watered capital, on which Mr. Forbes admitted dividends had not been paid, it leaves us little over £2,500,000. I am bound to say that, in the opinion of the Post Office, £40 a wire is a very large sum indeed. £40 is the price for which wires can be constructed in London, which is the most expensive place in the world for constructing telephonic communication; but in Glasgow actual tenders have been received at an average considerably under £19 per wire. If you take an average of £30 throughout the country, you are taking an average very much in excess of what it will cost. Therefore, if you multiply 96,000 by 30, you will get a very different result indeed. So far, then, from being wide of the mark in my estimate of 2½ millions, it should on this calculation be less than £2,000,000. Now, I may be asked why London has been picked out from among the other large towns. It has been done for two reasons. In the first place, the area of the London exchange is something enormous — 634 square miles, with a population of 6,000,000, and its public wires number 19,000, representing more than one fifth of the whole of the wires of the country. In that large area the Post Office is determined to compete at once. It may be said, why are you not entrusting these powers to the London County Council or the other local bodies? Well, in the first place, the area is enormously larger than anything controlled by the London County Council, and even if it had been a more limited area the London County Council would have much preferred that the Post Office should do the work. But the plain reason why in London the Post Office is to take the work itself arises out of the question of wayleaves. The County Council are not the road authority and they would not be able exercise wayleaves. Then the Post Office has got the trunk wires, and I do not think anybody will deny that the trunk-wire system in London is, perhaps, the best system in Europe. I do not deny the Post Office has hardly had a fair chance. There has been a tradition that it ought not to oppose this company, and that has no doubt had its effect; but the Post Office has been hampered much more by certain Treasury regulations framed in 1884, which seem to me perfectly ridiculous. Though we started the Post Office and told it to work a telephonic system in the metropolitan area, we tied it down hand and foot; but these Treasury regulations have been withdrawn, and I hope that it will in future do its work like any business firm, and that the competition will be real and genuine. Then we do not propose to work on the system of subscriptions only. We propose to adopt the system prevalent in Switzerland, by which you pay a very small subscription—I believe the subscription for London would be about £3 a year—and after that you pay a small fee for every message that is sent. We mean to popularise the system, and throw it open to rich and poor alike. I do not believe there will be any unfair competition with the National Telephone Company. I believe

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there is work for both the Post Office and the company in London, and, indeed, in all exchange areas. I believe we shall not draw away to any great extent the present subscribers to the National Company, but we shall draw our *clientèle* from a totally different class, and the two systems will work satisfactorily side by side. We are also going to establish a system by which the Post Office will arrange by means of express letters and otherwise to work more harmoniously with the telephonic system than hitherto. The result of enabling a telephonic message to be delivered by express messenger and the toll system we are about to inaugurate will be that anybody, whether a subscriber or not, will be able to use the telephonic system. I now come to the question of municipalities, and what we propose to do is to enable certain large municipalities—and we have fixed the limit at about 50,000, which corresponds roughly with the county boroughs—to start a municipal telephonic system of their own. That system. we hope, they will be able to start at once, and we are not, therefore, going to put them to the trouble and cost of a provisional order. All that is necessary is a clause in the Bill to enable them, if they receive a license from the Postmaster-General, to work a telephonic system themselves at the cost of the borough rates. It may be said, Why do not you extend the system to the smaller municipalities? There are two reasons. In the first place, we shall have a large amount of money over after London has been dealt with; and I am sorry to say that so many large areas have been granted by the Post Office that, granted the fact that it is necessary that the municipality should work over the whole area, it would be impossible for any body but a large municipality to work over the large areas which have been conceded to the National Telephone Company. I ought to add that we enable the municipalities to go outside their own jurisdiction if they can make private arrangements for wayleaves with the local authorities outside. Again I ask, is this fair to the National Telephone Company? They have raised special objections to the granting of licenses to municipalities. They have said, we can compete against a company (and they can buy up a company), but we cannot compete on fair terms against a municipality. Again, I say there has been no understanding whatever that a license should not be granted to municipalities. The confidential letters to which I have referred disclose the fact that the National Telephone Company had a hard battle with the Postmaster-General of the day. They did everything they possibly could to prevent the Postmaster-General from granting any such licenses. They did their best to extract such a promise from him, but he absolutely and finally refused to give any undertaking of the sort. In fact, he said it would be grossly unjust to give it. But, still, I do recognise the fact that the competition of the municipality may be very serious to the National Telephone Company. I will take two cases. There is the case of wayleaves. It is perfectly true that a municipality will be able to grant itself wayleaves and to refuse them to the National Telephone Company. Of course, it will be equally able to grant wayleaves to a rival company, and still refuse them to the National Telephone Company. What we propose is that the National Telephone Company will be reasonable and if in the interests of the public service it will connect itself with the system of the municipality, then it ought to have exactly the same wayleaves as the municipality. With regard to the purchase of the plant in 1911, we quite admit we can get no municipality to undertake this work unless it has some promise that under certain conditions its plant will be purchased, and it would not be fair to give that concession to the municipality and refuse it to the company, even though we are under no obligation to buy a single pennyworth of the plant of the National Telephone Company in 1911. Therefore we are willing where the two systems are in competition to give a pledge to purchase the property of both—that is to say, all that is good and useful—giving, of course, the preference to the municipality, because it will have been the last in the field. That is a perfectly legitimate and fair arrangement as between the two. Are the municipalities, however, fit to undertake this work? Undoubtedly we have the report of the Treasury commissioner at Glasgow reporting against their fitness in two respects. In the first place, he would have refused a license to the Corporation of Glasgow because, he said, the area was not sufficient, and unfortunately in that enquiry the Corporation only asked for a license for their own area. Of course, it would have been absurd to grant a license to them only within the area of their own jurisdiction and not to enable them to work the much larger area around. That difficulty has been got over by allowing the Corporation to work outside their own area—of course, as the result of private agreement with the local authorities. Again, the Treasury commissioner objected that the telephone was not of common advantage, and, therefore, it ought not to be constructed at the cost of the rates. Nobody would contend that the telephone system as worked in this country is for the common benefit, but under the new system it will be popularised, and we shall require it to be thrown open to everybody. So that question of common benefit is got over there. There are only two other limitations which I need mention at the present stage. We shall reserve the right to purchase at the then value of the plant, and we must insist in the interest of the general public that there is the most absolute right of free inter-communication between all these rival systems throughout the country. That is a necessary condition to impose. There is also a limitation that they should not impose terminals on one another or against the Post Office. By this arrangement, then, we have endeavoured to do two things: we have done our best to extend and popularise a system of communication in which this country is behind-hand, and which is yet vital to the trade and commerce of the country; and, at the same time, I hope that even the National Telephone Company itself will recognise that we have done our best, if this competition must come, to ease it off, and establish the fairest possible practical terms, as far as that company is concerned. There is only one other result I should like to mention, which I hope will follow from the system we propose to establish. Hitherto what I believe might be a great trade has gone abroad. All the principal appliances of telephony have to be purchased in Sweden, in Norway, and, I believe, in Holland. I hope that if we have competitors in the field, if we have a large extension of telephonic communications, if we have these three services working side by side, we shall get such competition that a trade for making telephonic instruments, wires, and the rest of it, will be established in this country, and we shall not any longer have to make our purchases abroad. If so, I think useful results may follow from this useful Bill. I have only now to move: "That it is expedient to authorise the issue out of the Consolidated Fund of a sum not exceeding two millions for making further provision for the improvement of telephonic communication and to enable local authorities to raise or apply money for telephonic purposes."

Sir J. Fergusson said that as the right hon. gentleman had in almost every line of his speech referred to the National Telephone Company the House might not think it inappropriate if he, as a director of the company, should rise at once. He was Postmaster-General when the agreement to which the right hon. gentleman referred was come to, in 1891—an agreement which certainly did not err in strictness. He entirely agreed as to the absolute discretion which was reserved to the Post Office, and which the Government of the day was most careful to maintain He thought the right hon. gentleman must have had some misgivings as to whether that agreement was so fair to the company as he asserted, or he would hardly have excused himself so profusely. He never should have thought of questioning for a moment the right of the Post Office to compete with the National Telephone Company in any part of the country, or to license any other company, or to license a municipality. The right hon. gentleman indicated that telephony had made imperfect progress in this country. There was no doubt it had not gone so far as its best friends could wish or the National Telephone Company could have wished, although they had made active endeavours to push the system all over the country. But, still, it had not done so badly. Let it be remembered that at this moment there were only 75,000,000 telegraphic messages sent in the year, while there were 450,000,000 of telephonic communications. Again, for every 12 words sent by telegram the sender has to pay 6d., whereas in telephonic communication two persons could carry on a conversation averaging 100 words at a cost of about ½d. He was afraid he must consider himself on his defence to a very considerable extent. The right hon. gentleman had treated the National Telephone Company as criminal to some extent, as an enemy of the public, and especially of the Post Office. Since 1892 and especially since 1896, when the agreement was completed the Post Office and the Telephone Company had been in the most complete harmony; they had co operated together, and there had been no sort of difference between them. Sometimes the Telephone Company thought the Post Office was hard upon it, but no allegation had been made by the Post Office that the company was not doing its duty. The scientific advisers of the Postmaster General told the committee of 1895 that the company was doing its work extremely well, that the system was the best that could be introduced, and that the company was pushing its business as hard as it could. The right hon. gentleman said that the company held a monopoly, that it was not like gas and other companies with restrictions placed upon it, that it had unlimited powers to charge what it liked. He could not understand how the right hon. gentleman could make such a statement as that. What was the reason why the company was not restricted in its charges? It was that it had no rights, no powers. Gas and water companies had compulsory powers. They could place their undertakings where they liked, and where there were such powers there were corresponding restrictions. The Telephone Company had no right to put a wire across a public road or a house unless it had the sanction of the local authority or of the individual, as the case might be. The right hon. gentleman quoted the terms of the license of 1884, and also of the Treasury minute respecting the right of competition in proof of the fairness of what the Post Office were now proposing. The right hon. gentleman rather ridiculed the idea of brotherly co-operation. The word co-operation was not coined by Mr. Forbes, but it was in the forefront of the Treasury minute of 1892, which laid down the principle upon which the public were going to make an agreement with the Telephone Company. Clearly it was the intention of the Government to co-operate with the company. The right hon. gentleman stated that the company had fought the Post Office tooth and nail. Did he mean that the company tried to get subscribers from the Post Office exchanges by undercutting the Post Office rates? Such was not the fact. The Post Office for the most part withdrew their competition, and the company did nothing more than push their business in the areas respecting which they were licensed.

Mr. Hanbury said he meant that at Cardiff and other places where the Post Office were working the Telephone Company came in and fought tooth and nail the very body that had granted them licenses.

Sir J Fergusson said that Cardiff was one of the areas sanctioned. Why did the Government sanction that area if the Telephone Company were not to go there and try and supply every house in the town it could with telephony? How could the Post Office complain of the company operating effectively in an area which they had expressly licensed?

Mr. Hanbury said the Post Office did not complain; all they said was that there was not co-operation.

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Sir J. Fergusson said there was no idea that the company was not co-operating. The right hon. gentleman had mentioned the solitary case of Cardiff. Did he say there was not co-operation at Newcastle?

Mr. Hanbury: I meant every exchange of the Post Office.

Sir J. Fergusson: Every exchange! And the Post Office made no objection? The right hon. gentleman seemed to be as adverse to his own department as to the company. He never before heard a Secretary of the Treasury talk of the regulations of his own department as ridiculous, but he supposed that in the right hon. gentleman's opinion everyone who came before him was prejudiced and narrow minded. The Post Office, with the long purse of the State at its back, could, if it pleased, have put the company in a corner in every part of the country, but it never intended to do so because friendly co-operation between the Department and the company was the intention of the agreement. The right hon. gentleman asked whether the service was efficient. It was a curious thing that he never referred to a judicial enquiry that was held in Glasgow two years ago in consequence of the desire of the Corporation of Glasgow to have a telephone system of their own. A very skilful judicial officer was appointed to conduct the enquiry, and the first question he put was as to whether the service was efficient and sufficient. The commissioner said that the service was efficient.

Mr. Hanbury: He said it was not efficient.

Sir J. Fergusson said that the commissioner stated that it was very good, but it was not as good as it should be, and the main reason why it was not as efficient in Glasgow as it should be was that the municipality would not give the facilities the company had obtained in nearly every other town. The right hon. gentleman asked if it was tolerable that the present system should exist on sufferance. The question was unfair in view of the terms on which the company was allowed to work. The Secretary of the Treasury really ought to ascertain the facts a little better before he addressed the House. Last year the right hon. gentleman told the House that the whole of the plant of the company could be bought for about £2,000,000 or £2,500,000.

Mr. Hanbury: I said it could be replaced for that.

Sir J. Fergusson, continuing, said the right hon. gentleman also talked about watering stock. There was no idea of purchasing any company at a fancy price. All the Telephone Company did was to purchase other undertakings at their market price, but the capital expenditure on the undertaking—that was to say, the construction cost—really amounted to £5,000,000. In the ordinary course of things mistakes were made in the first instance, and no doubt the capital expenditure was much greater than that of another company which started now with the knowledge possessed by the present company would be. What was the case with any large railway company? The London and North-Western Railway Company, for instance, had had to rebuild its stations because the original buildings were found to be insufficient. Out of £6,242,000 invested in the company over £5,000,000 had been actually expended in the pure work of construction, and such a company should not be told that it had watered its stock, especially as the gross revenue for one year was very nearly equal to the whole amount of what the right hon. gentleman called its "watered stock." In early days Government regulations which were designed to protect the telegraphs revenue cramped the development of telephones. It had been the object of subsequent policy to remove those obstacles; and it was not the case that the company alone had been slow, while the Post Office had done everything, to build the trunk wires. So far from that being the case, there were places to which the Post Office refused to extend the trunk wire except under a guarantee of interest by the company. The right hon. gentleman said that the company claimed to pick and choose where they should lay their lines. As a matter of fact, wherever a dozen or so subscribers could be obtained the company had been ready to open an exchange. Up to the time when it was so violently attacked the company was going ahead as fast as it could. The right hon. gentleman said that the company had the right to levy different rates on different subscribers. The only difference in rates was caused by the difference in working costs. In very large towns the working cost was much greater than in small towns. The right hon. gentleman had pointed out that the general manager of the company (Mr. Gaine) admitted that the company acted on an erroneous principle in having a fixed subscription instead of a sliding scale of charges. The company had been considering the propriety of altering the present system so as to provide for a low subscription and a charge according to the number of messages sent. They had not adopted that plan simply from fear of provoking violent displeasure in commercial communities, which were very jealous of any change. The right hon. gentleman was quite wrong in asserting that the present tariff of the company limited the use of the telephone to the richer classes. In London alone there were 304 offices at which anyone could send a message to a subscriber for 3d., or could telephone a message and have it delivered by express messenger to a non-subscriber for an extra 3d. The general public had just as much access to the telephones as they had to the telegraphs. As to the plan on which the competition of municipalities was to be permitted, he was glad to hear that something was to be done to give the company wayleaves. It would be an injustice so gross that no Government would perpetuate it, to give licenses to the municipalities, with the power to take up the streets, and deny that power to the company.

Mr. Hanbury: We only give these wayleaves to the company where they consider the public interest and work hand-in-hand with the municipal system.

Sir J. Fergusson asked whether that meant that municipal subscribers were to be placed in communication with the company's subscribers, not only in their own area, but all over the kingdom.

Mr. Hanbury said that co operation between the municipal and company's systems would not deprive the former's subscribers of the right to use the trunk wires.

Sir J. Fergusson said he understood so much; but what he wanted to know was whether co-operation meant that the municipal subscriber was to have the right to communicate with every subscriber of the company in any part of the kingdom.

Mr. Hanbury said that the company would undoubtedly be able to charge terminals. The municipalities would not be allowed to charge terminals, but undoubtedly that right could not be taken from the company.

Sir J. Fergusson said he must express a doubt as to the perfect fairness of the proposal. The right hon. gentleman had said that the Post Office would in 1911 purchase such of the properties of the National Telephone Company as were useful to the Post Office. He had never imagined the Post Office would do anything else.

Mr. Hanbury: I explained that at the present moment there is no obligation whatever in 1911 to buy one single pennyworth of plant.

Sir J. Fergusson said he never imagined the Post Office would take anything from the National Telephone Company in 1911 except such property as it suited them to take at its actual value, and not at a fancy value. No other idea had ever occurred to them. The National Telephone Company had done nothing to justify its being treated as a criminal. It was only natural where there were competing systems, with their consequent confusion, that one should swallow up the other, and that had for many years been recognised, and recognised by the predecessors of the right hon. gentleman. It was more convenient to have it all in one hand. He could assure the committee that all the National Telephone Company desired was to have fair play. Certainly if the company was not strong enough at this time of day to compete on fair terms it was very badly managed, but it was not fair terms to tie a man's hands behind his back. The company was now actually told that the Postmaster-General would not bring the company's subscribers into the Post Office in any area in which the Post Office competed. Moreover, although it was stated in the House at the time by the then Chancellor of the Exchequer that the grant of wayleaves for a nominal rent was part of the agreement of 1892, they were now told that the Postmaster General would not grant wayleaves to the company in any area where he was competing.

Mr. Hanbury: I explained to the committee that the only wayleaves that the Post Office ever contemplated giving, the only wayleaves which they were bound to give by the agreement, are the wayleaves between exchange and exchange in the same area.

Sir J. Fergusson said one of the chief conditions made in return for the surrender of the trunk wires was that wayleaves should be freely granted at a nominal rent, and the Chancellor of Exchequer at the time actually made an apology for charging anything at all. The competition proposed was a grossly unfair competition. He was quite sure that in 1892 the trunk wire would never have been surrendered if it had been thought that such an interpretation would have been put on the agreement. He should be ashamed of belonging to any company against which any just charges of unfair dealing could be brought, but the National Telephone Company, which had the greatest ability at its command had endeavoured to make the telephonic system of this country as good as possible, and he was very sorry that a Minister should treat it with the hostility which the right hon. gentleman had shown.

Several other speakers took part in the discussion, and almost all complimented Mr. Hanbury on his proposals. The objection raised by Sir J. Lubbock was on the use of municipal credit for telephone purposes. Others advocated the immediate purchase of the whole of the National Telephone Company's property rather than the establishment of competing exchanges. Eventually the resolution was agreed to.

ELECTRIC LIGHTING IN BATTERSEA.

The following is the report of the Electric Lighting Committee of the Battersea Vestry, which was presented on Wednesday last. The report is dated March 1, 1899, and reads as follows:

1. Pursuant to the authority of the Vestry, your committee have for some time past had under consideration the preparation of a scheme for electrically lighting the parish. Prof. Kennedy, the engineer, and Mr. C. Stanley Peach, the architect, have attended and conferred with your committee on several occasions, and, after going thoroughly into the matter, your committee beg to submit the following scheme of Prof. Kennedy: (*a*) Power to be provided for 24,000 lamps of 8 c.p. (wired) and 240 arc lamps, and mains large enough for 20,000 more lamps, thus providing for extensions without opening up the streets. The first instalment of plant in the central electric lighting station at Lombard-road also includes 500 h.p. in reserve, which, in itself, is sufficient for 9,000 more lamps alight at once. The mains are proposed to be laid considerably beyond

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the compulsory area of supply referred to in the Battersea electric lighting order. (*b*) The arc lamps are proposed to be fixed in the following thoroughfares—viz.: St. John's-hill, Lavender-hill, Northcote-road St. John's-road, Falcon-road, Latchmere-road, Albert Bridge-road, Prince of Wales-road, Cambridge-road, Bridge-road, Battersea Park-road, Victoria-road, portion of Queen's-road from Victoria-road to the station, Battersea-rise, and Bolingbroke-grove. (*c*) The description of the system proposed, which has been approved by the Board of Trade, with the concurrence of the Postmaster-General, is the continuous-current direct supply on the three-wire system, having lamps at 230 volts. Some of the mains (feeders) will be armoured cables laid directly in the ground, and the others (distributors) laid in troughs filled up with insulated materials on the solid system. The system will lend itself easily to the supply of power which may be required, and would enable the Vestry without difficulty to use practically similar machines for the supply of current for the working of electric tramways within the parish if necessary. Provision has been made in the specifications for the mains to be supplied at schedule prices, so that in the event of any deviation being made in the laying of the mains no difficulty will arise. (*d*) The approximate estimates of the cost of the works are as follows: for buildings, etc., at the central electric lighting station, £42,000; for plant, mains, arc lamps, lampposts, cables, etc., £60,000—total, £102,000. The buildings proposed provide for extra size of engine-room and boiler-house to admit of future extension of machinery, without enlarging the buildings, and for the residence of the engineer, timekeeper, etc. The official portion of the buildings will front on to Holman-road, the walls inside the station will be faced with glazed bricks, and fireproof material provided throughout as far as possible. Provision has also been made for the erection of the buildings for the central station, excavation and reinstatement of roads, and other similar works, to be carried out by men in the employ of the Vestry. (*e*) With 24,000 lamps wired, and 240 arc lamps in circuit, it is estimated that 810,000 units would be sold per annum. The cost of generating this current, including maintenance and repairs and all expenses of management whatsoever, should not exceed £6,500. (*f*) The amount of capital charges, assuming that interest and repayment of loans together amount to 5½ per cent., and that the total amount borrowed is £102,000, will amount to £5,610, so that the total annual expenses when in full work will be £12,110. (*g*) The estimated amount proposed to be charged for street-lighting is at the rate of £16 per arc lamp per annum, at which rate 240 arc lamps would bring in a total of £3,840. The sum of £16 per arc lamp is low. The City Company charge £26. 10s. per lamp, and the Hammersmith Vestry £22. 10s. (*h*) The Battersea Electric Lighting Act entitles the Vestry to charge 8d. per unit, but Prof. Kennedy considers it desirable that the price should be made low in order that the output may be as great as possible, and has provided that the charge shall be at the rate of 5½d. per unit, in which case the average income from private lighting, including meter rents, with the number of lamps mentioned, would be £10,200. The total income, therefore, when 24,000 lamps are wired and 240 arc lamps fixed would be £14,040.

2. Your committee having carefully considered the matter, recommend that the foregoing scheme be approved, and that your committee be directed and authorised to take all necessary steps with a view to carrying the scheme into effect at the earliest opportunity.

This report was adopted by the Vestry, and the work will therefore be proceeded with in the usual way.

LEGAL INTELLIGENCE.

THE CASTNER-KELLNER ALKALI COMPANY v. THE COMMERCIAL DEVELOPMENT CORPORATION, LIMITED.

This was an appeal in the Supreme Court of Judicature, before Lords Justices Rigby and Vaughan Williams, against a decision of Mr. Justice Bigham, which was reported in the *Electrical Engineer* of July, 1898. The plaintiffs alleged an infringement by the defendants of letters patent (No. 20 259 of 1894) belonging to the plaintiffs for improvements in electrolytic apparatus for decomposing alkaline salts, and to restrain further threatened infringements. The infringement was said to consist in the use of certain apparatus made according to the plaintiffs' specification, and other letters patent (No. 21,509 of 1896) belonging to the defendants. The defendants alleged that the plaintiffs' patent was bad, there being no conformity between the provisional and the complete specification. They also denied the infringement. Both points were decided in favour of the plaintiffs, and an injunction was granted. The defendants appealed.

Mr. T. Terrell, Q.C., Mr. Astbury, Q.C., Mr. MacConkey, and Mr. J. H. Gray were for the defendants; Mr. Moulton, Q.C., Mr. Bousfield, Q.C., Mr. J. C. Graham, Mr. A. J. Walter, and Lord Robert Cecil were for the plaintiffs.

The hearing of the arguments upon the appeal has occupied some days, and yesterday the Master of the Rolls being unable to be present, Mr. Terrell's reply was heard by the two Lords Justices.

The judgment of the Court was reserved.

COMPANIES' MEETINGS AND REPORTS.

CHELSEA ELECTRICITY SUPPLY COMPANY, LIMITED.

The annual general meeting of this Company was held at the head office, Cadogan-gardens, on Monday.

Mr. J. Irving Courtenay presided, and in moving the adoption of the report and the payment of dividends of 6 per cent. on the preference and the ordinary share capital for the previous year, pointed out that this was the same rate of distribution as in 1897, but was on a larger capital by £40,000, the amount of the last issue of ordinary shares. He would be able to show the meeting that although there was no increase in the dividend, the directors had been looking ahead and trying to consolidate the position of the Company. A matter of great interest in the work of 1898, and of much benefit for the future, was the passing of their Act for the compulsory purchase of land. The result of the passing of this Act, the first of its kind, was not only to give them power to acquire sites necessary for their stations at reasonable prices, but also to free the works and operations from the hardship of what was commonly known as the "nuisance clause" of the provisional order, under which the production of electricity was liable to be stopped at any moment by a private owner or resident through an action-at-law, although they might be using the best known method of working, and the most scientific and modern machinery. It was different now, for a complainant had to show that the company were not exercising reasonable care, and not using the best known methods in their machinery. Now mark the result. One immediate effect of the passing of the Act was the satisfactory settlement of an action brought by a resident which had been over them since 1897, and they were able to proceed with their Alpha-place generating station. In connection with the procedure of parliamentary committees, he also mention that the question of vestry competition—a matter of importance to all electric lighting companies—was satisfactorily dealt with. The decision in the case of the Marylebone Vestry, whose Bill was thrown out, showed, he thought, that Parliament did not approve of Vestry competition. Where a vestry or local authority had refused to do the work itself, and had given its consent to a company's provisional order, such vestry or local authority had, in fact, granted the company a lease of 42 years, unless, of course, the latter neglected their duty and did not fulfil their obligations. The Company's business was steadily growing, there having been an increase of nearly 16,000 lamps of 8 c.p. or their equivalent during the year. The revenue had not increased in the same proportion, mainly owing to the fact that the two winter quarters were exceptionally bright and fine. He might also say that it was quite evident consumers had lived and learned, for they had practised economy. In consequence of such a large number of the most important houses in the district remaining unoccupied except during the London season, the average amount earned per lamp was extremely low—the lowest, he believed, of any of the London supply companies. Having referred to the capital expenditure of the Company, he said the balance of premium on the issue of debenture stock, after deducting costs of issue, etc., had been added to the reserve fund, which now stood at £46,818. In conclusion, he might say he considered that the position of the Company to be stronger than ever it was, and that they might fairly anticipate increased prosperity.

Major-General Webber, C.B., seconded the motion, remarking that the gratitude of the other supply companies in London was due to the Chelsea Company for being the first to bear the brunt of the struggle, to which reference had been made. It was one which must inevitably come and fall to the lot of one of the companies, and, curiously enough, it had fallen upon Chelsea.

After some further discussion, the report was unanimously adopted, and at a subsequent extraordinary general meeting a resolution was passed increasing the capital by the creation of 40,000 ordinary shares of £5 each.

BRITISH INSULATED WIRE COMPANY, LIMITED.

The report of the directors for the year ended Dec. 31, 1898, to be submitted to the shareholders at the third ordinary general meeting, to be held at the offices of the Company, Prescot, Lancashire, on March 15, states that the gross profits of the year amount to £72,185. 1s. 6d., from which has to be deducted administration, legal expenses, fees on patents, and interest on debentures, amounting to £17,475. 1s. 7d., leaving a balance of £54,709. 19s. 11d. This amount has been charged with depreciation of buildings, plant and machinery, according to scale, £5,958 5s. 8d.; amount written off goodwill and patents, £9 344. 6s. 11d.; and balance of preliminary and reconstruction expenses, £3 800. 19s. 6d —a total of £19 103. 12s. 1d., leaving a balance to be dealt with of £35,606. 7s. 10d. The following dividends have already been paid—viz., dividend on preference shares, £5,121. 8s. 9d., and interim dividend on ordinary shares at the rate of 10 per cent. per annum, £8,999. 19s. 6d., leaving a final balance of £21,484. 19s. 7d. The directors recommend that a further dividend of 10 per cent.

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shall be paid to the ordinary shareholders, making 15 per cent. for the year, which will absorb £19,499. 19s. 9d., carrying forward £1,984. 19s. 10d. to next account. During the year 7,500 preference shares additional have been issued. The results of the year's working have been most satisfactory, and have fully justified the extension of the works and the introduction of additional capital. Though a much larger quantity of goods was sent out during the year, the amount of orders on hand at the end of 1898 is so greatly increased that a larger business may be anticipated for the current year. Mr. John E. Pearson and Mr. Thomas Snape, who are the retiring directors, being eligible, offer themselves for re-election. Messrs. Chalmers Wade and Co., the auditors, also retire, and offer themselves for re-election.

BIRMINGHAM ELECTRIC SUPPLY COMPANY.

A meeting of this Company was held on Wednesday at the offices, Dale End, Mr. G. S. Albright presiding in the absence of the chairman—Mr. Henry Buckley—through illness. The report was adopted.

Lieutenant-Colonel Wilkinson, in seconding the report, remarked that he regarded the report as so satisfactory that it almost made one wish that they had not entered into an arrangement with the Corporation.

Resolutions were subsequently passed re-electing Mr. J. F. Albright and Mr. Buckley as directors, and reappointing the auditors, Messrs. Sharp, Parsons, and Co.

METROPOLITAN ELECTRIC SUPPLY COMPANY, LIMITED.

Directors: Sir Eyre M. Shaw, K.C.B. (chairman); Sir James Pender, Bart., M.P. (deputy chairman); Admiral of the Fleet Lord John Hay, G.C.B.; W. Harrison Cripps, Esq.; John Birkbeck Lubbock, Esq.; John Verity, Esq.; Frank Bailey, Esq. (engineering director). Secretary: E. Cunliffe Owen, Esq., C.M.G. Engineer: Reginald R. Todd, Esq. Consulting engineer: Lord Kelvin, D.C.L., F.R.S.

Report of the directors (with abstract of accounts) to be presented to the shareholders at the twelfth ordinary general meeting, to be held at Winchester House, Old Broad-street, E.C., on Tuesday, March 14, at 12 noon:

The capital expenditure, which at the end of 1897 amounted to £850,831. 10s. 9d., has now reached a total of £993,761. 13s. 9d., being an increase during the year of £142,930. 3s. The principal items are mains and plant, and the expenditure on the new works at Willesden. The balance of capital in hand at the end of the year was £5,197. 15s. 10d. The gross revenue for the year amounted to £151,605. 12s. 3d., against £138,267. 14s. 6d. in 1897, being an increase of £13,337. 17s. 9d., to which reference is made in the next paragraph. The cost of generation, which in 1897 was £58,604. 5s. 4d., amounted in 1898 to £76,736. 8s. 7d., or an increase of £18,132. 3s. 3d. Although the sales of current during the past year increased, the profits have not been in proportion. This is principally accounted for by necessary considerable reductions in rates of charge, by the coal strike in South Wales, and by the fire at the Manchester-square works, which for a time incapacitated this important station. During the year, as the shareholders are aware, negotiations were carried on with the holders of founders' shares which resulted in the rights attaching to these shares being extinguished on the terms submitted to and approved by the shareholders. The Bill authorising the Company to erect generating works at Willesden and to supply current therefrom, to which sanction was given by the shareholders on March 7, 1898, was duly passed by Parliament during the year. The Bill promoted by the Marylebone Vestry to enable them to obtain competitive powers of supply to this Company was successfully opposed. The balance to the credit of the revenue account before providing for depreciation is £53,563. 14s. 3d. The directors have set aside £13,000 as an addition to the depreciation and reserve fund, carrying to the credit of the net revenue account the sum of £40,563. 14s. 3d., which, with the balance brought forward from last account and other receipts, makes a total of £44,473. 18s. After deducting debenture and share interest and other charges, there appears a balance of £17,872. 6s. 4d. An interim dividend of 5s. per share on the ordinary share capital was paid on Sept. 23, 1898, amounting to £15,625, and the directors recommend that a further dividend of 5s. per share on such shares be now paid, making a total distribution of 10s. per share for the year, or 5 per cent. on the capital. The dividend upon the new shares will be at the same rate per cent. calculated from the due dates of the instalments. This will absorb a further sum of £16,420. 4s. 3d., and leave a balance of £1,452. 2s. 1d. to be carried forward to the next account. The number of 8-c.p. lamps supplied by the Company increased during the year 1898 from 360,000 to 430,000. The present number of lamps connected is 440,000, and the applications show no signs of decrease. A report from the Company's engineer is appended, showing that the satisfactory condition of the stations, machinery, and plant has been maintained. In accordance with the articles of association, the following directors—viz., Sir Eyre Massey Shaw, K.C.B., Sir James Pender, Bart., M.P., and John Verity, Esq.—retire from the Board, and are eligible for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., also retire, and are eligible for re-election.

Engineer's Report.—I have pleasure in certifying that, subject to normal depreciation, the Company's stations, machinery, and plant are being maintained in an efficient condition, and have worked satisfactorily up to the present date.—REGINALD R. TODD, Engineer.

REVENUE ACCOUNT, YEAR ENDED DEC. 31, 1898.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£45,393	2	11			
Oil, waste, water, and engine-room stores	5,520	12	7			
Salaries of engineers, superintendents, and officers	2,918	19	8			
Wages and allowances at generating stations	7,951	0	10			
Repairs and maintenance: buildings, £840. 14s. 11d.; engines and boilers, £7,552. 11s. 6d.; dynamos and exciters, transformers, motors, etc., £1,008. 14s. 3d.; other machinery, instruments, and tools, £746. 16s. 5d.; accumulators and accessories, £94. 16s. 8d.	10,243	13	9			
Purchase of current	4,708	18	10			
				76,736	8	7
Distribution of Electricity.						
Repairs, maintenance, and renewals of mains of all classes, including materials and laying the same	1,210	6	2			
Repairs, maintenance, and renewals of transformers, meters, and other apparatus on consumers' premises	1,180	4	1			
				2,390	10	3
Rents, rates, and taxes				3,590	14	11
Management Expenses.						
Directors' and trustees' remuneration	3,275	0	0			
Salaries of management, secretary, engineers, accountants, clerks, and messengers	5,070	0	8			
Wages of meter readers and wiring inspectors	464	4	3			
Stationery and printing	817	14	7			
General establishment charges	2,748	3	9			
Auditors—Board of Trade, £85; Company's, £157. 10s.	242	10	0			
				12,617	13	3
Law and Parliamentary Charges.						
Law expenses	788	13	8			
Parliamentary charges	913	3	2			
				1,701	16	10
Special Charges.						
Insurances				848	7	3
Surplus properties—repairs and expenses after deducting rents received				156	6	11
Depreciation and reserve fund				13,000	0	0
Total expenditure				111,041	18	0
Balance carried to net revenue account				40,563	14	3
				£151,605	12	3

Cr.	£	s.	d.
Sale of current (6,845,066 B.T. units), £147,974. 1s. 3d.; less provision for bad and doubtful debts, £1,000	146,974	1	3
Rental of meters on consumers' premises	4,478	0	10
	151,452	2	1
Rents receivable	98	0	0
Net proceeds of work done for and goods supplied to sundry consumers	55	10	2
	£151,605	12	3

Dr. — GENERAL BALANCE SHEET.	£	s.	d.
Capital account—amount received	998,959	9	7
Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, etc.	22,232	9	5
Sundry creditors on open accounts	1,771	3	4
Loan from bankers	15,000	0	0
Depreciation and reserve fund	51,360	16	5
Balance at credit of net revenue account	17,872	6	4
	£1,107,196	5	1

Cr.	£	s.	d.
Capital account—amount expended for works	993,761	13	9
Stores on hand: coal, £363. 17s. 5d.; oils, waste, etc., £322. 18s. 8d.; general £5,382. 14s. 2d.	6,069	10	3
Sundry debtors for amounts paid on account of contracts in course of completion	2,586	14	6
Sundry debtors for current supplied	63,547	2	6
Other debtors	5,374	16	2
Suspense accounts waiting adjustment	1,090	0	4
Deposits (provisional orders, vestries, etc.)	665	0	0
Investments at cost	31,198	6	7
Cash at bankers on current account	2,903	1	0
	£1,107,196	5	1

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HOVE ELECTRIC LIGHTING COMPANY, LIMITED.

The annual general meeting was held on Wednesday at the Cannon-street Hotel. Colonel A. J. Filgate presided. The report, already published by us, was unanimously carried, and a dividend declared, which is to be paid on April 15 next, upon the shares of the Company, at the rate of 8 per cent. per annum, for the six months ended Dec. 31, 1898, making with the interim dividend 6½ per cent. for the year. A resolution was afterwards passed for increasing the capital of the Company by the issue of 10,000 additional shares of £5 each, to rank *pari passu* with the existing shares.

NORWICH ELECTRICITY COMPANY, LIMITED.

The ordinary general meeting of this Company was held on Thursday, March 2, at the Company's Offices, Old Bank of England Chambers, Norwich. Sir C. R. Gilman presided.

The following report was adopted: The directors beg to submit their seventh annual report to the shareholders. The amount received for current during the past year shows a gratifying increase upon that of 1897, and fresh customers are still being gained. Two new engines, each of 300 h.p., making a total of 11 of 2,000 h.p. in all, and an additional boiler, have been erected, and four miles of new mains have been laid down since the date of the last report. It will be necessary to provide further plant in view of the increased demand for current expected during the coming autumn. Parliamentary powers have been obtained enabling the Company to extend its operations where desirable into the suburbs of the city, and mains have been already laid down to the village of Thorpe. The directors regret to say that it has been found impracticable to continue the system hitherto adopted of charging half-price for current during certain hours of the day, and they have been compelled to adopt a uniform price of 5d. per unit, as from Jan. 1, instead of 7d. and 3½d. as heretofore. This will be found to compare very favourably with the cost of electricity in other large towns. The system of free wiring, introduced at the end of 1897, has proved very successful, nearly 200 new consumers having been acquired by this means during the past year. A pre-payment meter, similar to the "penny in the slot" meters so largely used by gas companies, but available for silver coins only, the invention of Mr. Long, the company's engineer, and Mr. E. Schattner, formerly in their service, is being introduced with very satisfactory results. The premium on new shares issued during the year amounted to £1,522. 10s., and has been placed direct to the reserve fund. Including £202. 3s. 4d. brought forward from last year, and allowing for interest on debentures, bank interest, and depreciation, the net revenue shows a credit balance of £3,922. 1s. 11d., out of which the directors propose to declare a dividend of 6 per cent., free of income tax, and to place £477. 10s. to reserve, carrying forward a balance of £575. 1s. 11d. A resolution will be submitted to the meeting to increase the nominal amount of the Company's capital from £50,000 to £100,000. The directors who retire by rotation are Mr. A. R Chamberlin and Mr. R. J. Colman, and, being eligible, they offer themselves for re-election. The auditor, Mr. J. Mottram, also retires, but is eligible for re-election.

The **Chairman** said the income of the Company was increasing, for, in spite of the reduction in the price of current last year, there was an increase in the sale of current. During the past year they had added 317 new customers, making a total of 1,267.

It was resolved that the capital of the Company be increased to £100,000, by the creation of 5,000 additional shares of £10 each, ranking for dividend and in all other respects *pari passu* with the existing shares in the Company.

HOUSE-TO-HOUSE ELECTRIC LIGHT SUPPLY COMPANY, LIMITED.

Directors: Henry Ramié Beeton (chairman), William Page (managing director), William Reginald Davies, Robert Arthur Germaine, William Francis Leese. Manager: Henry W. Bowden. Secretary: Thos. J. Owens.

Abstract of the report of the directors and accounts for the year ended Dec. 31, 1898:

The revenue account shows a credit balance of £14,066. 3s., which, with the balance of £226. 5s. 10d. brought forward, and £742. 15s. 7d. balance of interest received, makes a total of £15,035. 4s. 5d. After deducting £2,250 for interest on debenture stock paid and accrued, £1,767. 10s. for interim dividend paid on the 7 per cent. cumulative preference shares, and £1,982. 12s. 6d. for interim dividend at the rate of 5 per cent. per annum for the half-year to June 30, 1898, on the ordinary shares, the directors recommend that the sum remaining—viz., £9,035. 1s. 11d.—be dealt with as follows: To credit of depreciation account, £4,000; to payment of the remainder of dividend to Dec. 31, 1898, on the 7 per cent. cumulative preference shares, £2,100; to payment of a dividend on the ordinary shares for the half-year to Dec. 31, 1898, at 7 per cent. per annum, making 6 per cent. for the year, £2,775. 13s. 6d.; and that the balance of £159. 8s. 5d. be carried forward to the next account—total, £9,035. 1s. 11d. The increase in the number of lights connected during 1898 was equivalent to 13,937 8-c.p. (35 watt) lamps. Additions and alterations to the plant and mains have been made at a cost of £19,423. 8s. 2d. As stated in the last report, certain of the plant having been superseded, has been sold at a loss. Your directors consider that the proportion of this loss chargeable to the current year has been adequately provided for by the increased sum placed to the credit of depreciation account. Mr. W. R. Davies and Mr. W. F. Leese retire from the Board by rotation, and, being eligible, offer themselves for re-election. Messrs. Miall, Wilkins, Randall, and Co., the auditors of the Company, offer themselves for re-election.

REVENUE ACCOUNT, YEAR ENDED DEC. 31, 1898.

Dr.				£	s	d.
Generation of Electricity.						
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£2,766	8	9			
Oil, waste, water, and engine-room stores	439	9	7			
Proportion of salaries of manager and superintendents	927	16	6			
Wages and gratuities at generating station	1 469	16	4			
Repairs and maintenance as follows: buildings, £198. 12s. 2d.; engines and boilers, £300. 18s. 2d.; dynamos, exciters, motors, etc., £12. 4s. 5d; other machinery, instruments, and tools, £88. 19s. 9d.	600	14	6			
Cartage of ashes	17	5	0			
				6 221	10	8
Distribution of Electricity.						
Proportion of salaries of manager and engineers	85	0	0			
Wages	138	16	11			
Repairs and maintenance of mains of all classes	17	13	10			
Repairs, maintenance, and renewals of transformers, meters, and other apparatus on consumers' premises	46	17	0			
				288	7	9
Rents, Rates, and Taxes.						
Rents payable	336	7	4			
Rates and taxes	1,030	17	4			
				1 367	4	8
Management Expenses.						
Directors' remuneration, £1,500; less amount waived, £500	1,000	0	0			
Managing director's special remuneration	200	0	0			
Salaries of secretary and clerks	532	9	2			
Salaries of collectors	159	6	8			
Stationery and printing	148	14	11			
General establishment charges	307	10	10			
Auditors of Company	42	0	0			
Auditors of the Board of Trade	41	0	0			
				2,431	1	7
Law and parliamentary charges				146	7	9
Special charges—insurances				165	1	2
Remuneration to trustees of debenture stock holders, cancellation of founders' shares, and sundry other charges				221	1	4
				10,840	14	11
Balance carried to net revenue account				14 066	3	0
				£24,906	17	11

Cr.	£	s	d.
Sale of electricity per meter (less discounts)	23 379	8	8
Rental of meters on consumers' premises	1,480	7	10
Transfer fees	35	10	0
Students' instruction	11	11	5
	£24,906	17	11

Dr. GENERAL BALANCE-SHEET, DEC. 31, 1898.

Capital account—amount received	190,635	0	0
Sundry creditors on open accounts and for debenture interest accrued	6,093	10	1
Doubtful debts reserve account	175	5	0
Depreciation account	14,000	0	0
Balance at credit of net revenue account	5,035	1	11
	£215,938	17	0

Cr.	£	s.	d.
Capital account—amount expended for works, less receipts on sales of superseded plant and mains	177,538	3	2
Stores on hand at Dec. 31, 1898: coal, £175. 4s. 11.; oil, waste, etc., £237. 11s. 10d.; general, £30	442	15	11
Sundry debtors for electricity supplied to Dec. 31, 1898	10,035	0	11
Other debtors, and prepaid and suspense charges	1,042	14	0
Cash at bankers	2,841	18	4
Cash at office	38	4	8
Loans against securities	24 000	0	0
	£215,938	17	0

CAMBRIDGE TRAMWAYS COMPANY.

At the ordinary half-yearly meeting of this Company last week, **Mr. C. S. Drummond**, of the British Electric Traction Company, gave an account of some systems of traction utilised in various parts of the world. He said they would in all probability equip the cars throughout the country with 50 h.p, although in Cambridge 30 h.p. might be sufficient. But that was a matter for

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subsequent arrangement. His company was now making experiments with the surface-contact system, on which they had spent £10,000; but they were not yet satisfied that it was commercially workable and absolutely safe in the streets, therefore they were thrown back on the overhead system as the one they knew would work well.

Mr. Grumbley, engineer to the Company, said the whole outlay might approach £100,000.

BIRMINGHAM ELECTRIC SUPPLY COMPANY, LIMITED.

Directors: Henry (Buckley chairman); Geo. S. Albright; J. F. Albright; G. H. Johnstone; Francis W. V. Mitchell; J. C. Vaudrey (managing director).

Report of the directors presented to the shareholders at the ordinary general meeting of the Company, held at the offices, Dale End, Birmingham, on the 8th inst.:

The sale of the Company's business to the Corporation on terms approved by the shareholders at the extraordinary general meeting, held on June 17, 1898, requires the confirmation of Parliament. The Bill will be submitted in the present session, and will in all probability receive the Royal assent before the middle of this year, the date for the completion of the purchase (subject to the right of the Corporation to anticipate) being fixed for Dec. 31, 1899. It was a condition of the agreement with the Corporation that the Company should be entitled to declare and pay dividends at the rate of 6 per cent. per annum, from Jan. 1, 1898, until the completion of the purchase. The amount of net profit, including £989. 3s. 9d. brought forward from last year, is £18,516. 3s. 5d, of which £5,307. 13s. 10d. has been placed to the credit of the depreciation reserve fund. An interim dividend at the above rate was paid for the half-year ending June 30 last, and it is now proposed to pay a dividend at the same rate for the second half-year of 1898. These payments absorb £11,999. 7s. 5d., leaving £1,209. 2s. 2d. to be carried forward. In accordance with the articles of association, two directors, Mr. J. F. Albright and Mr. Henry Buckley, retire by rotation and are eligible for re-election. The auditors, Messrs. Sharp, Parsons, and Co, also retire and are eligible for re-election.

BALANCE-SHEET, DEC. 31, 1898.

Dr. Capital and Liabilities.	£	s.	d.
Capital issued and called up	200,000	0	0
Unpaid dividend	5	16	0
Sundry creditors	15,239	3	8
Bankers	11,941	9	4
Depreciation reserve fund, as at Dec. 31, 1897, £14,411. 17s.; additions to date, £5,307. 13s. 10d.	19,719	10	10
General reserve, £3,108. 11s. 1d., and special reserve against provisional orders, £4,027. 4s. 8d.	7,135	15	9
Profit and loss account—balance from Dec. 31, 1897 £989 3 9			
Profit one year to date 17,526 19 8			
18,516 3 5			
Deduct amount applied to depreciation reserve 5,307 13 10			
13,208 9 7			
Less interim dividend for half-year ending June 30, 1898 5,799 7 10			
	7,409	1	9
	£261,450	17	4

Cr. Property and Assets.	£	s.	d.
Land and buildings as at Dec. 31, 1897, £41,525. 12s.; balance of further outlay to date, £6,203. 7s. 2d	47,728	19	2
Mains, machinery and plant, furniture and fittings, meters and electrical instruments, as at Dec 31, 1897, £173,524. 7s. 8d.; further outlay to date, £23,000. 0s. 6d.	196,524	8	2
	244,253	7	4
Cost of provisional orders to Dec. 31, 1897	4,027	4	8
Cash in hand	18	9	11
Sundry debtors (less reserve)	11,385	14	9
Stock of stores and work in progress as per signed stock book	1,766	0	8
	£261,450	17	4

BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY COMPANY, LIMITED.

Directors: Aymor H. Sanderson (chairman); J. Atkinson Hosker; F. W. Reynolds; F. E. Savory; R. Percy Sellon. Secretary: H. B. Renwick.

Report of the directors to be presented to the shareholders at the second ordinary general meeting of the Company to be held at Winchester House, Old Broad-street, London, E.C., on Monday, March 13, 1899, at 2 p.m.:

The business of the Company for the year under review has been satisfactory, and the results anticipated by the directors have been fully realised. Since the close of the financial year a further 21 shares of the Bournemouth and District Electric Supply Company, Limited, have been acquired, so that the Company now holds the whole of the share capital of that company. The loans of the Bournemouth and District Electric Supply Company, Limited, amount to £63,892. The premiums received on the first issue of preference shares have been applied to reduction of the preliminary expenses, and the remaining balance of that account has been written off out of revenue. The balance to credit of net revenue account, after payment of the full year's dividend on the preference shares of the Company, is £3,468. 9s. 10d. Out of this sum the directors recommend the payment of a dividend on the ordinary shares of the Company at the rate of 4 per cent. for the year, less income tax, which will absorb £2,262, and leave the sum of £1,206. 9s. 10d. to be carried forward to next account. The progress made by the Bournemouth and District Electric Supply Company, Limited, during the past year may be judged by the fact that the equivalent of 8,752 8-c.p. lamps were applied for during that period, as compared with the equivalent of 3,482 8-c.p. lamps during 1897. The Company's application for a provisional order, including the borough of Christchurch, the rural district of Christchurch, the urban district of Pokesdown, and the urban district of Winton, is now before the Board of Trade. Application has been made to the Board of Trade for a transfer to this Company of the undertaking of the Bournemouth and District Electric Supply Company, Limited. The Right Hon. Lord Rathmore finding himself unable to give sufficient time to the business of the Company, the directors have with much regret to announce his resignation of the chairmanship and his seat on the Board. Mr. A. H. Sanderson, who was previously vice-chairman, has been elected chairman of the Company. The retiring directors are Mr. J. A. Hosker and Mr. F. W. Reynolds, both of whom, being eligible, offer themselves for re-election. The auditor, Mr. R. H. Marsh, also retires, and offers himself for re-election.

BALANCE-SHEET.

Liabilities.	£	s.	d.
Capital authorised	150,000	0	0
Capital issued—6 000 4½ per cent. preference shares at £10 each	60,000	0	0
6,000 ordinary shares at £10 each	60,000	0	0
	120,000	0	0
Sundry creditors	158	6	10
Profit for year ended Dec. 31, 1898, £6,013. 4s. 10d.; less interim dividend on 6,000 4½ per cent. preference shares for half-year ended June 30, 1898, £1,239. 15s.	4,773	9	10
	£124,931	16	8

Assets.	£	s.	d.
Investments at cost—2¾ per cent. consolidated Government stock	4 000	0	0
Bournemouth and District Electricity Supply Company, Limited, 5 704 ordinary shares of £5 each	51,108	10	2
Loans	63,891	9	10
	119,000	0	0
Preliminary expenses, £3,032. 16s. 10d.; less premium on shares, £3,014. 6s. 6d.; and balance written off, £18. 10s. 4d.—£3,032. 16s. 10d.	0	0	0
Christchurch, Pokesdown, and district electric lighting order—costs to date	297	6	8
Office furniture and books	38	0	2
Sundry debtors	4,430	19	8
Cash at bankers	1,165	10	2
	£124,931	16	8

Dr. REVENUE ACCOUNT.	£	s.	d.
Interest on calls paid in advance	18	11	2
Stationery and printing	11	19	3
General charges, postage, etc.	41	3	10
Balance of preliminary expenses account written off	18	10	4
Balance carried to net revenue account	6,013	4	10
	£6,103	9	5

Cr.	£	s.	d.
Interest and commissions receivable	4,698	2	8
Dividend receivable from the Bournemouth and District Electric Supply Company, Limited, less income tax	1,383	10	10
Transfer fees	20	0	0
Discounts	1	15	11
	£6,103	9	5

BOURNEMOUTH AND DISTRICT ELECTRIC SUPPLY COMPANY, LIMITED.

Directors: Aymor H. Sanderson, A.I.E.E. (chairman); J. Atkinson Hosker, M.R.C.S.; R. Percy Sellon, M.I.E.E. Consulting engineer: A. J. Lawson, M.I.E.E. Resident engineer: E. L. Ingram, A.M.I.E.E. Secretary: H. B. Renwick. Local secretary: W. D. Brightman.

Report of the directors to be presented to the shareholders at the eighth ordinary general meeting of the Company, to be held at the London offices of the Company, Moorgate-court, Moorgate-place, E.C., on Monday, March 13, 1899, at 1 p.m..

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The capital account shows an expenditure during the year of £17,557. 4s. 3d., chiefly upon machinery, mains, and transformers, making a total sum of £103,965. 17s. 10d. expended to Dec. 31 last. The balance to credit of the net revenue account, after payment of interest charges, commission, and reserve for depreciation, is £1,500. 17s. 6d., as against a loss of £92. 1s. 7d. for the previous year. Out of this sum the directors recommend the payment of a dividend on the ordinary shares of the Company at the rate of 5 per cent. for the year, less income tax, which will absorb £1,383. 10s. 10d., thus leaving £117. 6s. 8d. to be carried forward to the next account. The equivalent of 33,732 8-cp. lamps were connected to the Company's mains at Dec. 31 last, showing an increase equivalent to 7,619 8-c.p. lamps for the year, as compared with 2,910 8-c.p. lamps for the previous year, and applications representing a further 1,769 8-c.p. lamps were then awaiting connection. To meet the rapidly increasing demand for current, and with a view to further economy in station costs, additional plant has been installed; and it will be necessary to make still further additions thereto during the present year. The retiring director is Mr. J. A. Hosker, who, being eligible, offers himself for re-election. The auditor, Mr. R. H. Marsh, also retires, and offers himself for re-election.

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal and other fuel	£1,343	10	0			
Oil, waste, water, etc.	333	17	9			
Engineers' salaries	245	9	10			
Wages	660	15	8			
Repairs: buildings, £11. 9s. 1d.; engines and boilers, £242. 1s. 6d.; dynamos and exciters, £34. 17s.; other machinery, instruments, and tools, £21. 14s. 11d.	310	2	6			
				2,898	15	9
Distribution of Electricity.						
Engineers' salaries	96	12	0			
Wages	150	1	5			
Repairs: mains, £39. 5s. 7d.; transformer stations, £11. 1s. 8d.; apparatus on consumers' premises, £35. 7s. 2d.	85	14	5			
				332	7	10
Rents payable	135	6	0			
Rates and taxes	508	18	4			
				644	4	4
Directors' remuneration	200	0	0			
Salaries—head office	263	0	10			
Stationery and printing	64	16	4			
General establishment charges	197	10	4			
Auditors of Company	26	5	0			
Auditor of County Council	10	10	0			
Carriage	1	14	4			
Advertising	23	2	8			
Stores and works expenses	79	15	0			
				866	14	6
Insurance				95	3	7
Leasehold redemption account				10	8	5
Bad debts written off				7	10	0
Balance carried to net revenue account				7,068	13	3
				£11,923	17	8

Cr.	£	s.	d.
Sale of current per meter	11,115	0	6
Rental of meters	537	5	5
Transfer and probate fees	2	0	0
Discounts	101	3	2
Trading account	67	4	8
Rents receivable	97	4	11
Testing fees account	3	19	0
	£11,923	17	8

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	92,516	9	10
Sundry creditors on open accounts, £13,637. 10s. 5d.; bills payable, £2,459. 12s. 3d.	16,097	2	8
Leasehold redemption account	81	3	8
Reserve for bad and doubtful debts	38	10	4
Depreciation fund account	1,000	0	0
Profit for year ending Dec. 31, 1898	1,500	17	6
	£111,234	4	0

Cr. Assets.	£	s.	d.
Capital account—amount expended	103,965	17	10
Stores on hand at Dec. 31, 1898	725	10	9
Board of Trade deposit	100	0	0
Sundry debtors	4,634	14	8
Cash at bankers and in hand	1,808	0	9
	£111,234	4	0

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in Board of Trade units	620,001
Quantity sold to private consumers by meter	414,662
Quantity used on works	28,893
Total quantity accounted for	443,555
Quantity not accounted for	176,446
Total maximum supply demanded (kilowatts)	581

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Betanzos (Spain).—The Municipality will receive tenders for the electric lighting of the town by 2.30 p.m. on 16th inst.

Southport.—The Corporation offer for sale two Browett and Lindley engines and Mather and Platt alternators. Tenders by March 21.

Glasgow.—The Corporation are prepared to receive tenders for the reconstruction of tramways, as detailed in specification. Tenders by 15th inst.

Barking.—The Urban District Council are prepared to receive tenders for the supply and erection of various plant. Tenders by 12 o'clock noon on March 27.

Bury.—The Electric Lighting Committee invite tenders for the supply and erection of one Lancashire boiler, with steam and other pipes. Tenders by March 20.

Madrid.—The Public Works Department are inviting tenders for the building of an electric tramway in the city. Applications must be sent in by p.m. on April 14.

Southend-on-Sea.—The Corporation are prepared to receive tenders for the temporary transfer of their powers under the Southend Electric Lighting Order, 1891. Tenders by April 6.

Aberdeen.—The Corporation are prepared to receive tenders for the supply and erection of materials for the equipment of their George-street and Woodside tramway route. Tenders by March 29.

Greenock.—The Board of Police are prepared to receive tenders for contract No. 4, mains (low-tension system), including erecting arc lamps, poles, etc., for their electricity works. Tenders by March 16.

Rothesay.—The Electric Lighting Committee of the Town Council are prepared to receive tenders for the supply and erection of various plant for the electric lighting of the burgh and harbour. Tenders by noon on March 27.

Poplar.—The Guardians invite tenders for steam turbines and dynamos (direct coupled), electric motors, battery of accumulators, electric cables, wiring, and fittings, main switchboard, and distribution boards. Tenders by March 22.

South Shields.—The Corporation invite tenders for the supply and erection of the following plant: (Section A) multitubular marine boiler, 14ft. 6in. diameter; (B) boiler mountings; (C) fitting boiler mountings. Tenders by noon on 13th inst.

Hereford.—Tenders are invited by the Town Council for erection and completion of the buildings in connection with the electricity station in Widemarsh-street. Specification can be obtained at the office of Mr. John Parker, A.M.I.C.E. Tenders by 5 p.m. on March 13.

Sunderland.—The Corporation are prepared to receive tenders for the annual contracts for (*a*) indiarubber-covered cables; (*b*) cast and wrought iron pipes and street service boxes; (*c*) stoneware casings and bearers; (*d*) house fuse boxes. Tenders by noon on March 30.

Stockport.—The Committee of the Stockport Sunday School invite tenders for the efficient electric lighting of the whole of their premises from the town supply. Tenders to be submitted to Mr. W. B. Leigh, hon. secretary, Committee Room, Stockport Sunday School, not later than March 24.

Manchester.—The Great Central Railway Company invite tenders for the supply during 12 months ending April 30, 1900, of electric light and telegraph materials. Specifications may be obtained from Mr. Oliver S. Holt, secretary, London-road Station, Manchester. Tenders by 10 a.m. on 14th inst.

Torquay.—The Town Council invite tenders for the supply and delivery of 500 or 1,000 tons of coke at the electric lighting station, Beacon Quay, during the period from April 5, 1899, to March 25, 1900. Particulars may be obtained at the office of Mr. Fred. S. Hex, town clerk, Town Hall, Torquay. Tenders by 4 p.m. on 20th inst.

Dublin.—The Great Northern Railway Company (Ireland) invite tenders for the construction of about 2¾ miles of tramways through fields, etc., from the Bailey Post Office to Howth Station. Specifications (£2. 2s.) may be obtained at the office of the Company's Engineer-in-Chief, Amiens-street Terminus, Dublin. Tenders by 27th inst.

South Shields.—The Corporation invite tenders for the supply of coal, oils, waste, hardware, and other engine-room stores for their electricity works at West Holborn during year ending March 31, 1900. Specifications, etc., may be obtained from Mr. J. A. Jeckell, borough electrical engineer, West Holborn. Tenders by 12 noon on 13th inst.

Lewes.—The Corporation invite offers from responsible companies or persons willing to establish an electricity supply undertaking under and subject to the provisional order of 1898. Particulars may be obtained at the offices of Mr. F. J. Warden-Stevens, Connaught Mansions, 34, Victoria-street, Westminster, S.W., or at the office of the Clerk, Town Hall, Lewes, on deposit of £5. 5s. Tenders by March 24.

Dumfries.—The District Committee invite tenders for laying a tramway, building a loading bank, and supplying all necessary materials in connection with the opening of a whinstone quarry

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near Auldgirth Station (G. and S. W. Railway). Specifications, etc., to be seen on appointment at the office of Mr. A. V. Hart, Marchbank, surveyor to the District Committee, Dumfries. Copies of specifications can be obtained from the Surveyor on deposit of £1. Tenders by 13th inst.

Dundee.—The Gas Commissioners invite tenders for the supply and erection of the following plant at the electric station, Dudhope-crescent-road, Dundee: (Contract No. 12) four Lancashire boilers; (13) two 450-h.p. steam-engines and dynamos; (14) one 700-h.p. steam-engine and dynamo. Specifications, etc., may be obtained from Mr. Walter H. Tittensor, Dudhope-crescent-road, Dundee, on deposit of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders by March 15.

West Hartlepool.—The Town Council invite tenders for the erection of an electric light station in Burn-road, in accordance with amended plans and specification prepared by Mr. C. Stanley Peach, F.R.I.B.A. Bills of quantities, prepared by Mr. H. T. Neilson, can be obtained upon payment of £2. 2s., which sum will be returned upon the receipt of a fully priced-out and bona fide tender. Particulars may be obtained from Mr. J. W. Brown, borough engineer. Tenders by 4 p.m. on 13th inst.

Belfast.—The Electric Committee are prepared to receive tenders for the supply and erection of the following: (Section C 12) switchboard extensions. Specifications and conditions of contract may be obtained on application to Mr. Victor A H. McCowen, city electrical engineer, on payment of £1. 1s. per copy, which sum will be refunded on the return of the specification with a bona fide tender. Sealed tenders, endorsed "Tender for Switchboard Extension," must be sent to Sir Samuel Black, town clerk, by 12 a.m. on March 16.

Edinburgh.—The Corporation are prepared to receive offers for the construction of an electric main subway in M'Donald-road and Leith Walk; size 6ft. 6in. by 3ft. 6in., 1,080 yards or thereby in length, according to plans, sections, specification, and schedule of measurement prepared by the Burgh Engineer, from whom schedules of measurement and all particulars may be obtained. Sealed offers, endorsed "Tender for Subway, M'Donald-road and Leith Walk," to be lodged with Mr. T. Hunter, town clerk, City Chambers, before 10 a.m. on 17th inst.

Canterbury.—The Corporation invite tenders for supply and erection of the following plant for the municipal electricity works: (Section A) boiler-house plant (one Lancashire boiler and accessories, mechanical stokers); (B) engine-house plant (one 150-kw. steam dynamo and accessories, condenser, steam, exhaust, feed, blow-off, and sundry pipes, valves, etc.); (C) extension of switchboard; (D) extensions of mains (insulated cables). Specification, etc., may be obtained at the offices of Mr. Robert Hammond, M.I.C.E., M.I.E.E., 84, Victoria-street, Westminster, London, S.W., on payment of £5. 5s., which sum will be refunded on the return of the specification filled up with a bona fide tender. Tenders by March 14.

London, W.—The Vestry of Hammersmith invite tenders for the supply and erection of the following machinery by May, 1900: Contract A, three water-tube boilers; B (1), two 1,000-h.p. slow-speed engines, coupled direct to B (2), two 600-kw. alternators; C, underground feeders; D, cast-iron pipes. Specification, with general conditions and form of tender, can be obtained at the office of Mr. W. P. Cockburn, vestry clerk, Town Hall, Hammersmith, upon payment of the sum of £2. 2s., which amount will be returned on receipt of a bona fide tender. Specifications and drawings may be seen, but not obtained, at the office of Mr. A. H. Preece, 39, Victoria-street, Westminster. Tenders must be delivered at the Town Hall, Hammersmith, by 5 p.m. on March 15.

Shanghai.—The Shanghai Municipal Council invite tenders for a concession for constructing and working about 23 miles of electric tramways on the trolley system in the streets of Shanghai. The special attention of tenderers is drawn to the fact that the tender (if any) recommended by the Council will require ratification by the ratepayers. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 being deposited with Messrs. Pook and Co., which sum will be retained by the Council, and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China (telegraphic address Dynamo, Shanghai; "ABC," fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Tramway Concession," must be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, and received by 12 noon on June 30.

Shanghai.—The following resolution in reference to the telephone system in Shanghai was passed at the last annual meeting of the ratepayers of the Foreign Settlements at Shanghai, north of the Yang-king-pang: "Resolution VIII.—That the Council be and is hereby authorised to enter into negotiations with the China and Japan Telephone Company or any other company, and in its discretion grant a franchise with a view to the community being supplied with an adequate and efficient telephone service at a fixed maximum charge." In accordance with the above resolution the Shanghai Municipal Council invite tenders for a concession for a period of 30 years for the exclusive right of establishing and working a telephone system in Shanghai. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 sterling being deposited with them, which sum will be retained and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China. Telegraphic address, Dynamo, Shanghai (ABC, fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Telephone Concession," to be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, by 12 noon on March 31.

RESULTS OF TENDERS.

Kingston.—The Guardians have accepted the tender of Messrs. Stewart and Moore, of Ealing, of £108. 15s., for the erection of telephonic communication at the workhouse.

Birmingham.—The Town Council have accepted the tender of the Birmingham Electricity Supply Company for lighting the Council House by electricity at a cost of £1,774.

Bristol.—The Docks Committee have accepted the tender of Mr. C. A. Hayes for the erection of an electrical generating station at Avonmouth Dock in connection with the new granary.

Whitechapel.—The Electrical Committee have accepted the amended offer of Messrs. Manlove, Alliott, and Co. for the erection of a new destructor, at a cost of £17,740. 16s. upon certain conditions.

Doncaster.—The Guardians have accepted the tender of Mr. T. Scott Anderson, of Sheffield, amounting to £2,730, for the electrical lighting of the new workhouse. There were 32 tenders, ranging from £6,260 to £2,500.

Lincoln.—The Electricity Works Committee have accepted the tender of Messrs. Ruston, Proctor, and Co. for boilers at £1,145, and the tender of Messrs. Laurence, Scott, and Co., Norwich, for engines and dynamos at £4,423

Sheffield.—The Watch Committee have accepted the tender of the Sheffield Corporation Electric Supply Department for the erection of eight pillars and eight arc lamps, with all the electrical switches, fitments and accessories, cabling and wiring, for the sum of £350.

Bridgewater House (St. James's Park).—The contract for ventilating work, including the installation of electrical fans, has been placed with the Grahtryx Ventilating and Engineering Company, Limited, of 23, Sutterton-street, for the execution of the entire work for the sum of £1,250.

Accrington.—The Council have accepted the following tenders: Messrs. Johnson and Phillips, three engines and dynamos, with the specified spare parts, £2,804. 10s.; Messrs. W. T. Glover and Co., mains and cables £4,550, street boxes, etc., at schedule of prices; Chloride Electrical Storage Syndicate, storage batteries, £910; Messrs. Crompton and Co., switchboard, £641.

London, N.—The Guardians of St. Leonard, Shoreditch, have received the following tenders for materials and for wiring and fitting the Shoreditch workhouse, infirmary, casual wards, dispensary, nurses' home, porter's lodge, offices, etc., at Kingsland-road and Hoxton:

C. Peacock and Co. (accepted)	£1,330	0	0
J. Bolding and Son	2,089	8	9
Electrical Erection Company	1,355	0	0
National Electric Free Wiring Company	1,500	0	0
Electric and General Engineering Company	1,779	0	0
Handford and Driscoll	1,998	0	0

BUSINESS NOTES.

Mexico Electric Tramways.—The traffic receipts for the month of February amounted to £14,100.

Telegraph (Channel Islands) Bill.—This Bill has been read a second time in the House of Lords.

Bath.—The new electric light connections made during the last six months represent about 1,600 lights.

York.—The Electric Lighting Committee has been authorised to expend £2,000 to lay a cable in Micklegate.

Crosby.—The Urban District Council have resolved that no further steps be taken at present as to lighting by electricity.

Bury.—The Electricity Committee are about to lay mains in Manchester-road, Rochdale-road, Pimhole-road, and Bell-lane.

Colchester.—A joint sub-committee has been appointed to deal with the scheme for the proposed light railways in Colchester.

Thanet.—The Rural District Council have approved of the electric lighting scheme promoted by the Isle of Thanet Light Railway Company.

Eastbourne.—The advisability of using electric motors for dust and water carts is to be considered by the Highways Committee of the Town Council.

Torquay.—The electric light main is to be extended from the Primitive Methodist Chapel to Hatfield-road, Ellacombe, at an estimated cost of £438.

Central London Railway.—It is announced that the Central London Railway (Mansion House to Shepherd's Bush) will be opened for traffic on Nov. 1.

Extension of Time.—The Board of Trade have granted to the promoters of the Potteries Extension Tramways Company a further six months for carrying out the work.

Sale by Auction.—Messrs. Wheatley Kirk, Price, and Goulty will sell for the General Electric Company, Limited, on the 22nd inst., some slightly soiled electric fittings and apparatus.

Grimsby.—The Board of Trade have confirmed an order authorising the construction of a light railway in the county of Lincoln from Grimsby to Saltfleetby, with a branch to Cleethorpes.

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Newcastle.—At the meeting of the City Council on Wednesday a resolution that the working of the new tramways be retained in the hands of the Corporation was carried by a majority of 32 to 21.

Leytonstone.—An explosion occurred on Monday, caused by an accumulation of gas from a leaking main in the underground chambers which carry the electric lighting wires. No one was seriously injured.

Devonport.—A resolution to the effect that the Council should proceed with the lighting of all the main roads in the outer wards with electricity forthwith was before a meeting of the Borough Council yesterday.

Bilston.—The Light Railway Commissioners have held a public enquiry into the application made by the British Electric Traction Company, Limited, for an order to authorise the South Staffordshire Light Railway.

Dover.—The accounts of the Dover Electricity Supply Company, Limited, for 1898, show a gross profit of £2,133, being over £1,000 more than in 1897. No dividend will be paid on the ordinary shares of the Company.

Darwen.—It is anticipated that the new electricity works will be ready by June. An estimate has been made by the electrical engineer, according to which during the first year the probable loss would be £461 and in second year £79.

Appointments Vacant.—An assistant engineer-in-charge is required for a high-tension continuous and alternating electric light station. For particulars of this and other vacancies readers are referred to our advertisement columns.

Kingston.—At a meeting of the Town Council on the 6th inst. it was unanimously resolved to have a scheme prepared with a view to an application being made for a provisional order to construct an electric tramway through the town and district.

Leeds.—The Highways Committee of the Corporation will start the relaying of the tramway lines in Tong road on Monday next. Everything will be done to facilitate the adoption of electric traction when the Corporation resolve to extend that system to Armley and Wortley.

Mica and Micanite.—Mr. Henrich A. Brandt, mica merchant and general importer, informs us that he has opened offices and factory at 33, Minories, E.C., where large stocks of every description and quality of mica and micanite will be held and cut to required sizes.

Brighton.—Mr. C. C. Fowler has been appointed assistant manager at the Corporation electricity works, at a salary of £250 per annum, increasing by £50 per annum to £350 subject to his entering into an agreement to bind himself to the Corporation for a period of three years.

Sheffield.—At the meeting of the City Council on Wednesday the Electric Light Committee recommended that extensions of electric light mains be carried out, at a cost of about £750. The Committee also approved the extension for supplying cables and other works, at a cost of £5,083.

Kingswood.—Messrs. Alexander, Daniel, and Co. sold on Tuesday by auction the electric light installation for Kingswood and district. Mr J. Pugeley, of Cheese-lane, Bristol, bought the installation for £475 on condition of taking the land on which it stands upon a 99 years' lease at £25 a year.

Hampstead.—The Vestry have decided to oppose the scheme affecting the parish at the enquiry to be held on the 15th inst. into the following schemes: Finchley, Hendon, and District Light Railway; Hampstead, Finchley, and Edgware Light Railway; and the Highgate, Finchley, and Wood Green Light Railway.

Dudley.—An enquiry was held at Stourbridge on Saturday last by the Light Railway Commissioners into proposals by the British Electric Traction Company for branches at Stourbridge and Dudley. Lord Jersey said that, subject to the widening of Foster-street, Stourbridge, the Commissioners would recommend the order.

Constantinople.—According to the *Eastern Morning News*, the electric light was introduced for the first time in Constantinople at a new circus last week. It is stated that the proprietor recently had the honour of giving a cinematograph exhibition at Yildiz, and the Sultan was so delighted that he granted permission for an installation.

Pontefract.—The Guardians have adopted Mr. R. Holliday's report on the proposal to instal the electric light throughout the workhouse. The initial cost will be £900, and the annual expenditure, including 4 per cent. interest and renewals, £136, as compared with £233. 9s, the present cost of the gas supply, repairs to fittings, etc.

Rhyl.—On Wednesday the Light Railway Commissioners (Lord Jersey and Colonel Boughey) held a public enquiry at Rhyl into an application made by the Rhyl and Prestatyn Light Railway Company. Limited, to lay a light railway between these seaside resorts. Lord Jersey said the Commissioners would recommend the issuing of the order.

W. T. Henley's Telegraph Works Company, Limited.—This Company have opened a branch office and warehouse at 30, Mosley-street, Newcastle-on-Tyne, where, we are informed, a large stock of wires and cables are to be kept. The branch is under the management of Mr. W. Odgers, who has been in the employ of the Company for many years.

London Gazette.—Amongst the dividends under the Bankruptcy Acts, 1883 and 1890, we notice that in the estate of Mr. John Dewhurst, of West Kensington, electrician, a first and final dividend of 8s. 1½d. in the pound is payable, and may be received any day except Saturday between 11 and 2 at the offices of the Official Receiver, Carey-street, W.C.

Cheltenham.—The Town Council have finally settled the draft provisional order for the proposed light railway, which will run through the borough and up to the top of Cleeve Hill, and will support the promoters' application before the Light Railway Commissioners provided that an undertaking be given to insert the committee's amendments in the order.

Hereford.—At a meeting of the Town Council on Tuesday the Electric Lighting Committee reported that the Board of Trade had intimated their approval of the scheme for the installation and distribution of electric light in the city, and the committee hoped to have the order completed within a few days. Tenders for the necessary works had been advertised for.

Worcester.—The City Council is early in the field. At the meeting on Tuesday the General Purposes Committee were instructed to consider the advisability of petitioning Parliament to extend to county boroughs the powers proposed to be conferred on municipalities with a population of 50,000 under Mr. Hanbury's Bill in establishment of their own telephones.

Oban.—The Fort-William Electric Lighting Company, Limited, are offering to the Burgh Commissioners to supply current for six extra 16-c.p. incandescent lamps for the use of the surplus water from the town supply. The Commissioners have deferred their reply, as they are about to make a counter-proposal to the electric lighting company for the use of the water in question.

Bacup.—At a recent special meeting of the Cemetery, Lighting, and Recreation Committee the chairman, vice-chairman, Councillors Haworth, J. H. Lord, and T. Smith were appointed representatives of this committee upon the Electricity Committee. On the resignation of Councillor Haworth from the Electricity Committee, Councillor Hardman is to be appointed in his stead.

Ilkeston.—At the meeting of the Town Council on the 7th inst., the Town Clerk reported that, although the Great Northern Railway Company had lodged a petition against the provisional orders for the tramways and electric lighting schemes, since the last meeting of the Council they had withdrawn their opposition, and both orders were now quite unopposed, and were progressing very well.

Islington.—The Vestry are disposed to consider favourably the proposal to construct a railway from the Archway Tavern, at Highgate, along the Archway and Great Northern roads to the Manor Farm, at the bottom of the North-hill, Highgate, across fields to Hendon, and thence down the Edgware-road to Hampstead. The overhead trolley system is to be adopted along the Archway-road.

Calverley.—The order of the Light Railway Commissioners authorising the construction of the Bradford and Leeds Light Railway, by the Leeds and Bradford Light Railway Company, was considered by the District Council on Tuesday night. It was decided to seek to secure the insertion of clauses for the protection of local interests without opposing the confirmation of the order by the Board of Trade.

City Lighting.—At a meeting of the Court of Common Council yesterday, Mr. T. H. Brooke-Hitching proposed: "That it be referred to the Streets Committee to approach the City of London Electric Lighting Company, Limited, with a view to ascertain the price and terms on which the company would be prepared to sell their undertaking to the Corporation of London, and to report the company's reply to this Court."

Portrush.—At the last meeting of the Council, some correspondence was read from Mr. Brett, county surveyor of Antrim, and Mr. W. A. Trail, C.E., engineer of the Giant's Causeway tramway, in reference to objections against the erection of the posts required for the overhead electrical traction. It was agreed that Messrs. Traill and Brett be requested to confer with the Improvement Committee on the subject.

National Telephone Company's Bills.—In the House of Commons leave has been given to introduce Bills to provide for the dissolving of the National Telephone Company, and for its reincorporation, for defining its objects and powers, and for other purposes. These Bills and the Telegraph Act (1892) Amendment Bill have now been read for the first time. It will be curious to watch the result of the second reading.

Bettws-y-Coed.—The Bettws-y-Coed Urban District Council have received a report stating that the only available water supply for a local installation was the Swallow Falls. An installation could be put down, including building and the wiring of the district, for less than £2,000. On account of the beauty of the Swallow Falls, which are an attraction to visitors, the electric lighting will be deferred for the present.

Killarney Electric Lighting Company, Limited.—This Company was formed some five years ago with a share capital of £6,000 divided as follows: 3,000 7 per cent. preference shares of £1 each, and 3,000 ordinary shares of £1 each, and £6,000 in 600 6 per cent. debentures of £10 each. There are offered this week £1,000 debentures and £2,000 preference shares for public subscription. The subscription list closes to-day.

Personal.—Mr. W. Wyld, A.I.E.E, assistant electrical engineer to the county borough of Salford, has resigned his position, having been appointed electrical engineer to the Patent Shaft and Axletree Company, Limited, of Wednesbury, where he will have the erection and management of a large power plant on the multiphase system.—Mr. A. Sharp has been appointed electrical engineer for the Parade lighting by the Bridlington District Council.

Liverpool.—Reduced fares, which will come into operation at the opening of the extension to Aigburth-vale, have been adopted

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by the Tramways Committee. At the meeting of the Electrical Committee of the City Council there was read an extract from the proceedings of the Estate Committee transferring to this committee 66,000 square yards of land for the purposes of an electric generating station in Lister-drive. The surveyor was instructed to prepare plans of the proposed station.

Greenock.—The Police Board, after discussing the proposals of the Greenock and Port Glasgow Tramways Company in regard to lease of line and electric traction, have agreed to continue negotiations with the company. A Greenock solicitor has submitted an alternative tender, which, it is said, gives better terms than that of the tramway company, and will be considered by the Board. The Town Council have resolved to oppose the Bill of the tramways company relating to electrical traction.

Wimbledon.—The proposed scheme of the United Tramways Company, Limited, has been referred to the Road and Drainage Committee of the Urban District Council. The intention of the company is to bring the tramway from Hampton Court, through Kingston, New Malden, and the Worple-road, Wimbledon. Mr. Preece has informed the committee that the electric lighting plant will be ready for the private lights in April, but the whole installation for the streets will not be ready for some months later.

Parliament.—The following Bills have been read a second time: Southport and Lytham Tramroad Bill, Caledonian Railway Bill, Paisley and Barrhead District Railway Bill, South Staffordshire Tramways Bill, Weston-super-Mare, Clevedon, and Portishead Tramways Company (Light Railway Extensions) Bill, Oystermouth Railway or Tramroad Bill (Lords); Central London Railway Bill, Charing Cross, Euston, and Hampstead Railway Bill, Gateshead and District Tramways Bill, Harrow and Uxbridge Railway Bill (Commons).

Walker.—The District Council have written to the gas company, in reply to a letter giving the terms agreed to by the Wallsend and Willington Quay Urban District Councils, and a list of the streets in the Walker district in which the company is prepared to lay electric mains within two years, that, as the Council is applying for a provisional order, the only proposition they can offer the company is that they should eliminate from the Bill all reference to the district of Walker, and so save the district and Council the expense of opposing their Bill.

Competition in the City.—We are informed that a Board of Trade enquiry will be held in the Guildhall, E.C., on Monday, March 27, at 11 a.m., to consider the applications by the Charing Cross and Strand Electricity Supply Corporation, Limited, the Metropolitan Electric Supply Company, Limited, and the Smithfield Markets Electric Supply Company, Limited, respectively, for provisional orders to authorise them to supply electricity for all public and private purposes within the City of London. Sir Courtenay Boyle, K.C.B, will preside over the public enquiry.

Southampton.—A deputation from the Corporation has visited Glasgow and inspected the electric tramway system there. They were received by Convener Paton, Mr. John Young (general manager), and several members of the Glasgow Committee, by whom they were conducted over the system. After inspection of the satisfactory working on the steep route down High-street, and of the car-building works at Coplawhill, the party was entertained at luncheon in the Municipal Buildings. The deputation also visited Bradford on Saturday, and inspected the Horton section of the tramways.

Worthing. — Messrs. Burstall and Monkhouse have been instructed to furnish the necessary plans and particulars to enable the Town Council to apply to the Local Government Board for a loan for the purpose of carrying the electric lighting order into effect. The loan for the foregoing work is to be restricted to £37,500, and the estimates are to be framed on the assumption that the average charge for current to private consumers will be 6d. per unit and for public lighting 2½d. per unit. For the purpose of acquiring lamp columns and suitable lanterns application is to be made to the Local Government Board to sanction a loan of £960, so that the lighting may be entirely under the control of the Corporation, the gas company supplying only the gas.

Orpington.—An enquiry was held last week by the Earl of Jersey, G.C.M.G., Colonel Boughey, C.S.I., R.E., and Mr. Gerald A. R. Fitzgerald into an application by the Orpington, Cudham, and Tatsfield Light Railway Company for an order to construct a light railway from Orpington Station to Tatefield. After hearing evidence, Lord Jersey said the Commissioners were agreed that the line would be of general advantage to the district, but they would require the names of some responsible persons to be handed in as promoters before they recommended the order to be granted. They thought that a limit of two years should be imposed for the acquisition of the land, and that the line should be completed in three years' time from the granting of the order.

Fulham.—The Lighting, Electric Lighting, and Dust-Destructor Committee have appointed a sub-committee to consider 39 applications received for the appointment of clerk of works for the building of the electric light station, etc., and have selected six candidates. The time for sending in contracts for the complete electrical equipment for the Fulham Vestry is to be extended from March 8 to March 22. Messrs. Crompton and Co. have returned the plans and specifications sent to them, with an intimation that their works are so very full up with orders that, even if they obtained the contract, it would not be possible for them to deliver in time. The General Electric Light Company, of Manchester, have been asked to tender, so that eight tenders will be received for the work.

"Beacon" High-Resistance Wire.—We have received from Messrs. W. N. Brunton and Sons, of Musselburgh, Scotland, a list of their high-resistance wires, which are sold under the name of "Beacon." The list has been prepared for them by the Electrical Standardising, Testing, and Training Institution, of London, and the results of these tests are contained in a useful list which covers all gauges of wire from No. 8 S.W.G. to No. 30 S.W.G. The list gives for each wire the yards per pound, the resistance for given lengths, weights, etc., and, what is more important still, the carrying capacities for a given final temperature of 80deg. C. and 220deg. C. This makes the list very handy indeed for reference, and should assist engineers in designing resistance frames in which the "Beacon" high resistance material is employed.

A New Friction Clutch. — We have received from the "Unbreakable Pulley and Mill" Gearing Company, Limited, of West Gorton, Manchester, their list of a new friction clutch and pulley, which seems to be well made and easy of adjustment. The two friction blocks which go inside the pulley to be driven from the shaft are forced against the inside rim by means of two double-threaded screws working in gunmetal nuts. These gunmetal nuts are revolved by means of links from the small groove pulley into which the striking gear works. The arrangement of screws is such that they can be easily adjusted, and hence any wearing on the friction surface can be taken up. The pulleys are at present made in six sizes, which are capable of transmitting from 7 h.p. up to 100 h.p. at 100 revolutions per minute.

Birmingham.—The City Council on Tuesday adopted the report of the Public Works Committee, and proposed a resolution approving of the recommendations with respect to the future working of the tramways within the city, and instructing the committee to carry them into effect. This commits the Council to the municipalisation of the tramways when the present leases expire. It was said the resolution did not close the door to further negotiation with the companies, and every inducement would be given them, except purchasing or renewing their leases, to improve the traction without delay. A suggestion that the committee and the tramway authorities should consider the question of adopting the overhead system of electric traction as an experiment on one of the routes did not meet with a favourable response.

Glasgow.—Mr. Horace F. Parshall, London, has submitted a report upon the system of generating and distributing electric energy for the overhead system of electric traction in Glasgow. He says that a single generating station, with high-tension multiphase transmission to sub-stations located in some of the existing car sheds and stables, will be found the most economical to work, involves less capital outlay, takes less time to instal, lends itself to complying with the Board of Trade requirements and the safety of the gas and water mains, and is of a type least likely to be superseded when further demands are made, either as an increase in the area to be served or increase in traffic over the existing system. In making a comparison of the cost between a three-phase generating station with converting sub-stations and a system of several generating stations, he estimates the former at £316,000 and the latter at £390,000.

Hackney.—The Hackney Vestry have adopted the Electric Lighting Committee's report noted in our last issue. The committee recommended the adoption of scheme B, a combined scheme of electric lighting and dust destruction. The total cost of this scheme, exclusive of the charges for site, is estimated at £242,367, and such expenditure would be extended over a period of four years as follows: at the end of the first year's operation, £107,772; at the end of the second year, £157,910; third year, £204,090; fourth year, £242,367. The committee's further recommendation that the scheme be referred back to them with power to confer as to sites, and also to engage Mr. Hammond to carry the scheme into effect at the usual engineering commission of 5 per cent., has been also agreed to. Mr. Hammond has prepared plans of the proposed lighting station and destructor, and of the mains for distributing the current throughout the area of supply.

Reading.—The Town Council have adopted a report recommending as follows: "That all tramways of the Corporation, whether acquired or newly constructed, be worked by electrical power upon the overhead trolley system. That the scheme for extension of the existing tramways and the tramways proposed to be authorised by the proposed provisional order shall include tramways for the following routes and such other routes as may hereafter be determined on—namely, from a point in Basingstoke-road, opposite Christchurch-road, along Whitley-street, Southampton-street, Bridge-street, St. Mary's Butts, West-street (across Friar-street) to and along Caversham-road to the Moderation Inn. That wherever possible double lines shall be provided. That an electrical engineer be appointed to advise the committee and the Council on the matter, and that the committee be empowered to arrange for the appointment of such an engineer upon such terms and for such purposes as they may deem proper."

Manchester.—The Earl of Jersey and Colonel Boughey, commissioners under the Light Railways Act, sat at the Town Hall on March 7 for the purpose of holding an enquiry into the application of the British Electric Traction Company for an extension order authorising them to construct a light railway between Cheetham Hill and Rhodes, near Middleton All the local authorities over whose districts the proposed railway would run were present to oppose the application. The Earl of Jersey said a local authority had not an absolute veto under the Light Railways Act, yet the Commissioners were bound to pay the very greatest attention to what it said. A light railway was intended to be laid down for the benefit of the people in the district through which it passed. If the authorities representing those people said a scheme was not one which they could support, the Commissioners would hesitate

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very much before forcing it upon an unwilling district. They thought therefore that it was useless to go on with the enquiry.

Bangor.—The members of the City Council who were good enough to sign a bond guaranteeing the city against any loss from the electric lighting installation for five years have reaped the reward which often follows a disinterested action. Now the validity of their seats is questioned. The Council have consulted Mr. Levett, of the Equity Bar, who has declared that the bond is not a legal instrument. Yet a notice appears on the agenda of the Council of intention to move a resolution to the effect that all members of the Council who have signed the bond, having thereby disqualified themselves from sitting on the Council, should at once withdraw in order to avoid further trouble. The signatories of the document held a meeting on Tuesday and decided to withdraw the bond. It is stated now that the promoters of the scheme intend to promote a company to supply the town with electricity. This would probably meet with the approval of the ratepayers, the majority of whom are strongly opposed to the Council undertaking the matter.

Aberdeen.—The Town Council have adopted a report of the Gas and Electric Lighting Committee containing a report by Mr. J. A. Bell on the progress made in the electric lighting department in the previous year, and the need for additional plant to meet the increased demands by private consumers and the supply for the trams. The estimated cost of this plant is stated at £7,500. The committee recommended that the engineer be authorised to invite tenders for the additional plant. The committee has further reported that the electric lighting undertaking's accounts for the year ending Dec. 31, 1898, showed a deficiency of £126. 10s. 8d. With the view of increasing the capacity of the feeder and distributing cables to meet next winter's demand, the committee have authorised the electrical engineer to invite tenders for the copper strip required, the additional copper to be installed when the culverts are undergoing the change to the Crompton system, as it would much reduce the cost of the work. The minute has been also approved.

Edinburgh.—The Town Council at their meeting on Wednesday agreed to provide additional boiler plant at Dewar-place electric lighting station at a probable cost of £4,000; also that the resident electrical engineer be allowed, as at present, so far as consistent with his regular duties, to perform work connected with the wiring of buildings for the Corporation, and to charge the proper department therefor. The Electric Lighting Committee recommended the formation of a subway for electric wires, and asked a remit to obtain estimates for the work. The probable cost of the work is £11,000. The report was approved on the understanding that the estimates should be brought before the Council before acceptance. On the submission of estimates for works at the M'Donald-road electric lighting station, it was stated that the lowest estimate had been accepted in all cases except one, and in that case Prof. Kennedy had reported that the estimate did not conform to the specifications. It is expected that the electric light will be turned on in Portobello about the middle of May.

Kensington.—The Electric Lighting Committee of the Vestry have been informed that the House-to-House Electric Light Supply Company are prepared to fix the remaining six of the seven arc lamps which they are authorised to erect in Kensington-road, one of such lamps having been recently fixed in the centre of the road near Earl's Court-road. As it appears it is not practicable to fix the lamps in the footway on the south side of the road owing to the presence of vaults and mains therein, the committee recommend that permission be given to the company to erect the six trial lamps in the centre of Kensington-road, at equal distances apart; and that the company be required to keep the arc lamps alight from the time of lighting the public street lamps until midnight, and the incandescent lights from midnight until the time of extinguishing the public street lamps. Pedestrian refuges are to be formed at the bases of the lamp columns at an estimated cost of £8 each. Extensions of mains by the Notting Hill and the House-to-House Electric Light Supply Companies were agreed to at Wednesday's meeting.

Rawcliffe Hall Lighting.—The *Blackpool Times* has an interesting account of the electric installation recently laid down at this mansion by Messrs. Thos. Brown and Sons, of Blackpool. The work has been carried out under the superintendence of Mr. J. B. Fielding, manager, late with the Edison-Swan Company, Manchester, and has given complete satisfaction. The power is supplied by a Hornsby-Ackroyd patent safety oil-engine of 5 b.h.p., coupled to a Parker dynamo, with an output of 140 volts and 30 amperes, running at 1,200 revolutions per minute. The engine can be run direct without any fluctuation in the light whatever, the secret of this being found in the extra flywheels on the engine and dynamo. There is a most elaborate switchboard. The cells can be charged or lamps run direct from the engine with the same switchboard. The accumulator cells are by the Electric Power Storage Company, of the well-known L type. They can discharge over 30 amperes for nine hours without running the engine. In order that the fumes shall not tarnish the bright parts of the engines, etc., the accumulators have been partitioned off. The current is conveyed from the dynamo-house to the Hall by a couple of overhead mains. There are 55 lamps in use at present.

Wednesbury.—The following resolution is before the Town Council: "That it be expedient, if the tramway lines within the borough, with their steam and electrical equipment (except the cars and depôt at King's Hill), can be acquired by agreement with the South Staffordshire Tramway Company on reasonable terms, for the Corporation to purchase them, and to agree to grant a lease of the lines to an approved company to work them for a term not exceeding 21 years at such an annual rent as will secure the Corporation from loss in respect of both interest and sinking fund, and the outlay for the maintenance of the lines, poles, trolley wires, cables, etc., and on such terms and conditions as will give the Corporation limited power of control over the running of the cars and fares to be charged (and that, if found to be practicable, it be a condition of such agreement that the Corporation shall have the right to supply the electric current required for running the cars in the borough at a price to be agreed); and that a sub-committee be appointed to conduct negotiations and enter into a provisional agreement with the company for purchasing and leasing the lines, and also to confer and advise with the town clerk as to the opposition to the company's Bill in Parliament if it should be necessary for the same to be proceeded with."

Blackburn.—At the last meeting of the Town Council, the minutes of the Lamps, etc., Committee, which were adopted, stated that the electrical engineer had submitted report and plan on the present and suggested further electric street lighting, with an estimate of the cost of the same, on the basis of the Electricity Committee reducing the price of electricity, and it was resolved that the matter be referred to the Joint Lamp Sub-Committee to report upon, including the lighting of Preston New-road. Additional electric brakes were ordered to be fitted to the cars, in accordance with the recommendation of the Board of Trade made in connection with the Bradford enquiry. It was referred to the chairman, vice-chairman, and Mr. Councillor Hamer to negotiate for the purchase of property in Simmons-street in view of possible extensions of the car depôt. It was also resolved to borrow from the Public Works Loan Commissioners the sum of £23,337, the purchase money of so much of the undertaking of the Blackburn and Over Darwen Tramways Company as lies within the borough of Blackburn, including the option of the company to take a lease of so much of the undertaking for such term of years as would make up the aggregate term of 21 years from the date of the passing of the Blackburn and Over Darwen Tramways Act, 1879, pursuant to the provisions of the Tramways Act, 1870, the Blackburn and Over Darwen Tramways Act, 1879, and the sanction of the Board of Trade dated Feb. 6, 1899, such sum to be repayable with interest at £2¾ per cent. per annum within a period not exceeding 30 years.

Bootle.—The Town Council on Wednesday adopted the following recommendations: That powers be given to the Council, by the Liverpool Corporation Tramways Act, 1897, to alter and reconstruct the tramways in the borough and adopt the use of electrical power; to exercise the power given to the Council by the said Act to supply the electric power required for the working of the tramways in Bootle; to inform the Liverpool Corporation that the Council would also be prepared, on the passing of the Bootle Corporation Bill this session, to supply electric power for the service in Litherland, if the Liverpool Corporation were willing to take the same; to sanction the expenditure of the estimated sum of £13,436 for the station plant, feeders, mains, and overhead construction required for the Stanley-road and Strand-road sections of the tramways, and any additional sum that might be approved by the Council; to urge on the Liverpool Corporation the great desirability of Strand-road being included with Stanley-road in their present scheme of electric car service; to sanction the employment of Mr. T. L. Miller, electrical engineer, Liverpool, to advise the committee and prepare specifications of the electrical works required, and superintend the erection of the station, plant, etc., subject to a formal contract on terms similar to his present contract with the Corporation. The Finance Committee's minutes, which were also adopted, include resolutions involving the expenditure of the following amounts: electric lighting, £33,500; station plant, feeders, mains, and overhead construction required for Stanley-road and Strand-road sections of the electric tramways, £13,436.

City and South London Railway.—Subscriptions are invited (open until March 14) for an issue of £375,000 in 37,500 ordinary shares of £10 each, offered at the price of £6. 18s. for each share (equal to £69 for £100 of ordinary stock), and payable by six instalments, extending to April, 1900. The new capital is required principally for the completion of the extension from Finsbury-pavement to the Angel, at Islington (about 1¼ miles). It is anticipated that the extension, including three stations, will be completed and open for traffic by the end of 1900. Interest at the rate of 3 per cent. per annum will be paid on the amount for the time being paid up until the opening of the extension. This, the first electric railway in London, has up to the present time been an isolated line of three miles in length, connecting the southern suburbs of Kennington and Stockwell with the City. But by the extensions which are to be opened for traffic in a few months, it will become a line through the heart of the City, having connections with all the principal existing railways engaged in metropolitan traffic in the centre and South of London, and by the further extensions now to be made it will bring in the traffic from the North, as well as from the South, and form a connection between the two, which has so long been wanted. When it reaches the Angel it will be within half a mile of the Midland Railway, and there is little doubt that a connection with that line will be made before long, and afford another access for the vast growing traffic of that system, the necessity for providing for which was so urgently dwelt upon by Sir Ernest Paget at the half-yearly meeting a few days ago.

Light Railways.—It is stated that the Light Railways Commissioners have intimated to the London United Tramways, Limited, that they cannot even consider the company's scheme for a light railway or electric tramway through Ealing. The Hornsey Urban

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District Council have decided to oppose the light railways scheme for the district. The Board of Trade have confirmed the 1898 order authorising the construction of a light railway between Didcot, in the county of Berks, and Watlington, in the county of Oxford. An enquiry will take place at Westminster on the 15th inst. into the light railways proposed for the Wembley district. The Roads and Bridges Committee of the East Suffolk County Council have recommended the County Council to inform the East Anglian Light Railway Company that, whilst still reserving their right to oppose, they are not hostile to the principle of having the proposed light railroad. The Standing Orders Committee of the House of Commons have decided to dispense with standing orders in the case of the Southport and Lytham Tramroad Bill, on condition that the references to short lines connecting the new tramroad with the existing tramways in Lytham and Southport are struck out; petitions against this Bill have been deposited in the House of Lords In connection with a deputation which recently waited upon the Tramways Committee of the Blackpool Corporation to ask for support in the promotion of a Bill in Parliament, under the Light Railways Act, for the making of a new tramroad from Talbot-road Station, Blackpool, to Poulton, we learn that the town clerk has been instructed to ask for the best possible terms which the promoters are prepared to offer the Corporation; in case of an amicable agreement, the Corporation will supply the electricity. At the last meeting of the Teignmouth District Council Mr. Marshall Stevens, formerly manager of the Manchester Ship Canal, interviewed the members relative to the construction of a light railway between Teignmouth and Torquay. The Chairman said they would be glad to consider such a scheme. The Clevedon Urban District Council have deposited a petition against the Weston, Clevedon, and Portishead Tramways Company Bill. The Colne Town Council have entered into an agreement with Messrs. Greenwood and Batley, of Leeds, whereby they undertake to support this firm's application for a light railway from Colne to Trawdon. The agreement specified the time allowed the company to complete the railway, a deposit of £2,500 to be made with the Corporation as a guarantee. The charges for the supply of electricity are based on those in force at Carlisle. The enquiry into the light railway application of the Nelson and Colne Corporations, and also of Messrs. Greenwood and Batley, Limited, was heard at Colne on Monday, March 6.

Hammersmith.—The report of the Electricity and Lighting Committee presented to the Vestry at the meeting on the 1st inst. stated that the number of applications received for private lighting was 301 for a total of 21,570 lamps of 8 c.p., the number of consumers already connected 254, with 17,768 lamps, and the maximum number of lamps alight at one time 16,713 (including street-lighting) In his report upon the subject of the proposed extensions of the plant and buildings, the consulting engineer, Mr. A. H. Preece, suggested that the direction of the engine-room and boiler-house should be changed, and that it should go at right angles to the existing engine-house and boiler-house. The new engine-room ought to be made 40ft. wide, so as to allow a much larger class of engine being installed. The boiler-house would also be required to be about 45ft. wide, as he proposed to put in larger boilers. The plant which should be put down in the new extension should be double the size of that which had already been erected, that was, the engines and dynamos should be of 1,000 h.p. The following is the plant proposed: two 1,000-h.p. engines and dynamos, three 500-h.p. boilers, and one 1,000-h.p. condenser. The whole of the accessories would be carried out in the same way as the work at present had been designed. The total capacity of the station in 8-c.p. lamps burning at one time, as completed with the two new 1,000-h.p. sets, would be sufficient for about 50,000 lamps, excluding one 1,000-h.p. set as the spare plant. The present maximum load was equivalent to nearly 15,000 lamps. Therefore, the extensions recommended would produce a supply at least three times the demand. The applications, however, already exceeded a further demand of 5,000 lamps. Mr. Preece stated that the strides which the industry was taking everywhere, and which was taking place at Hammersmith, justified the Vestry in taking immediate steps towards the extensions. By the winter of 1900 this plant would be required. The danger of delay in ordering engineering plant was now fully appreciated by them. The ordering of machinery as early as possible for delivery 18 months hence was by no means an unnecessary step to take. It would not be wise to delay the matter further. As regarded the plans of the buildings, he had considered it necessary to go very carefully into the question of the handling of the coal and providing a proper coal store, so as to avoid being so much at the mercy of the fluctuations of the market. He proposed to have a shed erected, and to make arrangements so that the carts could carry the skips, which would be loaded in the barges, direct into the coal store. The skips could then be lifted off the carts and the coal tipped to any desired position. This method would save two handlings of the coal, and as they were dealing with Welsh coal of a friable nature, a great deal of benefit would be obtained. He proposed also to utilise the coal shed to support some large tanks to enable a large storage of water to be kept; these tanks would then form a suitable roof to the coal bunkers. The committee have approved the surveyor's plans of engine-house, boiler-house, coal store, with testing rooms and additional office accommodation, and recommended that the above report of the engineer and the plans prepared by the surveyor be adopted by the Vestry, and that tenders be invited for the building so soon as the specification and quantities are prepared. They also recommended that Mr. Walter Herring, who prepared the quantities for the present buildings, be appointed quantity surveyor on the same terms as previously. These recommendations were agreed to by the Vestry.

PROVISIONAL PATENTS, 1899.

FEBRUARY 27.

4276. Improvements in automatic potential regulators for dynamos. Newnham Browne, 73 Cheapside, London. (The Tirrill Automatic Potential Regulator Company, United States.) (Complete specification.)

4312. Improvements in electric welding and apparatus therefor. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Geo. L. Thompson Manufacturing Company, United States.)

4313. Improvements in alternating-current meters. Max Déri, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

4318. Improved electric signalling device for railways. Lionel Calisch, 40, High Holborn, London.

4327. Improvements in electro-pneumatic controlling system. George Westinghouse, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Aug. 20, 1898, being date of application in United States.)

FEBRUARY 28.

4360. Improvements in or relating to apparatus for use in electric traction on the conduit system. Edouard Vedovelli and Charles Priestley, 111, Hatton-garden, London.

4370. A rise-and-fall pendant or electrolier for electric light. Peter Stevenson, 115, St. Vincent-street, Glasgow.

4409. Automatic telephone exchange system. Anatole Heiny, 45, Southampton-buildings, Chancery-lane, London.

4416. Improvement in direct-current systems of electrical distribution. Benjamin Garver Lamme, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Aug. 4, 1898, being date of application in United States.)

4417. Improvements in or relating to conduits for electric conductors. Frank Jones and Frederic Arthur Pocklington, 6, Lord-street, Liverpool.

MARCH 1.

4442. Improvements in the manufacture of accumulator plates. Wilhelm Majert and Fedor Berg, 18, Southampton buildings, Chancery-lane, London. (Complete specification.)

4455. Improvements in and appertaining to electric street tramways. Richard Riley, Thomas Winstanley, and Samuel Riley, 12, Turley-street, Queen's-road, Cheetham, Manchester.

4486. Improvements in electric signals and alarms. John Ernest Kelly, 51, Penn-road-villas, Holloway, London.

4496. Improvements in or relating to electrical contact breakers. George Bowron, 111, Hatton-garden, London.

4498. Improvements in and relating to telephonic apparatus. Gregor Blank and H. M. Salmony and Co., Limited, 11, Southampton-buildings, Chancery-lane, London.

4512. Improvements in and relating to perforators for use in connection with automatic telegraph transmitters. Walter John Murphy and George Draper, 323, High Holborn, London.

4528. Improvements in electric bells for cycles and other vehicles. Alwin Rufus Gould, 6, Bank-street, Manchester.

MARCH 2.

4595. Improvement in apparatus for working tramways by electric power. Robert Henry Lendrum, Portland-place, Reinwood-road, Huddersfield.

4598. Protecting the overhead wires of electric tramways and construction of trolley or current collector adapted thereto. John Sturgeon, 28, Grimthorpe-street, Headingley, Leeds.

4605. Improvements in electric motor controllers. Arthur David Stevenson and Arthur Vernon Gifkins, 17, Victoria-street, Westminster, London.

4632. Improvements relating to the operation of electric motors at different speeds. Charles John Reed, 322, High Holborn, London.

4633. Improvement in method of and means for operating electric motors. Charles John Reed, 322, High Holborn, London. (Date applied for under Patents, etc., Acts, 1883, Sec. 103, Aug. 17, 1898, being date of application in ———.)

MARCH 3.

4683. Improvements in automatic switches for alternating electric-current circuits. Horace Field Parshall, 83, Cannon-street, London.

4684. A method of and apparatus for regulating the voltage of electric currents. Horace Field Parshall, 83, Cannon-street, London.

4699. An improved ceiling rose for electric lights and the like. Henry F. Clayton, 70, Palace-chambers, Westminster, London. (Complete specification.)

4705. Improvements in connecting boxes or fittings for use with electric conductors. Albert Mayo Stansfield, 6, Lord-street, Liverpool.

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4727. Improvements in and connected with electric tramway and railway conduits. Alfred Mills Taylor, 77, Chancery-lane, London.

MARCH 4.

4774. An improved electrical cut-out or fuse. Frederick William Heaton and Harry Smith, Salford Switch Works, Sidney-street, Salford.

4778. An improved electric therapeutic apparatus. Percy John Wilkinson and Charles Philip Lowndes Titherley, 34, Castle-street, Liverpool.

4788. Improvements in or connected with electric arc lamps. William James Davy, 40, Chancery-lane, London.

4801. Improvements in and connected with resistance switches for electric circuits. John Henry Holmes and Frank Broadbent, 47, Lincoln's-inn-fields, London.

4821. Improvements in and relating to motor suspension for electrically-driven vehicles. Alfred George Brookes, 55 and 56, Chancery-lane, London. (Theodor Stort, Germany.)

4822. Improvements in and relating to motor suspension for electric automotor vehicles. Alfred George Brookes, 55 and 56, Chancery-lane, London. (Theodor Stort, Germany.)

4838. Improvements in portable electric primary batteries. Charles Hamilton Cole, 321, High Holborn, London.

SPECIFICATIONS PUBLISHED.

1888.

7696.* Incandescent electric lamps. Coad. (Amended.)

1891.

11526 * Electric lamps, etc. Adams. (Amended.)

1897.

19431.* Electric lamps. Adams. (Amended)

26118. Conduit and aerial electro-locomotor primarily for laying or drawing in electric mains or other cables for any service. Benjamin.

26343. Methods of and apparatus for manufacturing filaments for electric lamps. Maxim.

1898.

533. Electric arc lamps. Hills.

2849. Electric switches. Albert Edgar Tanner, Frederick Augustus Cortez Leigh, and George Hill.

3218. Electric motors and dynamo-electric machines. Lake. (Cantono.)

3555. Combined switch and controller for electromotors. Elieson and Naylor.

3563. Electric arc lamps. Brown.

4282. Automatic cut-outs for arc electric lamps. Byng and Angold.

4761. Electric controlling and regulating apparatus. Emmott.

4764. Process and apparatus for tanning by the aid of electricity. Andersen Westengaard, and Zerener.

4812. Alternating-current electric motors. Heyland.

6371. Driving of sewing machines by electricity. Lea.

7333. Construction of plates for electrical accumulators or storage batteries. Mérian.

7764. Apparatus for the electro-deposition of metals. Hope.

8054. Means for fixing or fitting incandescent electric lamps into lanterns. Moores and Farrell.

8920. Trolley poles and standards for electric traction. Siemens Bros. and Co., Limited, and Ayton.

13569. Jointing electric cables. Barker.

16556. Galvanic batteries. Benedict. (Doe.)

17659. Electric meters. Lake. (Bergmann.)

19824. Means or apparatus for facilitating calculations relating to secondary electrical batteries. Cotterell.

20274. Systems of controlling electrically-propelled railway trains. Case. (Date applied for under International Convention, Feb. 28, 1898.)

20275. Controlling electric motors and electrically-propelled railway trains. Thomson. (Date applied for under International Convention, Feb. 28, 1898.)

20276. Systems of train control for electrically-propelled vehicles. Potter. (Date applied for under International Convention, Feb. 28, 1898.)

21758. Systems of train control for electric motors. Case. (Date applied for under International Convention, April 12, 1898.)

24371. Regulation of alternating-current electric motors, applicable also to distribution systems. The British Thomson-Houston Company, Limited. (Steinmetz.)

25710. Dynamos. Fuller.

25985. Methods and means of electric ignition for explosion motors. Pichard.

27593. Systems of train control for electrically-propelled vehicles. The British Thomson-Houston Company, Limited. (Case.)

1899.

101. Electrodes for storage batteries. Willard.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1899.	Corresponding week 1898.	Increase or decrease.	Total receipts for half-year. 1899.	1898.
		£	£	£	£	£
Birmingham Tramway	Mar. 4	3,742	3,417	+ 325	33,769	31,353
Blackpool and Fleetwood Tramroad	,, 4	196	—	—	1,463	—
Bradford City Trams	Feb. 5	145	—	—	6,733‡	—
Bristol Tramways and Carriage Co.	Mar. 4	2,498	2,322	+ 176	—	—
City and South London Railway	,, 5	1,111	1,089	+ 22	11.108	10,720
Dover Tramways	,, 4	140	100	+ 40	1,283	948
Dublin U.T., elec. cars	,, 3	951	667†	+ 284	7,508	6,226†
Dublin S.D. Electric Tramways	,, 3	659	375	+ 284	5,445	3,551
Halifax Corporation Tramways	,, 1	302	—	—	9,428*	—
Liverpool Overhead Railway	,, 5	1,285	1,364	− 79	12,909	13,494
South Staffordshire Tramways	,, 3	631	559	+ 72	4,345	5,255

* Since June 30, 1898. † Including horse cars. ‡ Since July, 1898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	23½-24½
Bournemouth and Poole Electric Supply, Limited, Ord.	10	13-13½
—— 4½ per cent. Cum. Pref.	10	10½-11½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	17½-18½
—— 6 p. c. Cm. Pf., 30,001-40,000 (all paid)	10	18½-19½
—— 5 per cent. Perpetual Debenture Stock	100	125-127
Brush Electrical Engineering, Limited, Ordinary	2	1½-2½
—— Non. Cum., 6 per cent. Pref.	2	2½-2¾
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	101-104
Callender's Cable Company, Debentures	100	114-117
—— Ordinary	5	12½-13½
Central London Railway, Ordinary	10	9½-10½
——	3	7½-8½
—— Pref. Half-Shares	3	3½-4
—— " "	5	4½-4¾
Charing Cross and Strand	5	11½-12½
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	8½-9½
—— 4½ per cent. Debentures	100	114-116
City of London, Ordinary	10	19½-20½
—— " 90,001-100,000	10	19-20
—— 6 per cent. Cumulative Pref.	10	15-16
—— 5 per cent. Debenture Stock	100	124-129
City and South London Railway, Consolidated Ordinary	100	70-72
—— Ordinary	3	4½-5½
—— 4 per cent. Debenture Stock	100	133-135
—— 5 per cent. Pref. Shares	10	14½-15½
—— " " '96	10	14-15
County of London and Brush Prov. Elec. Light Co., Ord.	10	12-13
—— " " No. 30,001-40,000	10	12-13
—— 6 per cent. Cum. Pref.	10	14½-15½
Crompton and Co.	3	3½-3¾
—— 5 per cent. Debentures	—	98-101
Crystal Palace District, Ordinary 5 per cent. Stock	100	130 135
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2½-2¾
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	98-100
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5½-5¾
Electric Construction, Limited	2	2½-2¾
—— 7 per cent. Cumulative Pref.	2	3-3½
—— 4 per cent. Perp. 1st Mort. Deb.	100	103-106
W. T. Henley's Telegraph Works, Ordinary	10	27-28
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	113-116
House-to-House Company, Ordinary	5	9-10
—— 7 per cent. Preference	5	9½-10½
Imperial Tramways, Limited	6	34½-35½
India Rubber, Gutta Percha, and Telegraph Works	10	22-23
—— 4 per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	13-14 xd
London Electric Supply, Ordinary	3	3½-4
—— 6 per cent. Pref.	5	6½-7
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	104-106
Metropolitan Electric Supply, Limited, Ord., No. 1-62,500	10	16½-17½
—— " " No. 62,501-85,000	4	12½-13½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-121
National Telephone, Ordinary	5	4½-5
—— 6 per cent. Cum. First Pref.	10	13-15
—— 6 per cent. Cum. Second Pref.	10	13-15
—— 5 per cent. Non. Cum. Third Pref.	5	4½-5
—— 3½ per cent. Deb. Stock, Red.	100	99-101
Notting Hill Electric Lighting Company, Limited	10	16½-17½
Oriental, Limited, 1879	1	1-1½
—— £5 Shares	5	7-7½
—— £4½ Shares, New	4½	6-6½
Oriental Telephone and Electric Company	1	½-¾
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6½-7½
Royal Electrical Company of Montreal	1½	180-190
—— 4½ per cent. First Shares Mortgage Debentures	100	107-109
South London Electric Supply, Ordinary	3	3½-3¾
St. James's and Pall Mall, Limited, Ordinary	5	16½-17½
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	40-44
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	100	109-112
Westminster Electric Supply, Ordinary	5	15½-16½

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NOTES.

The Wehnelt Interruptor.—A full description of this electrolytic current interruptor (with which Mr. Campbell Swinton gave a successful demonstration at the Institution of Electrical Engineers on Thursday, 9th inst.) will be found in this issue in the report of the last meeting of the Physical Society.

Automatic Telephones.—By direction of the Post Office authorities in Berlin, automatic telephones are to be placed in all their offices, railway stations, and in various other places, with a view to their becoming popularised. They will be on the penny-in-the-slot principle, and for the small sum of 1d. the necessary number of minutes allowed for a brief conversation may be obtained.

The Electric Arc.—The Institution of Electrical Engineers are to be honoured on the occasion of their next ordinary general meeting, on the 23rd inst., by a paper which Mrs. Ayrton will contribute on "The Hissing of the Electric Arc." This will be the first time the Institution has had such a compliment paid to it by a lady. The communication will be illustrated by experiments.

Electric Traction in Canada.—We understand that the various street railway engineers of Canada are considering the question of organising themselves into an association for the purpose of discussing topics relating to street railway management. This organisation will be somewhat on the lines of the large one now in full swing in the United States, but from the opinions expressed in the *Street Railway Review* we do not gather that great unanimity exists on the question of the advisability of organising an association at once.

Glasgow International Exhibition, 1901.—We have received the prospectus of this exhibition, which will include the following sections: "Fine Art, History, and Archæology," "Locomotion and Transport," "Electricity," "Labour-Saving Machinery," "Marine Engineering," "The Women's Section," and "Sports." The Fine Art section will be a prominent feature, and the exhibition will include in sculpture and paintings much that is illustrative of fine art in the nineteenth century. All communications referring to the exhibition should be addressed to Mr. H. A. Hedley, the general manager and acting secretary.

The Darjeeling Lighting Trouble.—We have referred several times to the unfortunate dispute which has arisen over the electric lighting undertaking at this important town in India between the Municipality and the electric lighting contractors. We understand from *Indian Engineering* that it has been decided to refer the question of the safety of the electric lighting installation to expert opinion in England, together with certain points raised in the same connection by the engineer to the Darjeeling Principality. The choice of experts is said to lie between Mr. Preece, F.R.S., and Prof. Ayrton, F.R.S.

A Possible Danger.—A short-circuit between two main feeders was recently the cause of a total breakdown at the Frankfort-on-Maine electricity works. The fault occurred at the switchboard, to which several new marble panels had been added. The current seems to have pierced one of these panels, setting fire to the woodwork of the older portion of the board, which circumstance necessitated the supply to the town being cut off until temporary repairs had been effected. After a careful investigation, the probable origin of the fault was attributed to a vein of metal running through one of the marble slabs, which previous examination and insulation tests had failed to disclose.

Where Ignorance is Bliss, etc.—The following [illegible] in the *St. James's Gazette* of March 15 shows that people are far too eager to suggest impossibilities without due consideration: "Fog Signals.—Sir,—The serious catastrophe which occurred near Brussels the other day during a fog, owing to the inability of the driver to see signals set against him, induces me to think that it might be feasible to erect an arc of red light (electric) over the line at a suitable distance from stations where delays—shunting operations, etc.—occur, the light to be switched on in times of danger; such arc of light to be just clear of the train, so that, for or no fog, it must be seen by the drivers."

Telegraph Rates.—The London Chamber of Commerce recently wrote to the Agent-General of the Cape of Good Hope with respect to the high postal and telegraph rates to Rhodesia and the Bechuanaland Protectorate. This letter has called forth a reply from the Treasury Department of Capetown, in which the London Chamber of Commerce is reproved for interfering in matters without first ascertaining the true facts of the case. It seems that the two districts in question have refused to come into the South African postal union, and that in any case the Capetown authorities have no powers to fix the rates in these districts. The letter implies that the high rates are caused by the wide distances over which letters and telegrams have to be transmitted to comparatively small populations.

Alternate-Current Motors.—We notice in the *Electrical Engineer* of New York a note on starting single-phase motors under load. The note describes some tests made by Prof. R. B. Owen on a single-phase Wagner motor, which it is claimed has exceptional capabilities in this direction. We, however, regret to find that, as quoted by the Wagner Company, Prof. Owen does not go beyond possibilities. Thus they say that "a motor is able to start under a heavy load, and that it has been ascertained that it is able to pull up from standstill more than 50 per cent. overload without an excessive increase from the full-load current." As earlier in the note it is stated that figures cannot be given owing to a want of transformers, we feel quite at liberty to state that we do not believe in a motor started under the conditions stated.

Instruction by Correspondence.—About a year ago we announced the fact that the Electrical Engineers' Institute of Correspondence Instruction had been inaugurated in connection with the *Electrical Engineer* of New York, by means of which young men in any part of the country could receive good technical instruction through the post. We now understand that this enterprising institution has secured the services of Mr. Alfred Wiener, the well-known author and electrical engineer. This gentleman will assume charge of the instruction department of the institute. From what we know of Mr. Wiener's writings on dynamo construction, we are sure that the students and the institute are to be congratulated on the acquisition of Mr. Wiener's services. The address of the institute is 120, Liberty-street, New York.

A New Thermo-Electric Couple.—According to the *Elektrotechnische Rundschau*, experiments carried out by Messrs. Hartmann and Braun, Frankfort-on-Maine, to determine the thermo-electric qualities of different platinum alloys have shown that an alloy of platinum and nickel in conjunction with pure platinum yields a comparatively high thermo E.M.F. For instance, a thermo-electric couple composed of pure platinum and a platinum-nickel alloy—the nickel in the alloy amounting to 10 per cent.—yielded an E.M.F. about double that of the well-known combination platinum (pure), platinum-rhodium, with the couples at equal temperatures. Since, moreover, a platinum-nickel wire is capable of withstanding continued temperatures up

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to 1,000deg. and above, a thermo-electric couple of platinum-nickel and pure platinum would appear eminently adapted for high temperature registration.

Liverpool-to-Manchester Express.—We have received, in common, we presume, with all papers, both technical and untechnical, a notice that the Lord Mayors of both Liverpool and Manchester have consented to join the committee to investigate the engineering and commercial possibilities of Mr. F. B. Behr's single-rail "lightning express." The notice forwarded to us concludes with the statement that "now that the joint committee has been formed it will not be long before work on the new line is actually commenced." As far as we can see, at present there is absolutely no connection whatever between the formation of the joint committee and the commencement of the new line. The usual tedious course of procedure will have to be gone through before the line can be started, and, although a joint committee may tend to remove local opposition, it cannot give the promoters any power to acquire land compulsorily.

Books Received.—We have received a copy of No. 137 of volume xxvii. of the *Journal* of the Institution of Electrical Engineers, which contains the following papers and discussions thereon: "Rotary Converters," by Prof. S. P. Thompson, F.R.S.; "Electric Intercommunication in Railway Trains," by W. E. Langdon; "Improvements in Magnetic Space Telegraphy," by Dr. Oliver Lodge, F.R.S.; "Telegraphy by Magnetic Induction," by S. Evershed; and "Ætheric Telegraphy," by W. H. Preece, C.B., F.R.S. The publishers are E. and F. N. Spon, Limited, 125, Strand, London. The price of the volume, which is accompanied by an index, is 7s. 6d. We have also received Nos. 1 and 2 parts of *Science Abstracts* (for January and February), from the same publishers, with an index for the past year. Single numbers of this publication may now be obtained for 2s. A yearly subscription of 24s. entitles a subscriber to all the issues of that year, and also to the index.

Electric Railways in Germany.—A consular report sent to the United States from Hanover furnishes some clear and concise data as to the progress of electric traction in Germany. The Consul states that up to the end of the year 1891 the number of cities in the German Empire enjoying the advantages of electric street railways, was three; up to the end of 1892, five; 1893, 11; 1894, 19; 1895, 32; 1896, 44; 1897, 61; and on Sept. 1, 1898, no less than 68. In 35 other cities or districts, railways are in course of construction, or finally determined upon. The entire length of electric lines in operation in Germany on Sept. 1, 1898, was 885 miles, the number of motorcars was 3,190. The length of the new lines in course of construction, or about to be begun, at that date was 677 miles. Most of the large industrial cities in Westphalia and the Rhine Province are connected by a network of electric roads, which serve not only for passengers, but for goods traffic.

The American Street Railway Association.—The 1899 convention of this association is to be held in Chicago next autumn, the dates of the meeting running from Oct. 17 to 20, inclusive. The president on this occasion will be Mr. C. S. Sergeant, of Boston. The following subjects have been set down for reports and discussion: "The Modern Street Railway Shop: its Design, Machinery, and Shop Practice"; "Maintenance of Car Equipment"; "Train Service and its Practical Application"; "Investments in Street Railways: how can they be made secure and remunerative?"; and "Construction and Maintenance of Street Railway Tracks." The committee organising the convention express the opinion that it is better to have a fewer number of subjects than has been the custom in the past, in order that the discussions may be more thorough in detail. Delegates attending will be asked to consider the subjects beforehand, so as to be ready to take an active part in their discussion.

Unused Provisional Orders.—In the House of Commons last week Mr. Thomas Bayley raised the question as to the number of local authorities who, holding provisional orders for electric lighting, had not proposed to put their powers into use. Mr. Ritchie, as President of the Board of Trade, replied that there were 30 local authorities who had obtained provisional orders for electric lighting who had taken no steps to give effect to their orders within the time prescribed for the execution of compulsory works. Besides these there were 63 other local authorities who obtained orders in 1897 and 1898, and had apparently done no work; but the time prescribed by their orders had not yet expired. The Board of Trade had lately been calling the attention of local authorities who were not exercising their powers to the matter, and had intimated that the Board proposed to consider the question of revoking the orders. In nearly all these cases the local authorities had replied that they were now taking steps to carry their orders into execution.

Electric Light in the Vatican.—Our French contemporary, *Cosmos*, gives in a recent issue somewhat full details of the electrical installation which has recently been put down in the Vatican. It seems that the Popes of Rome have hitherto employed entirely either candles or oil lamps, and that the present Pope is responsible for the radical change now established. The machinery supplying the light consists of a turbine of 10 h.p. and a gas-engine of 20 h.p. The turbine is driven by a pipe from the fall L'Aigle. As a set of accumulators are being used the water will only be taken at night-time, so that the waterfall will not be disfigured during the day. The turbine drives the dynamo, giving 60 amperes at 180 volts at 1,000 revolutions, while the gas-engine drives the four-pole machine, giving 130 amperes at the same pressure. As only 58 cells of accumulators are being used, we presume that 110 volts will be the likely pressure. The article goes on to describe the religious ornaments, consisting of statues, etc., which have been placed in the engine-room, and which it considers both artistic and pious.

Ozonizers.—Mr. E. Andreoli writes us concerning our note about the Lamprey ozonizer, claiming that the apparatus of Mr. Lamprey is merely a modification of an old form of Mr. Andreoli's. The letter contains statements of a purely personal character, as well as a declamation that the Patent Office is too easy in granting patents. These are matters with which we have nothing to do. We are glad at all times to be made a vehicle for information, and that without fear or favour, but in no shape or form will we knowingly permit personalities. Mr. Andreoli objects to ozonizers being used for the destruction of greenhouse pests, and we agree with him. He says: "Instead of that tedious operation, it is much more practical to use a vaporiser for spraying on the plants a liquid which can easily be made by ozone. Ozone is not only an insecticide, it is a powerful germicide, and every day I make experiments of sterilisation by ozone of water containing from 22,000 to 25,000 micro-organisms per cubic centimetre, and which flows from my tanks at the rate of 300 gallons and more per hour."

Thawing Frozen Water-Pipes.—We notice from the American Press that Prof. R. W. Wood, of the Wisconsin University, has recently used an electric current for thawing frozen water-pipes with great success. He connects the electric light wires to the frozen portion of a pipe. The heating effect, due to the resistance of the

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pipe, then thaws the ice. The 1,000-volt alternating current was conveyed to the primary of a large transformer with an ammeter in circuit. The secondary wires of the transformer were then connected to the outside faucets of two adjoining houses the service pipes of which were frozen solid, with a water rheostat in circuit. In most cases a primary current of 13 amperes, and a secondary current of 250 amperes, at 50 volts were used. This current usually started the flow in 10 minutes. In this manner a service pipe over 300ft. long was thawed in 20 minutes, without in any way disturbing the pipes or ground. The pipes were heated to about 60deg., which was sufficient to rapidly clear them of ice, the water pressure in the main assisting in the operation by starting the flow as soon as a thin shell of ice was melted around the inner surface of the pipe.

Electro-Harmonic Society.—A smoking concert under the auspices of the above will take place in the banquet-room of the St. James's Hall Restaurant, Regent-street, on Friday evening, the 24th inst. It will be under the musical directorship of Mr. T. E. Gatehouse and Mr. Alfred E. Izard. The following is the programme: Overture, "La Souveraine" (Herman), the orchestra; song, "River of Dart" (Edith Cooke), Mr. Harry Stubbs; pianoforte solo, "Tambourin" (Raff), Mr. Alfred E. Izard; ventriloquial sketch, Mr. John Warren; song, "The Curfew" (Monk Gould), Mr. George Stubbs; intermezzo, "Cavalleria Rusticana" (Mascagni), and minuet for strings (Boccherini), the orchestra; humorous sketch, Mr. Tom Clare; vocal duet, "The Fishermen" (Gabussi), Messrs. Harry and George Stubbs; violin solo, "Fantaisie Ecossaise" (Sainton), Mr. T. E. Gatehouse; new song, "The Cup of Life" (Stephen Adams), Mr. Harry Stubbs; mimetic sketch, "The New Hat," Mr. John Warren; harp solo, "Watching the Wheat" (Thomas), Mr. G. T. Miles; song, "Let me Love Thee" (Arditi), Mr. George Stubbs; march, "Under the Double Eagle" (F. Wagner), the orchestra; humorous sketch, Mr. Tom Clare.

The Resistance of Dielectric Films.—A digest of an article by Walter Leick, signed "G. M.," upon the above subject appears in the *Elektrotechnische Zeitschrift*, from which we take the following: So early as 1885 it was pointed out by Mr. Schulz-Berge that the resistances offered by very thin layers of guttapercha, paraffin, and sulphur to the passage of a current varied with the intensity of the current employed. From experiments in the same field of research the author found thin films of these three so-called non-conductors to possess relatively better conductivities than thick sheets, the same being dependent upon the intensity of the current—the resistances, indeed, decreasing considerably with increasing current strength. Phenomena accompany this decrease similar to those observed in connection with hysteresis—namely, the resistances noted during a gradual weakening of the current strength are invariably less than those originally discovered for the same intensities of current. Further, while guttapercha and paraffin show no polarisation, sulphur, on the contrary, gives evidence of strong polarisation. For instance, a film of sulphur about 0·015mm. in thickness enclosed between two plates of Alibert graphite of the greatest possible purity, gave a polarisation E M F. amounting to about 0·9 volt.

The Telephone Industry.—At the meeting of the Institution of Electrical Engineers on Thursday, March 9, it was announced from the chair, with reference to the committee of members which was appointed some time ago to consider and report on the future of electrical engineering in these kingdoms in the branch of telephony, that the following report and rider had been adopted by the Council: "That in the opinion of this committee it is undesirable, from the point of view of the progress of electrical engineering, for the purely local telephone industry throughout the country to be held as a monopoly, or that legislation on the future of telephony in these kingdoms should discourage the undertaking of exchange systems within telephone areas by independent enterprise. The committee is therefore of opinion that the Council should strongly urge on the Government that such legislation may have the further effect of removing existing disabilities to the carrying out of the recommendation." It was mentioned that the Council had already decided to cause an intimation to be forwarded to the Government that, in the event of the latter desiring to communicate with the Institution, this body would be prepared to express any views which might be held as to the effect of possibly pending legislation upon the electrical engineering industry of this country. It should be added that the reading of the minute evoked considerable applause.

Electricity versus Steam.—The experience gained on the trolley lines round Dublin show that electric tramways which are well equipped can successfully compete with railways using steam-engines. This is largely due to the quick access between any two given points of the tramway on which a good service is provided at short intervals. We notice in the *Street Railway Review* some interesting figures concerning an inter-urban line near Wilkesbarre. One terminus of this line is at a town of about 3,000, and the other at a popular pleasure resort. The line, which is 12 miles long, passes through several villages, the largest of which has only 500 inhabitants. The town of Wilkesbarre, which is connected with the system, possesses some 40,000 inhabitants. When the line was equipped with steam plant it was operated at a loss, but since it has been converted for electric traction, considerable profit has been earned. One interesting item showing the relative merits of steam and electricity is that during the last month the steam-engines were in use, the coal bill for two locomotives was just five times the cost of coal for the whole power station during the first month the electric cars were in use. A high-voltage transmission is used on this line, with a potential of 8,000 volts, by which a regular voltage is obtained. Of course transformers and rotary converters are placed at different parts of the line.

Insulation Against High Potentials.—Mr. Charles P. Steinmetz has recently patented an interesting development in the art of eliminating occluded air from dielectrics intended to withstand extremely high potentials. The method is described in the following way in the columns of the *Electrical World*: "In the construction of condensers, transformers, etc., for high-frequency currents or oscillatory discharges of very high tension, it is customary to exhaust the air by a vacuum pump and fill the space with insulation melted and poured in. The organic materials customarily used, such as paraffin, occlude air with such tenacity that in spite of the vacuum sufficient air remains in the insulation to cause heating under the high-frequency alternations of electrostatic stress, and ultimately to disrupt the dielectric. The improvement consists in filling the spaces first with a light liquid hydrocarbon, which readily penetrates all of the cavities, and is so chosen that it boils above the melting point of the permanent insulating material, but below the temperature at which the latter is applied. The hydrocarbon is then eliminated by heat or the vacuum pump, or both combined, carrying with it all traces of air, and the melted insulating compound is admitted. Any trace of the hydrocarbon vapour will combine with the insulating material or be harmless, inasmuch as it is itself a good insulator. The

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apparatus may be assembled in a tank of the hydrocarbon and then removed and placed in the melted insulating compound, the heat driving off the hydrocarbon vapour without the use of an air-pump. Suitable hydrocarbons are benzine, kerosene, the alcohols and gasolene, the latter being preferred.

Niagara in Winter.—We notice in our contemporary, the *Western Electrician*, an interesting description by Mr. Orrin E. Dunlap of the troubles which have occurred from ice in and around Niagara Falls this winter. It seems that there has been an unusually large quantity of ice going down the river this year from Lake Erie, and that this has caused a great deal of trouble in the canal of the Niagara Falls Hydraulic Power and Manufacturing Company, where considerable blasting has had to be resorted to in order to keep the waterway clear. On the Canadian side of the river the cars of the Niagara Falls Park and River Railway Company were forced to stop running for days owing to lack of water power caused by the ice shutting off the supply. The author adds that one of the most remarkable sights in Prospect Park was the ice formation on the electric light wires. At Prospect Point the extent of this icy formation excited much attention. From the falling spray of the falls the ice gathered on the wire until it was nearly, if not fully, a foot in diameter, and between the trees right at the point it hung down in a festoon nearly to the ground. Further back in the grove of the park the wires were also heavily covered with the icy coating, and appeared like huge cables of white metal. The sides of the trees facing the falls were whitened by the ice until they looked like purest marble, while the other side showed the bark. To walk down through the park to the point and then turn around brought about a transformation scene of wondrous beauty. Prospect Point is now protected by a slender iron railing instead of by the stone parapet wall of old. The ice on the river side of this railing was many feet thick.

A Rapid Photometer.—We notice in the *Electrical World* of New York an illustrated description of an improved form of photometer designed by Mr. Hart, of the Fostoria Incandescent Lamp Company, U.S.A. The photometer is intended to be used in lamp manufactories for testing with great accuracy and rapidity the candle-power of lamps. It consists of the usual photometric bar carrying a metal scale graduated in inverse squares and having the 16 point in the centre. By this arrangement the photometer is directly reading when a 16-c.p. lamp is used as a standard. The photometer carriage has a screen of the Lummer-Brodhun type, for which great accuracy is claimed. Of course, other screens can be used if desired. An arrangement exists by which both the standard lamp and the lamp to be tested can be rotated when the test is being made. The speed provided is about 180 revolutions per minute. At the end at which the lamp to be tested is introduced are two spindles, which terminate in a lamp socket. These two axles revolve about a vertical axis, and the arrangements provide that a revolution through 180deg. is automatically given when a certain lever is pressed. In this way, while the operator is observing the lamp in one socket, an attendant is replacing one which has been tested in the other. A motion of the lever is all that is required in order to bring a fresh lamp into position, and in this way a large number of these can be tested in a very short time. The fact that the lamps are revolving prevents any trouble arising from the angle at which the filaments are placed with respect to the photometer. Finally, rheostats are provided, so that the voltage of either lamp can be varied at will. It seems to us in such a case to be rather preferable to keep the voltage on both the standard and the lamp to be tested the same, so that any slight variation of voltage may not cause great errors in reading the candle-power.

The Electrical Fuse.—It is not often that the information published in the *Scientific American* is behind the times, but an article on the above subject in its issue for March 4 might have been interesting reading 20 years ago. In it the author, Mr. A. D. Adams, carefully explains the use of Ohm's law in calculating electric circuits, and proceeds to deduce from such calculations the advantage of having a fuse in all electric circuits. In this process he commits a number of errors, which we can only hope are unintentional. For instance, he says: "The heat developed in any conductor depends on the number of amperes flowing, and if the amperes are sufficiently increased in any case the conductor may be made red hot, white hot, or melted. As the electric current is costly we cannot afford to let much of it be wasted in heating conductors that produce no useful effect thereby, and we consequently proportion the wires of an electric circuit so that their resistance in ohms is small, and there is but little heat produced in them by the electric current. Lamps and motors form most of the resistance of the electric circuit, and in them most of the heat is produced and work done." The author should surely remember that the heating of a conductor varies with the square of the current, and, certainly, speaking of motors, the question of work should come before that of heat. Further on he considers the question of arrangement of circuits, and then describes by implication the old and almost abandoned methods of using distributed fuses, which are placed wherever a decrease in section occurs. He also argues in favour of the fuse that it can be replaced for an insignificant sum, while he thinks the alternative would be to rewire the whole building. All these arguments, which are more or less correct, savour of the days when electric lighting was in its infancy.

The Efficiency of 200-Volt Lamps.—The *Elektrotechnische Rundschau* quotes the results of some experiments recently carried out in Karlsruhe to ascertain the life and efficiency of 220-volt incandescent lamps. No less than six different makes of lamp (all German, we presume) were subjected to the test, the first measurements with the photometer taking place after the same had been burning 15 hours, when the energy consumed was also determined. Subsequent to these measurements, the lamps were subjected to an endurance test on a 220-volt circuit. After 344, 792, and 1,150 working hours respectively, measurements were again taken to determine the energy consumed and the candle-power of the lamps. The graphic representations of the values so discovered show that the lamps, when new, consumed from 3·8 to 4·3 watts per candle, while the actual candle-power of 16-c.p. (nominal) lamps amounted to between 11·4 c.p. and 14·9 c.p., that of 10-c.p. (nominal) lamps being only 8 c.p. After 600 working hours the 16-c.p. lamps were found to consume four to five watts per candle-power, the intensity of the light given varying between 11·7 c.p. and 14·2 c.p. Thus the tests proved anything but favourable relative to the bulk of the samples. The energy consumed is considerable compared with lamps of lower voltage, and the candle-power decreases rapidly with the hour's run. This is especially the case with 10-c.p. lamps, which must, indeed, be termed unserviceable. Individual lamps supplied by the same firms differed considerably, both as regards candle-power and efficiency, which must be ascribed to careless grading. A variation in the voltage amounting to 1 per cent. effected a change in the candle-power of 6 to 7 per cent., which agrees with observations repeatedly made in regard to 110-volt lamps. In conclusion, it is remarked hat the introduction of high-

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voltage lamps will be of little advantage so long as their efficiency remains so much behind that of ordinary lamps.

Inductive Loads on Transformers.—Prof. D. C. Jackson communicated a paper to the North-Western Association at Milwaukee on the effect of inductive loads, such as arc lamps and motors, on alternating-current transformers. The facts of the paper are not new, as every station engineer who has had experience with alternate-current working knows the way arc lamps and motors interfere with the voltage of their systems. In the paper Prof. Jackson assumes three different 5-kw. transformers in which the drops due to magnetic leakage were respectively 3, 5, and 7 per cent. The resistance drop in each case was assumed at 2 per cent. and the voltage on the secondary terminals 112. The author then points out that whereas on a non-inductive load the voltages at full load would be about 109·6; with an inductive load due to arc lamps with a 70 per cent. power factor the extra drop would cause a voltage of 108 on the first transformer, 106·4 on the second transformer, and 103·8 on the third transformer. The author therefore advises that in every case the reactive drop due to magnetic leakage in a transformer should be measured. He advises the following procedure: Short-circuit the secondary coil through an ampere-meter and connect the primary coil to a lighting circuit through a variable resistance. Adjust the resistance until a normal full-load current is indicated by the ampere-meter. Then the reading of a voltmeter across the terminals of the primary coil gives the total drop of pressure. The reactive drop may be deduced by taking the square root of the difference between the voltmeter reading and resistance drop. The resistance drop is found directly from the copper loss by dividing it by the ampere-meter reading. He also points out the importance of determining the power factor of the arc lamps and motors when selecting between different makers.

A Rectifier for Alternating Currents.—For many purposes in which electricity may be used, says Dr. Kalischer in the *Elektrotechnische Zeitschrift*, the direct employment of alternating currents is not convenient. In consequence of this, one has been forced to make use of intermittent direct currents. But the rectifiers with movable parts finding employment for this purpose are more or less unreliable and irregular in their action, besides which a loss of energy is represented by the sparking which occurs at the contacts upon the opening and closing of the circuit. The substitution of a rectifier without these defects, and adapted to work in conjunction with alternating currents, would therefore appear desirable. This has been rendered possible by the recently published discoveries made independently by Messrs. Pollak and Graetz, who have utilised certain properties of aluminium to assist in rectifying alternating currents by employing anodes of this metal in conjunction with certain electrolytic solutions, such as, for instance, potash-alum and soda-alum. By this means a very great resistance may be opposed to the passage of the current in one direction, which is, indeed, quite prevented provided its E.M.F. does not exceed a certain maximum. It is obvious from the foregoing that if we connect one or several such cells, as may be necessary (in series), possessing aluminium and lead or carbon electrodes in circuit with an alternate-current generator and the primary winding of an induction coil, the current will be able to circulate through this winding only when the aluminium forms the cathode, so that the coil will be alternately choked and opened with perfect regularity. By employing two cells or group of cells, it is further possible to excite two induction coils simultaneously, and so to fully utilise the current generated. It need hardly be added that a part of the alternating current may be employed for other purposes without in any way interfering with the action of the induction coils. Electro-plating baths might also be connected, as will be readily understood, and at the same time a portion of the current from the common source of generation transformed into a continuous current through the medium of the arrangement of connections suggested by Messrs. Pollak and Graetz."

An Electric Torpedo.—The *Daily Chronicle* on Saturday last contained a minute description of an interview between one of their staff and a Swedish electrician named Axel Orling. Mr. Orling has come over to London to show a wonderful invention he has just made for controlling torpedoes from the shore without any wire connection. We understand that the torpedo is to be called the Orling-Armstrong torpedo, but there is nothing in the interview to indicate why the last name has been added. When we come to the description of the torpedo itself, the scientific terms employed become somewhat mixed, but, of course, it is impossible to say whether this is due to the *Daily Chronicle* reporter or to Mr. Orling. After a few preparatory questions, the following conversation is reported to have taken place. In reply to the leading question by the reporter as to the general principles under which the miracle was obtained, and as to whether it was by magnetism or wireless telegraphy, Mr. Orling answered, "No; if you ask me to express the general principle of my invention I may say, briefly, that it is a new means of transmitting motor power by means of rays of light." "X-rays?" I asked. "Well, I am not exactly prepared to give them a name," was the cautious reply, "but the light which I transmit from the controlling or steering apparatus on shore (or ship) to the torpedo attachment is transmuted there into electrical induction." "But is not that something like the wireless telegraphy of Signor Marconi?" "No; the difference between him and me is this, that I can concentrate my waves of light, while he cannot do this with his waves of sound." "Just so; and you call this a new means of transmitting electrical power?" "Yes, that is the best way of putting it." "And within what space limits, then, do you claim to direct the movements of your torpedo?" "As far as the eye—naked, or with the aid of a telescope—can reach—that is to say, from the shore to the horizon—which is about six miles; but, of course, if I take my stand on a shore-height, or on the deck of a ship, my area of view will be very much wider." "But then how about darkness, when you cannot see?" "Oh, yes. I can see the whereabouts of my torpedo even in the dark by means of an electric lamp surmounting the rod projecting out of the water—a lamp, on the other hand, which cannot be visible to the enemy by reason of the fact that its shade is always turned towards him." After this, we are not surprised to hear that the invention surpasses anything that has hitherto been known. A speed of 22 knots is to be obtained on the torpedo, and as far as we can read, there is no limit as to the distance it will go without recharging. It would seem, for instance, that a 12 miles' course would be nothing unusual. Mr. Orling also devises a small torpedo which can be discharged ahead of the larger one in order to break through any obstructions, such as torpedo nets. The most satisfactory point of the interview is that the apparatus is now in the London Docks, and that it will be tried in England, when the members of the Press will have an opportunity of seeing it. Until then we are afraid that the real facts of the case will not be known, in spite of the interview in the *Daily Chronicle*.

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ELECTRIC TRAMWAYS AT BLACKBURN.

We have on two separate occasions described the electric lighting works at Blackburn, and in our issue for April 30, 1897, the provisions then contemplated for electric traction were detailed. Since that date the consulting engineers to the Corporation (Messrs. Lacey, Clirehugh, and Sillar) have designed the complete arrangements for driving the trams on two sections by electricity. The works are now practically completed, and the sanction of the Board of Trade is expected in time to allow the service being started by Easter. The Corporation of Blackburn at present own some 14 miles of tramways, and have secured parliamentary powers to equip two other extensive routes. The line to Darwen is also now Corporation property, and is being worked by the Blackburn authorities. When the full powers over these tramways were secured, Mr. A. S. Giles, the borough electrical engineer, was converted at once into the tramway engineer for the town. Mr. Giles has therefore had an ample opportunity for comparing the advantages of electric motors over steam-engines, as the service at present is being given by steam locomotives. From the costs per car mile obtained with these we see every chance of electric traction in Blackburn making another record. The two sections now about to be opened are those going to Preston-road and Witton respectively. The total length of these two sections is four miles, and for a good portion of the way double tracks are provided. At places in the centre of the town, where the width of the road is limited, different routes for the out and home journeys are arranged.

The Station Plant.—The consulting engineers have paid special attention to the arrangement of the plant in the station in order that the most economical results may be obtained. They have also so specified the generating sets for the traction plant that they can supply on to the lighting switchboard. It will be remembered that at Blackburn the centre of the town is supplied on the direct-current three-wire system with 110 volts on the consumers' lamps and 220 volts across the outside wires. The new traction sets (Fig. 1) are arranged with two commutators, which are connected in series for traction work and in parallel for lighting purposes. The switch, seen on the front of the dynamo in Fig. 2, is designed so that the machine can be quickly thrown on to the lighting mains if need be. The advantage of this was proved this winter, when through the careless opening of a new range of steam-pipes one of the electric lighting engines was disabled. There were at the time no cables from the traction plant, but temporary wires were quickly run, and within 20 minutes a supply from this source enabled the whole of the lighting to be resumed. The only difficulty was that small wires only were available for the connections, and that the usual density of 1,000 amperes per square inch was largely exceeded. The two steam dynamos now installed consist of Bellis's engines coupled to Siemens's direct-current dynamos. The armatures of these dynamos, as described above, are wound with two distinct sets of wires connected to two commutators. The output of the machines with the two circuits in series is about 230 amperes at 500 volts. The general plan of the electricity works as now arranged is shown in Fig. 3.

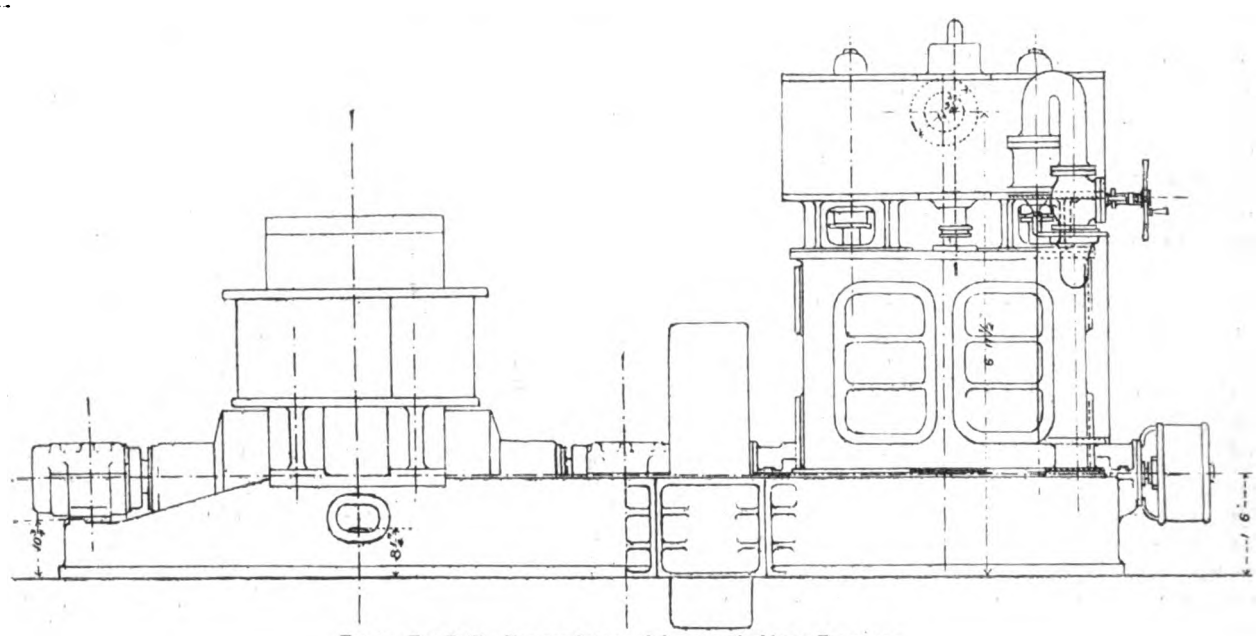

FIG 1.—The Bellis-Siemens Sets used for the Blackburn Tramways.

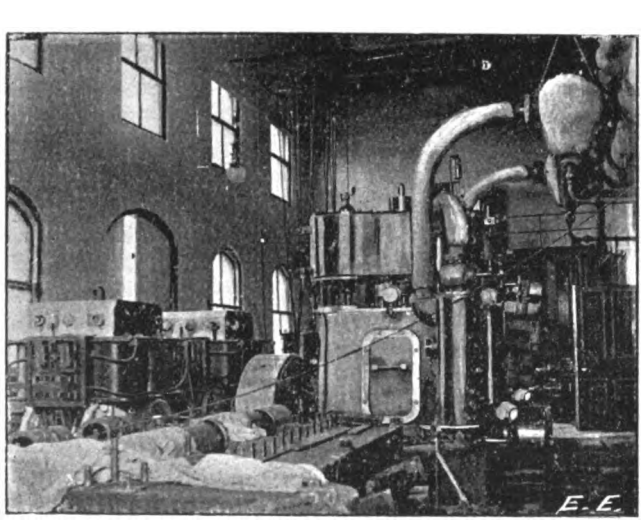

FIG. 2.—The Traction Generators at Blackburn.

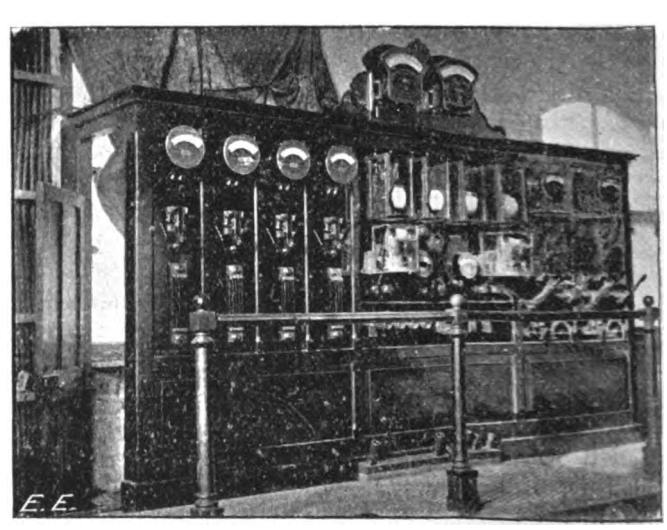

FIG. 4.—The Traction Switchboard.

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At present, however, there are only two of the new battery of four boilers installed. Also in the new engine-room the two traction sets are placed farther down the room than shown. The space between them and the old engine-room is occupied by a new 200-kw. alternator, made by the Electric Construction Corporation. This alternator is coupled to a Willans engine, and is driven at a speed of 250 revolutions per minute.

The new switchboard for the traction plant is illustrated by Fig. 4, while Fig. 5 shows diagrammatically the connection used. This board was also supplied by Messrs. Siemens Bros., who are the contractors for the whole of the traction plant. All the necessary recording voltmeters for insuring that the Board of Trade regulations are complied with are provided, together with the multiple-way switches, to enable them to be connected to the end of any feeder or to the rails at the feeding points.

The next addition to the station is to consist of a 400-kw. steam dynamo, also to be supplied by Messrs. Siemens Bros., which will be placed at the farther end of the new engine-room; and, besides this, provisions are now being made for a condensing plant. This will be placed below the ground level, and will encroach on part of the space in the boiler-house. Condensing water is to be obtained from the Blackwater brook in the following somewhat novel way: Where this stream passes the works it is confined to its bed by walls at either side. In order to make a condensing pond, two transverse walls have been built across the bed, and a duct provided to carry the ordinary volume of stream water. It is found that when the mills are shut down at the end of each week the water-level rises sufficiently to flow right over the first wall. In this way the water in the condensing pond can be frequently changed automatically without interfering with any water rights.

The track over which the electric trams are to run is, with the few unimportant alterations, the same as that laid down for the steam trams. The rails, which weigh 88lb. per yard, provide the necessary stiffness, and the alterations made have been chiefly due to the need of altering bad curves, etc. In such cases, rails weighing 92lb. per yard have been used for the new work. In the roadwork necessary for the alterations, and for fixing the poles for the trolley line, all work within 18in. of the tramway rails has been done by the tramway department. The repairs outside this have been carried out under the supervision of the borough engineer.

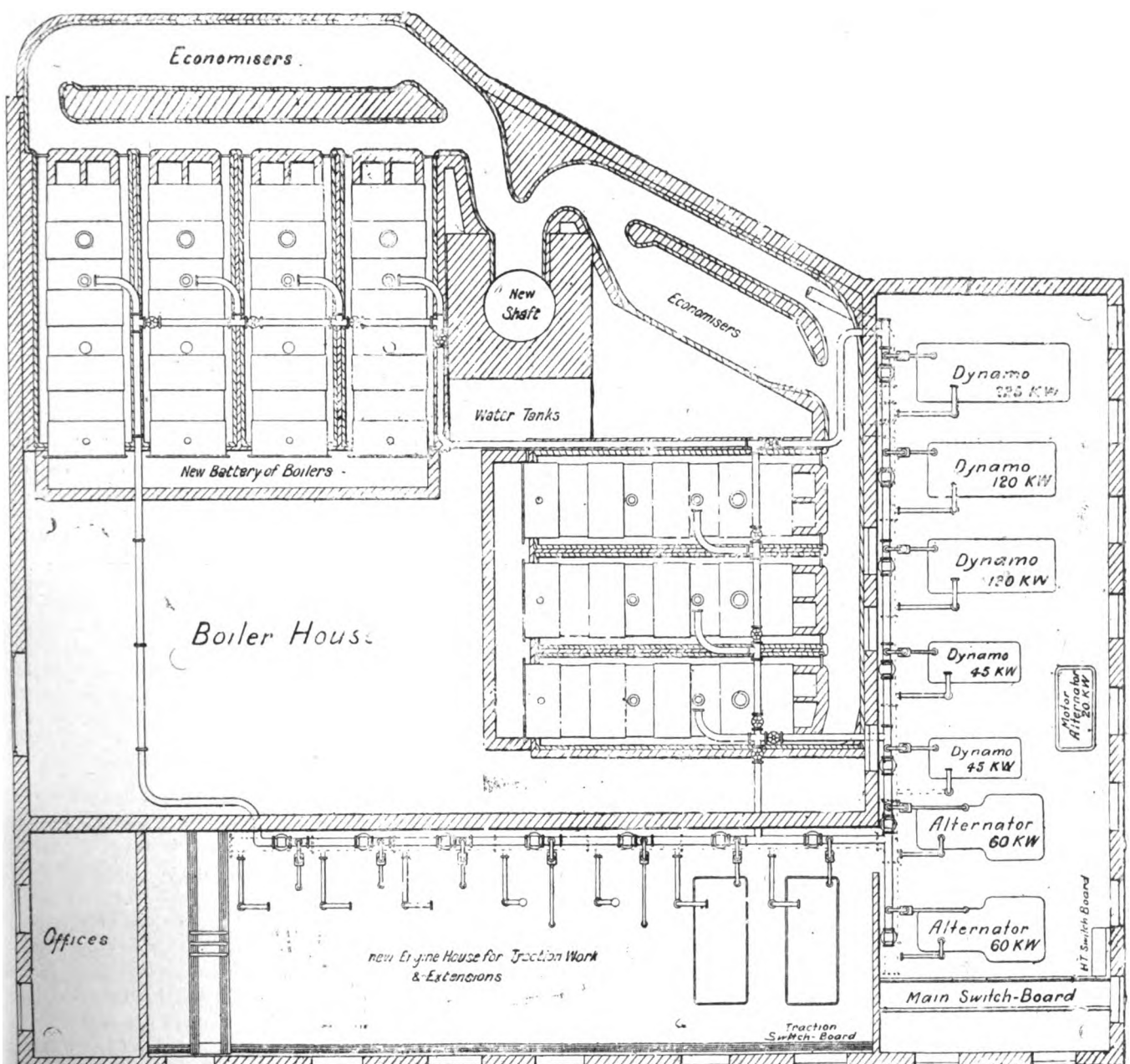

FIG. 3.—Plan of the Electricity Works at Blackburn.

Great care has been bestowed on the design of the overhead trolley line and its accessories in Blackburn, both by the consulting engineers and by Mr. Giles, who has superintended the carrying out of the arrangements. As a result of the careful selection of the position of the post, the number of strain wires at the corners has been reduced to a minimum. The general appearance of the line as we saw it last week is most pleasing, and the three following illustrations (Figs. 6, 7, and 8) will give our readers a good idea of the arrangements. Wherever a double track is used, the central pole construction has been adopted, as shown in Fig. 6. This view was taken just outside the entrance of the

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Municipal Park on the Boston-road of the route. On this part of the line, which is fairly straight, it has been possible to place the poles a good distance apart, so that an arc lamp is placed on every alternate pole. In other parts of the route one arc lamp on every third pole is found to be quite sufficient for lighting the streets. The arc lamp seen in Fig. 6 is supplied from the alternate-current mains. Fig. 7 was taken at the corner where a double track is divided into two single tracks. In this case, of course, the central-pole construction changes into two of the side-pole type, as can be seen in the distance. This photograph is taken in the central portion of the town, where direct currents are available; hence a shorter arc lamp is used. The remaining view (Fig. 8) shows a typical arrangement with side poles.

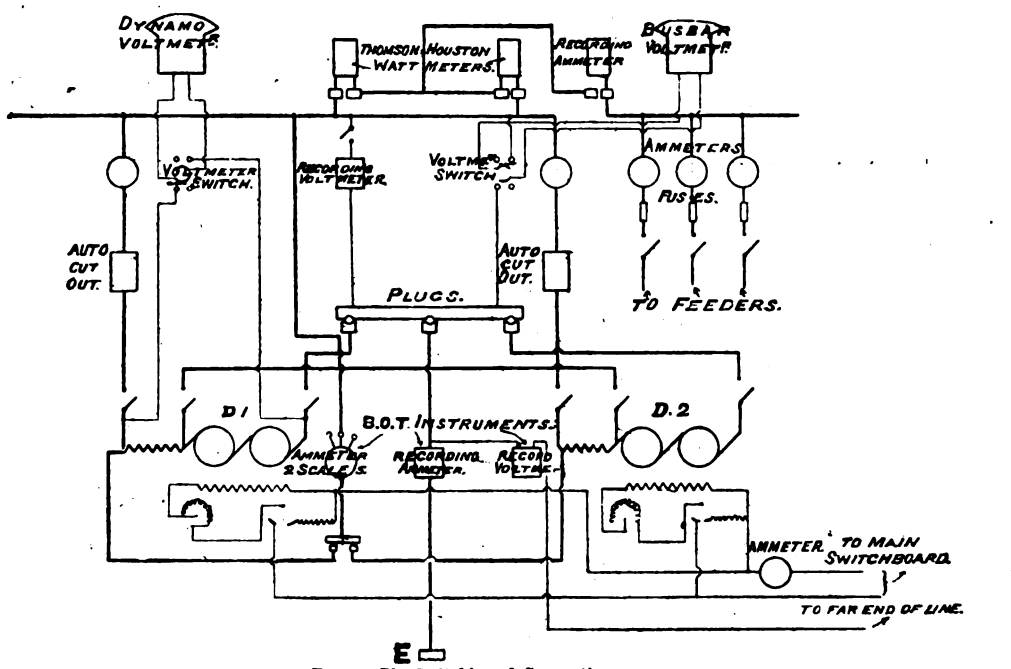

FIG. .—The Switchboard Connections.

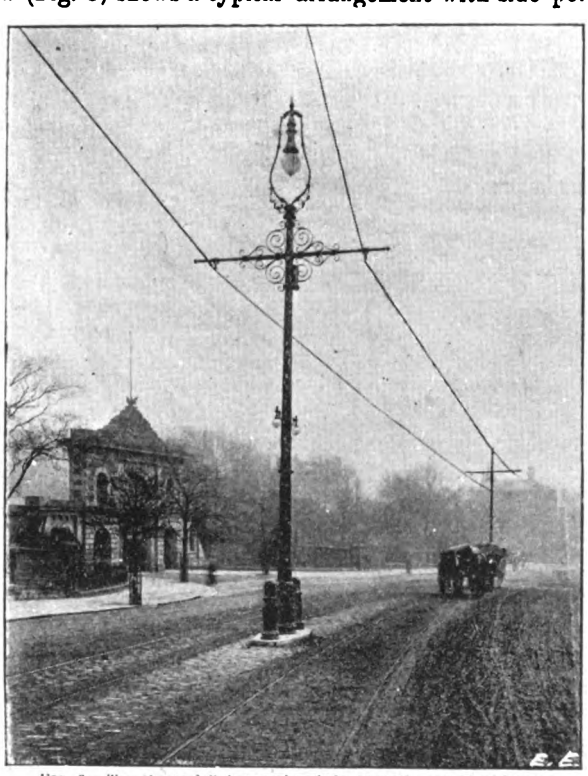

FIG. 6.—The Central-Pole Overhead Construction at Blackburn.

On practically every pole along the route incandescent lamps are fixed, which are supplied from the electric lighting mains. The arc lamps will be turned out about midnight, after which time the streets will be entirely lighted by these incandescent lamps, which are of 32 c.p. Four feeders leave the central station at present, and communicate to different parts of the overhead trolley. These are arranged to terminate in section pillars, as shown in detail in Fig. 9. These are equipped with the usual complement of switch fuses, by which either section of the line can be isolated at will, and also with lightning arresters. Pilot wires are led from these switch pillars back to the central station, so that a record of the voltage at the end of the feeder or of the voltage of the earth returns at this point can be ascertained, or, if wished, can be recorded on a recording voltmeter. The design of these pillars is a very neat one, and when the doors are opened ample access is provided to the switch fuses and other apparatus which may require adjustment.

One feature in which Messrs. Lacey, Clirehugh, and Sillar have made a radical departure in connection with

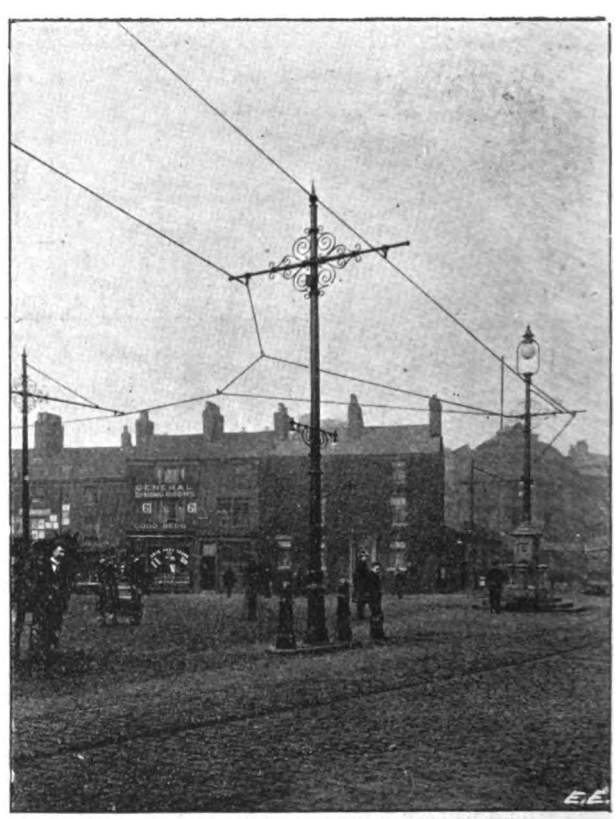

FIG. 7.—A Neatly-Engineered Corner in the Trolley Wires.

the overhead work is in the arrangement of the guard wires. They have succeeded in persuading the postal authorities and the National Telephone Company that guard wires arranged in the form of a cradle underneath their lines would be more efficacious than guard wires placed immediately over the trolley wire. This procedure has been adopted, and the guard wires under the telegraph and telephone wires have been erected at the expense of

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the tramway department. In one or two cases even changes of route have been made in order that a large number of telephone wires may cross the track at one place instead of being spread out over a considerable distance.

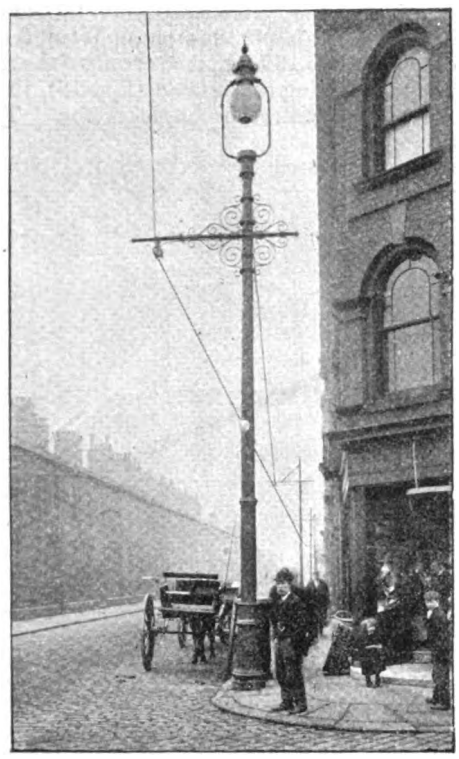

FIG. 8.—The Side-Pole Construction at Blackburn.

Although this system is new in England and has not yet been passed by the Board of Trade, we consider that it should give every satisfaction. It will be remembered that a similar arrangement has been adopted in Germany by the Verband Deutscher Elektrotechnisker for the protection of the public.

At present eight 60-passenger cars have been supplied, and these will be sufficient to work the two sections which are already equipped. As further extensions are added, of course the rolling-stock will have to be increased. These cars are shown in plan and elevation in Figs. 10, 11, and 12. It will be seen from this that one special feature in the car itself is the good platform space provided at either end. This, it is claimed, will allow of the passengers being able to leave the car in much less time than with the usual restricted outlets. The car bodies were provided by Messrs. Milnes and Co., the noted carriage builders of Birkenhead, and are fitted with everything necessary to provide for the passengers' comfort. In this respect they form a vast improvement on the tramcars to which the Blackburn people are accustomed. The bogie trucks were manufactured and supplied by the J. G. Brill Company, of Philadelphia, through their London agent, Mr. Maskell E. Curwen. The trucks are of the maximum traction type, as shown in Fig. 13, in which large driving wheels and small trailing wheels are used. The Brill trucks are so well known that it is unnecessary to describe them in detail, especially as the illustration shows very clearly the working parts. The solid-forged iron frame of the truck is perhaps its greatest feature, and the arrangement of springs is such as to give great ease in running. The makers inform us that the same type of truck is being used, or is about to be used, at St. Helens, Glasgow, Dublin, and Liverpool. The makers claim great advantage from the fact that the whole sidebar of the truck is in one

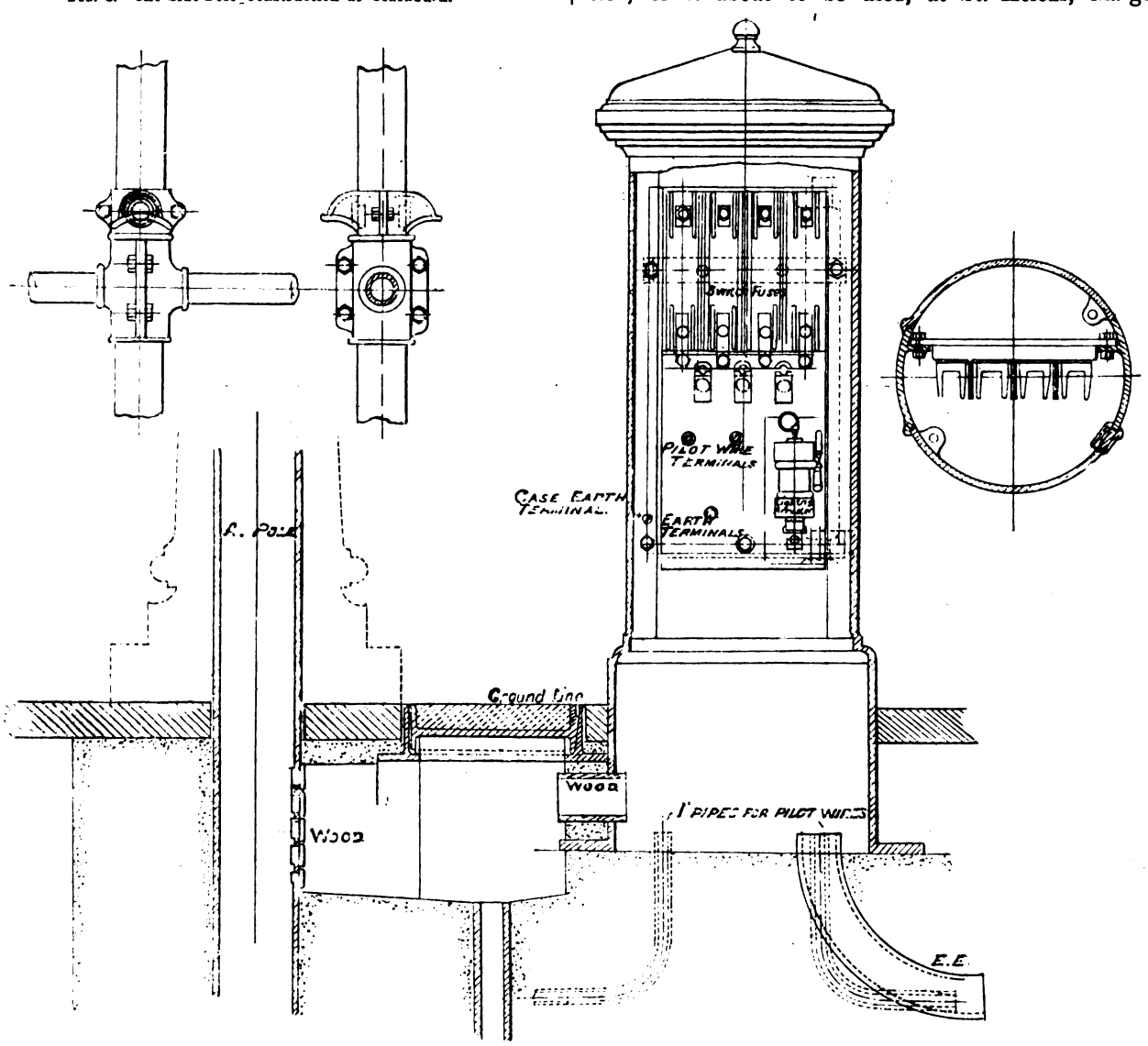

FIG. 9.—The Section Pillars used at Blackburn.

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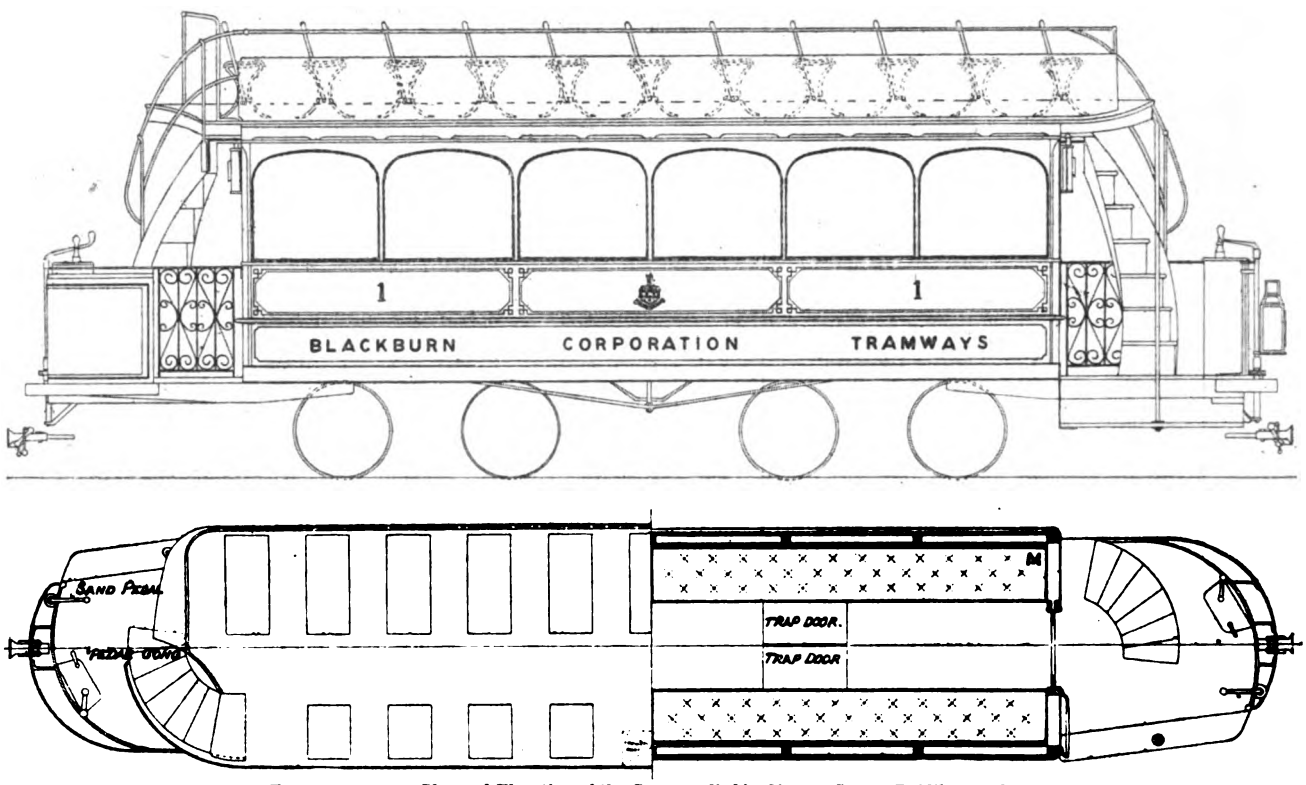
piece, free from any bolts or rivets which are liable to work loose under the strain to which they are subjected.

We regret not to be able to give a drawing of the motors at present. They are of the four-pole type with steel shells and the usual spring suspension. The brushes are of carbon, set at an angle, and the commutators on the occasion of our visit showed that the motors were running sparklessly. These are the first motors of the enclosed type made by Messrs. Siemens Bros., who have a large number of orders for them from other lines now in course of construction.

The controllers used on these cars are of the Siemens series-parallel type, which seem likely to have a great future before them. The general arrangement of the controller can be seen in Figs. 14 and 15, while the complete diagram of connections is given in Fig. 16. The great feature in the controller is the use of quick-break double-contact switches for making the various changes. These switches, which are seen on the left-hand side of the controller in Fig. 14, are provided with carbon breaks, which effectually prevent any damage being done to the main contacts when the current is broken. The quick break and the great length between the contacts after interruption are perhaps, however, the chief factors in the prevention of destructive sparking. The arrangement of cams for working these switches can be seen in the illustration. Diagrams Figs. 17 and 18 show the arrangements of the two motors when connected in series and also when in parallel. In the case of one motor being disabled, a commutator at the base of the controller allows of that motor being completely disconnected from the circuit. When this commutator is rotated through 180deg., it so arranges the resistances and the motor remaining serviceable (Fig. 18), that the car can be taken back with the single motor. The usual arrangements of canopy switches have been provided, so that the current can be cut off from either end of the car. In the switch used for this purpose there is a very neat arrangement of carbon points for taking the spark at break. For this purpose, two carbon pencils projecting through the base of the switch are held by springs against the main contact bar. When the switch is broken these carbon pencils are forced out, and maintain contact until the metal surfaces are some distance apart. The resistances used in connection with the controllers consist of iron strip for the main circuits, and German-silver wire for shunting the fields of the motor.

The other novel features in the Blackburn cars are the trolley and trolley head, both of which are of English design, and contain essential improvements over previous practice. Thus in the trolley gear, shown in Fig. 19, the use of external springs is entirely dispensed with. The spring necessary to keep the trolley wheel firmly against the wire



FIGS. 10 AND 11.—Plan and Elevation of the Cars supplied by Messrs. George T. Milnes and Co.

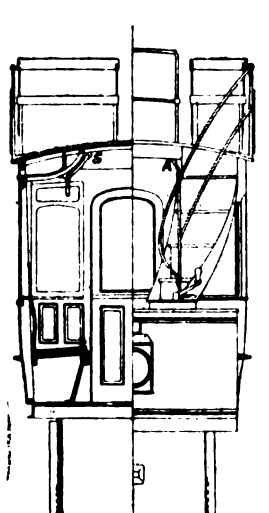


FIG. 12.—End View and Half-Section of Car.

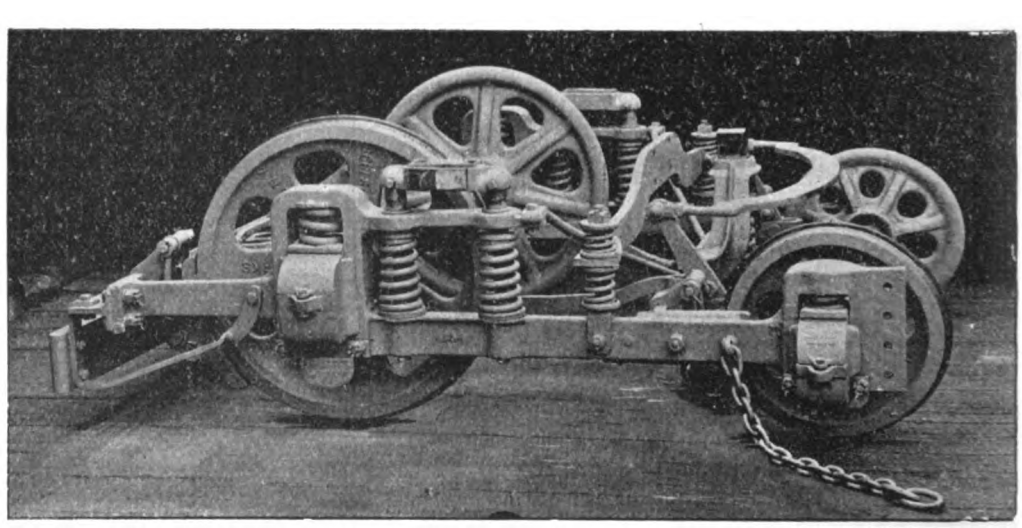


FIG. 13.—General View of the Brill Maximum Traction Truck.

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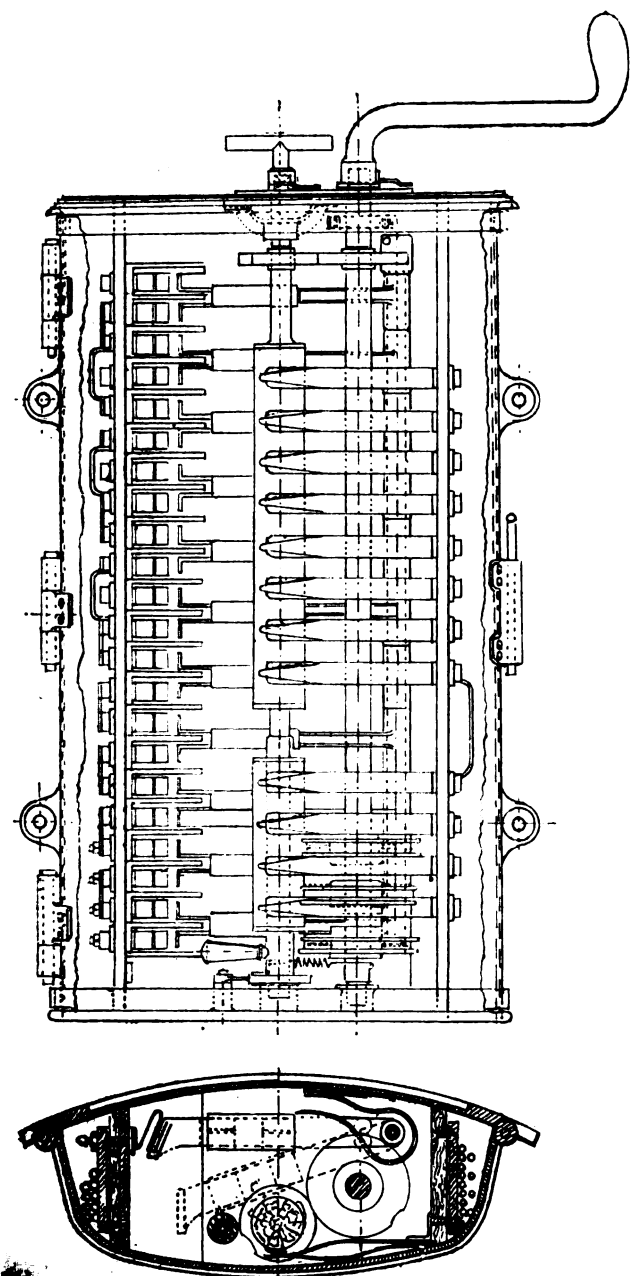
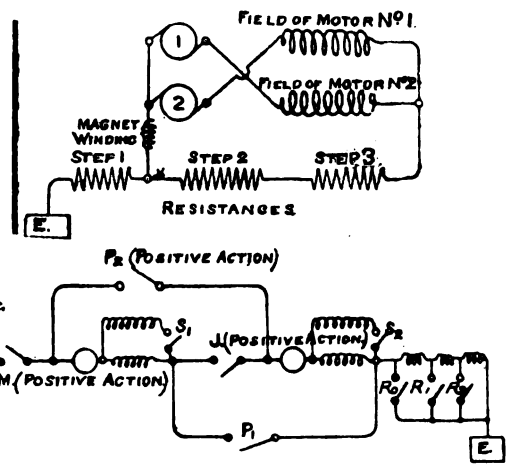


FIGS. 14 AND 15.—The Siemens Series-Parallel Controller.



FIGS. 17 AND 18.

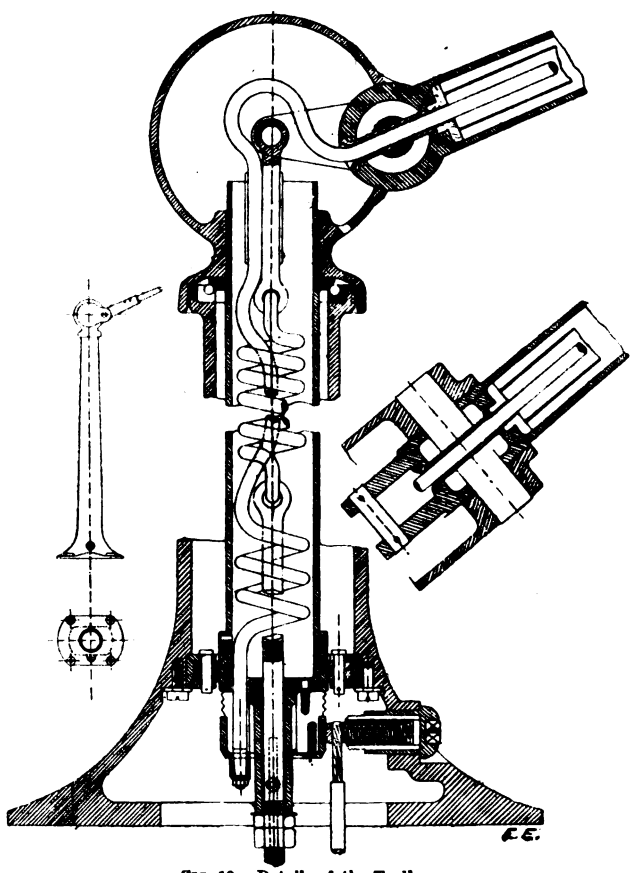


FIG. 19.—Details of the Trolley.

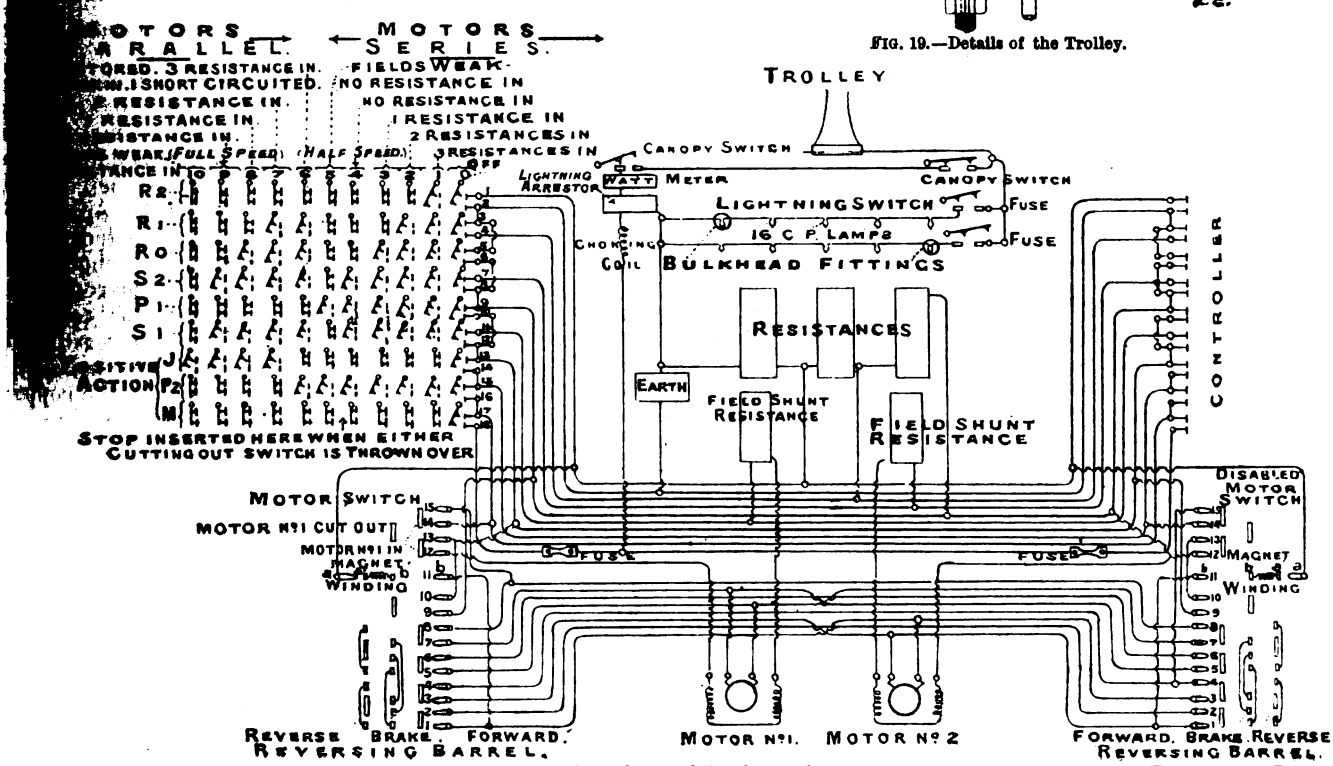


FIG. 16.—Controllers and Car Connections.

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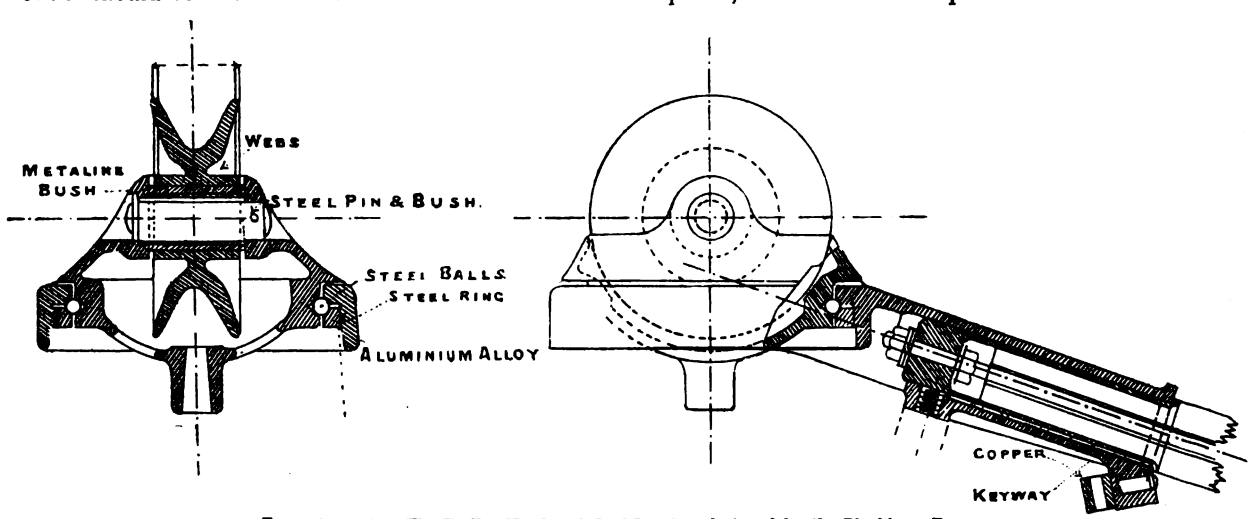
is placed inside the pulley standard, and the tension can be easily adjusted from the bottom. The next point is the arrangement for carrying the current to the base. This, as will be seen by the illustration, is such that the whole trolley can be turned round without putting any set on the insulated conducting wires. Ball bearings are provided to take the weight of the trolley and pole, and also again in the trolley head (Figs. 20 and 21). As a result, the trolley easily follows the wire, even when, with the side suspension, there is a considerable distance between it and the centre of the vertical pillar.

In conclusion, we must congratulate the consulting engineers (Messrs. Lacey, Clirehugh, and Sillar) on the results they have attained, and on the fact that they have used English designs, involving radical departures from American practice. The contractors, Messrs. Siemens Bros., have put good engineering work into the electrical equipment, and the results should be a low maintenance account. This will be appreciated by the Blackburn Council, and their engineer, Mr. A. S. Giles, will, we trust, find that his efforts to give a rapid and efficient service will be duly recompensed.



FIGS. 20 AND 21.—The Trolley Head with Ball Bearing, designed for the Blackburn Trams.

THE PRACTICAL TESTING OF ELECTRICITY METERS FOR CENTRAL STATIONS.

BY C. A. L. PRUSMANN, A.M.I.E.E., ASSISTANT ELECTRICAL ENGINEER, BRADFORD.

(*Continued from page 231.*)

Continuing now with our circuit, we may explain what purpose the connecting bars already mentioned are intended to serve. What is really required, is to make it possible to connect any of the standard instruments (for current measurement) with either the ampere-hour or watt-hour time-test circuits. Assuming that Thomson balances are employed, and that three of these are used, Fig. 14 shows how any or either of these instruments may be connected on to either of the above circuits. Looking at the diagram, it will be seen that one pole of each circuit is connected to a horizontal connecting bar. At right angles to these two bars are four similar ones, the horizontal and vertical bars being insulated from each other by means of ebonite, fibre, or slate slabs. At the points where these two sets of bars cross each other, holes are drilled right through the two bars and insulating material, the horizontal bar being tapped so as to enable a contact plug to be inserted through the face of the vertical bars and to be screwed home into the horizontal ones. The plug itself has a contact surface on it, so as to enable it to sit on the face of the vertical bars and make good electrical contact. Three of the vertical bars are connected direct to the standard balances (or other standards employed), and thence to another set of vertical bars separate and distinct from the first. Crossing this second set of vertical bars are two more horizontal ones, to which are connected the leads connected direct to the meter-testing racks and boards, the returns from the two meter circuits being taken to the adjusting resistances and then direct back to the returns to the batteries as shown. It will be noticed in the diagram that a fourth vertical bar is shown crossing both sets of horizontal bars. This fourth bar is not connected to any standard instrument, but straight through to the meters. This is often useful when it is not required to have a standard instrument in circuit, and when, for example, tests are being carried out by means of the ammeters fixed on each circuit. It will readily be seen that the bars, plugs, etc., must be so proportioned as to deal with currents required in actual practice, and it will be found advisable not to work at too high a current density at plug connections, etc. Before leaving the plugboard, it might incidentally be mentioned that the plugs are shown in position connecting balance A to the watt-hour circuit, and balance B to the ampere-hour circuit. Referring once again to the multiple switches, it must be borne in mind that two sets are required, one set for the ampere-hour meters and the other for the watt-hour meters. It is then possible to be carrying out tests on the two different classes of meters at the same time. An arrangement for obtaining similar results may be arrived at by substituting multiple switches in place of the plugs and bars. Four multiple switches of four contacts each would be required. The leads which are shown connected to the four horizontal bars would be carried to the centre points on the four switches, the leads to and from the balances, and the through connection, being joined up to the four contacts on the four switches. Leaving the "plugboard," our circuit is carried to the testing racks and boards; and a most useful arrangement along testing racks, etc., is to have screwed lengths of copper strip some 2ft. in length, each having terminals riveted on to the ends, or fitted with bolts and nuts, under which a wire can be clamped. These lengths of copper should be screwed about 1ft. apart, and between these gaps the meters can be connected. It will be found that if this is done, three lengths of strip can be screwed along each shelf of the testing racks, shown in Fig. 2, these being 1ft. apart and 1ft. from either end. If terminals are used riveted to this copper strip, connecting pieces of copper rod should be used, the ends being bent at right angles to the rod itself, and of just such a length as to drop into the terminal holes. By this means "looping gaps," when not required for looping in meters, are expeditiously made continuous. If bolts and nuts take the place of terminals, the copper rod connections are replaced by flat links made to slip over the bolts. This system of copper strip looping in connections saves a very large amount of time, besides keeping the circuits free from straggling connecting wires, which are always a source of trouble and annoyance. Of course, all terminals must be of ample size, and the author has found the ordinary thumbscrew terminal answer very satisfactorily; but perhaps bolts and nuts are more efficient from a contact point of view. Leaving the meters, the circuits are continued on to the adjusting resistances. Here a large field as regards choice lies open to us, and we will consider several types of resistances suitable for all requirements.

Resistances.—The resistances to be used in the main

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circuit must be able to carry without any risk currents ranging from a fraction of an ampere up to several hundred amperes if required, and also to enable the current in the circuit to be kept constant by means of an adjustment. Moreover, the method of the adjustment must be such that it is performed steadily and as uniformly as possible. If, therefore, a type of resistance is employed using a switch moving over a fixed number of contacts, connected to different points of a resistance, the resistance between the contacts must be so arranged as to allow of a very fine adjustment to be made; otherwise great difficulty will arise in keeping such instruments as standard balances from working in a most unsatisfactory manner as regards meter testing. The author has tried many different types of resistances for keeping the current in the main circuit constant, and has finally arrived at the conclusion that a form of resistance which is almost imperceptibly cut out or in, and which does not however, is more suitable in cases where the full town's voltage is employed—a practice, as mentioned before, not to be recommended, at any rate, as far as continuous-current work is concerned. There are also many forms of carbon resistances which are very useful. Some consist of carbon plates, about 40 or 50 in number, which can be compressed and adjusted by means of a screw and the alteration in position of a metal plate. Resistances built up in this manner may be made to carry currents up to 100 amperes for short periods, and considerable adjustment is also able to be obtained. Carbon resistances consisting of carbonised cloth are also manufactured, and may with advantage be used for small currents—say up to five amperes. Here again the adjustment is carried out by means of tightening a nut which compresses the layers of carbonised cloth, so decreasing the electrical resistance in circuit. Resistance wire resistances, of course, may be used for the heavy currents if preferred, and give undoubtedly good results

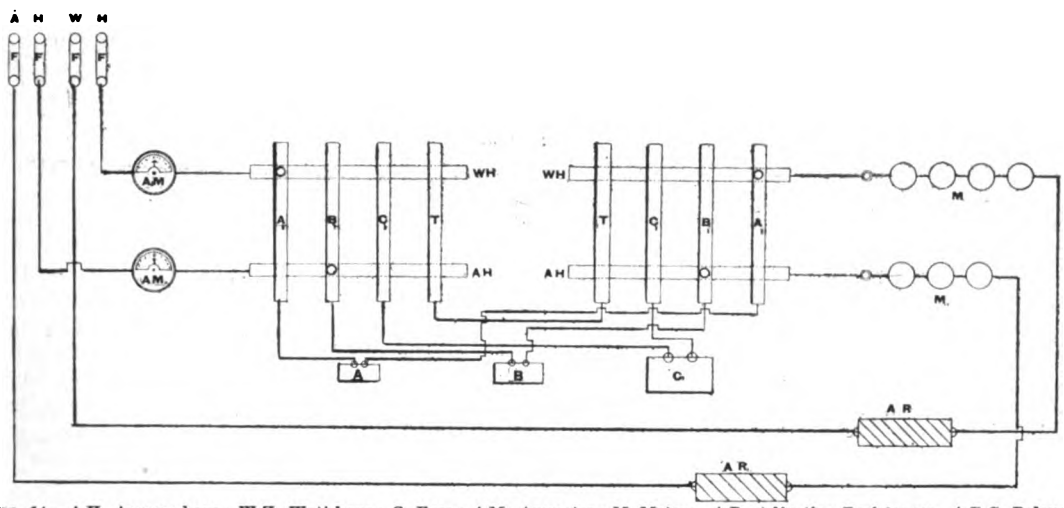

FIG. 14.—A H, Ampere-hour; W H, Watt-hour; F, Fuse; A M, Ammeter; M, Meters; A R, Adjusting Resistances; A B C, Balances; T, Through Connecting Bar.

depend on fixed resistances between contacts, is the best. Although much objection is sometimes urged against liquid resistances, no doubt a large proportion of this objection is without reasonable foundation. For currents from 25 amperes and upwards, liquid resistances are almost entirely used in Bradford, and from the results obtained there is no room left for doubt as to reliability or usefulness. The form and particulars of the liquid resistances used in Bradford will be described in the next section of these articles. It now becomes necessary to find a suitable form of resistance to deal with the small-current tests—that is, from 0·1 of an ampere up to, say, 10 amperes. Lord Kelvin's form of resistance for this requirement is very useful and well known. A stranded resistance wire is wound either on or off an insulated drum, off or on to a metal one, and the adjustment is made by means of gear wheels operated by a handle. With this resistance it will be found that the current can be regulated to a nicety. The great advantage of this resistance lies in the fact that it can be varied evenly and continuously, and so all jumps in the current are obviated. This form of resistance cannot be used for heavy currents, and great care must be taken to ensure no detrimental heating of the resistance wire takes place. Five amperes is the heaviest current used on the particular resistance in Bradford. The type of resistance used for currents over five amperes and under 25 amperes is one very similar to the Kelvin resistance, the difference being that the sectional area of wire is, of course, larger; and in place of the wire being unwound from one cylinder on to another, a sliding contact is employed, operated by means of a handle. The resistance in circuit is increased or decreased by the movement of a copper contact strip sliding along the resistance wires. The author has mentioned the three forms of resistances as chiefly employed at Bradford for meter testing. They have given most satisfactory results under many different conditions of testing. Of course, there are other forms of resistances which also work well. Among these may be mentioned a bank of lamps so arranged that lamps may be cut in or out of circuit as required. This form, if properly and carefully arranged. Whatever form of resistance is adopted, however, the primary object should be secured, at any rate, and that is an adjustment capable of a regular and continuous variation, no jumps being caused in the current during an adjustment.

(To be continued.)

THE DAVY IMPROVED ARC LAMP.

The name of Mr. W. J. Davy has been associated with the design and manufacture of arc lamps for many years, but the lamp we are about to describe is an entirely new departure, and will be manufactured without any connection with the previous commercial organisations associated with Mr. Davy's name. This latest lamp has been on view at Moorgate House during the past week, where every facility for inspection has been afforded. Owing, however, to the patent arrangements not being completed, we are unable to reproduce drawings of the lamp, which is of the enclosed type. The improvements claimed are based upon the fact that only one globe is used. This globe is of the elongated bell form, and fits against an asbestos washer under the base of the lamp. It is secured and held against this by means of two strong springs acting on a steel saddle which embraces the globe, and presses against a metal cap at the bottom of this. This spring and saddle are used to convey current to the lower carbon-holder, which is fixed into the globe and is of a special type. It is split into four parts, and a collar is placed over the horizontal part of the holder clamping the four segments firmly against the carbon. This collar has a steel pin running across it, so that when the carbon is pushed into the holder it also pushes the collar down, thus making the holder grip the carbon tightly. It also enables broken carbons to be easily extracted. The lampholder is centered inside the globe once for all, and in this way the lamp is an exceedingly easy one to trim. The upper carbon-holder slides in the hermetically-sealed tube

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running up the centre of lamp, and a somewhat similar grip is obtained in it. The arrangement in this case is that the upper carbon is at least 6in. or 8in. longer than necessary, in order that the heat of the lamp should never affect the holder. After the carbon has been burned down to this length it is used up in the lower holder. The feeding gear in the lamp is of a simple character, but designed to have a long range of motion in order that, with the large distance between the carbons required, the force given by the electromagnets may not vary appreciably. For this reason the rocking levers at the top of the lamp are furnished with quadrants, so that no difference shall be introduced by angular displacement. The actual feeding of the upper carbon is effected in the same way as was used in the earliest Brush lamps, except that the washer used to embrace the carbon is of much larger diameter. The dash-pot for preventing sudden fluctuations is an air one. We are afraid that more details would be unintelligible without drawings, but the following are some of the advantages claimed by Mr. Davy for his improved type. The first is that the sealing of the globe is practically perfect, so that no air gains admittance into the arc chamber. In this way the globe is not blackened to the extent commonly found with enclosed lamps; also, owing to the greater surface and distance between the lamp and glass, the deposit is not burned into the glass. The construction also allows of the globe being very easily cleaned. The lamp is particularly free from flaring, which Mr. Davy claims to be due to air getting into the arc. It is especially adapted for alternate-current working, and is remarkably silent. Its steadiness is, of course, impaired by the arc running round from side to side of the carbons, but this feature will be found in all enclosed lamps. The lamp complete weighs somewhere about 14lb., and is less than 2ft. in height. The arrangements of the weather-proof case and the globe are artistically designed, so that the lamp presents a pleasing exterior. We understand that the lamps are being manufactured for the new company at an exceedingly cheap rate, and hence good financial results are expected. We hope, however, that in forming the company the inventor will not allow his new lamp to be handicapped by over-capitalisation. We are told that a capital of £60,000 is proposed, but as there will be no costly factory equipment, we fail entirely to see the necessity for such a large capital.

INSTITUTION OF ELECTRICAL ENGINEERS.

Wireless Telegraphy.

BY G. MARCONI, MEMBER.

(Continued from page 309.)

For each signal, however short, the armatures of the relay and tapper perform some very rapid vibrations dependent on each other, for it is the action of the relay which starts the tapper, but the tapper by its action interrupts the relay. The armature of the Morse recording instrument being rather heavy, and possessing a comparatively large inertia, cannot follow the very rapid vibrations of the tongue of the relay, but remains down all the time during which the rapidly intermittent action of the receiver lasts. In this way the armature of the inker gives a practically exact reproduction of the movements of the key at the transmitting end, dashes coming out as dashes and dots as dots.

Much has been said and written about coherers being very unreliable and untrustworthy in their action, but I must confess that this has not been in any way my experience. Provided a coherer is properly constructed and used on a suitable receiver, it is just as certain in its action as any other electrical apparatus, such as an electromagnet or an incandescent lamp. I have coherers which were made three years ago that are now quite as good, if not better, than they were at that time, and we have had tubes working for months in most important installations without ever giving trouble. At the installation my company have erected at the South Foreland Lighthouse, which, as you probably know, is working to the East Goodwin Lightship, the coherer was mounted on the receiver when we first started in December of last year, and has done its work in a most satisfactory manner ever since. I must call your attention to the object and function of the vertical wire, *w*. It has been by means of this addition to the apparatus that we have been able to telegraph over distances which have been so far unattained, I think I am right in saying, by any other method of space telegraphy. The way I came to appreciate the great importance of the addition of the conductor, *w*, and earth connection, E, to the apparatus was as follows (I take this data from a copy of a letter I wrote to Mr. Preece in November, 1896): When carrying out some experiments in Italy in 1895, I was using an oscillator having one pole earthed and the other connected to an insulated capacity, the receiver also earthed and connected to a similar capacity. The capacities were in this case cubes of tinned iron of 30cm. side, and I found that when these were placed on the top of a pole 2m. high, signals could be obtained at 30m. from the transmitter. With the same cubes on poles 4m. high, signals were obtained at 100m., and with the same cubes at a height of 8m., other conditions being equal, Morse signals were easily obtained at 400m. With larger cubes of 100cm. side, fixed at a height of 8m., reliable signals could be obtained at 2,400m. all round, equal to about 1½ miles. These results seemed to point out that a system of transmitter and receiver designed according to the lines on Fig. 1—*i.e.*, a radiator of the Hertzian type having one pole earthed and the other connected to a vertical, or almost vertical, conductor, or to a lofty capacity area, and a resonator consisting of a suitable receiver having similarly one terminal connected to earth and the other to an insulated vertical conductor—constitute a system of transmitter and receiver capable of giving effects at far greater distances than the ordinary systems of Hertzian radiators and resonators.

(To be continued.)

Resumed Discussion.

At a meeting of the Institution of Electrical Engineers on the 9th inst. the discussion on "Wireless Telegraphy," which stood adjourned from the previous meeting, was resumed. **Prof. Silvanus P. Thompson** presided, and intimated that he had received a telegram, dated noon that day, from Boulogne-sur-Mer, from Mr. Marconi, deeply regretting his absence in consequence of being laid up with a bad cold. He added that he would reply to any points that might be raised in the discussion in writing.

Mr. J. Gavey said he would like first of all to congratulate Mr. Marconi on the advance which his paper indicated as having been made in his system during the last 15 months. He (Mr. Gavey) was fortunate enough to have been associated with him in his earlier experiments, and took a share in those conducted across the Bristol Channel. The apparatus used was to a great extent untried, and it was a little uncertain in its action. They, however, succeeded in obtaining very good signals from one side of the Channel to the other, and learnt enough to render it desirable to proceed with further experiments. Permission was obtained from the War Office for the use of one of the forts at Dover for experimental purposes, and the results of these trials furnished conclusions which had been verified by Mr. Marconi since and treated of in his paper. Thus, they proved the law of the square of the height of the wire; they found with single elevated conductors that syntony did not come into effect at all, and that the distance increased with the square of the height. Again, assuming that it were possible to transmit signals with two conductors 50ft. high, signals could also be transmitted over the same distance by using two other conductors of 70ft. and 35ft. respectively, these figures giving the same product. He then went on to show where evidences of syntony had been found. They came across a curious result bearing upon the actual height of the vertical conductor in the transmission of signals over land and sea respectively. Taking the experiments of the Bristol Channel as a guide, and other experiments also made by Mr. Marconi, he calculated that it required a height of 38ft. to transmit signals over a mile of water, and that there was a distinct difference in the transmission of signals overland as compared with over water. Subsequently he found that the professor who was sent over here by the German Emperor to watch the experiments made obtained the same results in the course of his investigations in Germany, and attributed this difference to the particles of dust floating in the atmosphere. He (Mr. Gavey) was afraid that he could not agree with this hypothesis. It was rather due to reflection of the water itself. As these experiments over water were generally conducted from considerable heights, from the high land overlooking the sea, he thought many of the waves that otherwise would go into space

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were reflected back by the water, whereas on land they would be reflected into space or absorbed. He would ask whether a height of 20ft. was a practical working height with a fair margin which could be taken to work under all conditions, or whether this was the shortest height which could be obtained when skilled experts were at the transmitting and receiving instruments? When they found the discrepancy existing between the results overland and sea, they investigated every possible cause which might have led to the difference, and, naturally enough, they suspected the earth, for on the chalky downs at Dover it was very difficult to get a good earth at a moderate depth. They accordingly disconnected the earth and substituted an ordinary coil of wire, which was insulated. They found the transmission equally good. This capacity was eventually reduced to a strip of brass, and from that small capacity it was found they could receive just as well as when they connected with earth. One speaker at the previous meeting of the Institution asked what amount of energy was taken up in producing these results. Well, it was rather a question of frequency than of energy. They had a very large coil capable of giving a 20in. spark, but, as a general rule, they adjusted it so that with a five-ampere current it would give a rapid vibration. Thus they got worse results with 10 amperes and a slow vibration than with five and a rapid vibration. They also tried copper reflectors, and at first he had hoped they were going to obtain very good results, as at a distance of half a mile they could pick up signals spreading over some distance in the open air, but when they extended the experiments they obtained very disappointing results—in fact, so disappointing that those experiments after a time were abandoned. It appeared that even slight undulations, when they were in direct line with the two reflectors, were quite sufficient to prevent the transmission of signals. He gathered from Mr. Marconi's paper that he had gained satisfactory results over distances of two miles. He must confess that it appeared to him (Mr. Gavey) that signalling by means of reflectors would be far more satisfactory than signalling by vertical conductors. If signals were transmitted from vertical conductors at stations within a limited range (and so practically in contact as far as signals were concerned), what was said at one station would be known at all the others. Reflectors would remedy this evil, and would be a practical advantage in the use of the system. Probably in his reply Mr. Marconi would like to glance briefly at one or two practical points, which would be of great interest to the Institution. The question of screening, for instance, was one of very great interest. The difficulty was solved by Captain Jackson in one way, and Mr. Marconi, he thought, had solved it in another. There were one or two other points which would, no doubt, be touched upon by Mr. Marconi—such as the protection of an installation from the effects of lightning—because installations for this signalling were practically lightning conductors, and to introduce lightning-rods into buildings or lightships without any protection would be very undesirable. No doubt other practical points which Mr. Marconi had come across in his observations would strike them also as being interesting, and he would be pleased to give them more information on these and other questions.

Mr. O'Gorman wished to suggest a theory of coherer of action at long distances with extended vertical wires, and to ask a question the answer to which would either condemn or admit his explanation. On sparking there was an oscillating difference of potential between the lower knob of a diagram he produced and an upper knob which was connected to a capacity—namely, the vertical wire which was erected away from the earth's inductive influence along its length. The result was a surging of the potential of the surface of the earth or sea. This surging was entirely superficial owing to the high frequency of the disruptive spark. It was more superficial, and it extended to a greater distance over the sea than over dry land because the sea was a better conductor. It was capable of being detected in all directions round the source of disturbance up to a radius of 18 miles and more by interposing between the earth's surface and a conductor at some height from its surface the only instrument we had capable of detecting such extremely instantaneous reversals—the coherer. To test the coherer under small changes of potential, he applied to its terminals two wires connected to a capacity previously charged by applying from ten to two volts. It always cohered, even when the discharge of the condenser (its ballistic throw) was directed to oppose the coherer deflection, thereby reducing for an instant the pressure on the coherer to zero, or nearly. He distinguished between Mr. Marconi's two methods of transmitting—the one where a transmitter knob is not earthed, and reflectors of true electromagnetic waves were used; the others where one knob and one coherer terminal were connected together by the earth, and in which, although Hertz waves were formed, it would be found that reflectors were of little or no consequence, as the signals were solely due to the surface of the earth fluctuating in potential. The simple test by which his theory might stand or fall was this: Did a reflector arranged to screen all Hertz waves from the direction of the coherer prevent the apparatus from working, or did it still continue to transmit signals? This would at once explain, first, why a horizontal wire was of little avail; second, why a vertical wire was useful; third, how Marconi signalled through a hill 130ft. higher than his transmitter, when Hertz waves would not go through or round such a hill; fourth, why Mr. Gavey got signals with the lower side of his coherer connected to earth through a small capacity instead of a copper wire; fifth, why the proximity of the lighthouse to the vertical wire at Rathlin diminished the effectiveness of that station; sixth, why Mr. Gavey found the distance of transmission was a matter of frequency, not energy, and that reflectors were of no use on the long-distance tests.

Mr. W. P. Granville said that since the last meeting of the Institution he had had an opportunity of thinking over Mr. Marconi's paper, and one or two practical points which he would like the author to answer had presented themselves. He then referred to the battery of 100 large Obach cells used in connection with the experiments at Alum Bay, and asked if those cells were directly connected to the induction coil. He asked the question because he had been informed that the 100 cells were used to charge accumulators, and that the induction coil was worked by the accumulators so charged. If so, it tended to show that Mr. Marconi's system could not be practically used in those places where a dynamo could not be used. Then, in regard to screening effects, they had gathered from the published accounts in the public Press much that was incompatible with other descriptions. First of all, they heard from the published accounts that even three men-of-war, when interposed between the receiving ship and the signalling station, had not prevented the messages being received. Then, again, they had heard that the transmitting waves could be reflected by thin sheets of metal. Of course, the two statements were opposed to each other, and he would like this point also cleared up.

Mr. Miller remarked that he had made a number of experiments, but only with horizontal wires. He would like to ask if it was not desirable to use several sparks acting in series with the transmitter? As to coherers, which was the most sensible metal for contact? It seemed to him that a coherer was wanted that would act in such a way that if a succession of weak waves reached it, it would finally act as a relay. He had heard that carbon reacted in this way, and he would like to know of any experiments in this direction. Having raised one or two other debatable points,

Mr. Campbell Swinton said that he had tried some experiments with carbon in connection with Röntgen rays, but did not find it an advantage.

The **Chairman** said he would like to make a remark or two in contribution to the discussion. The question had been raised, why there was an advantage in having these vertical conductors earthed. It seemed to him there was one advantage which had not yet been pointed out. This was, that the earth below the vertical reflector played the part directly underneath there of a mirror. Some years ago, in conjunction with Mr. Walker, he pointed out that a good many magneto-electric problems might be solved by the idea of a mass of iron acting as a mirror. He then proceeded to furnish an illustration of this, and went on to remark that the reflecting power of the earth and of the water had been mentioned by Mr. Gavey in considering the problem how it was that a greater distance could be reached over water than over earth. Having remarked that Mr. Marconi had touched upon and threw out a suggestion in his paper bearing upon this, other points were raised and discussed, and the debate terminated.

THE TELEPHONE BILL.

The following is the full text of the clauses of the short Bill being introduced by the Government to make further provision for the improvement of telephonic communication:

1. The Treasury may issue out of the Consolidated Fund, or the growing produce thereof, such sums not exceeding in the whole the sum of two million pounds, as may be required by the Postmaster-General for the purpose of the Telegraph Acts, 1863 to 1897, according to estimates approved by the Treasury, and sub-sections 2 and 3 of Section 1 of the Telegraph Act, 1892 (which relate to the mode in which money may be raised), shall apply with respect to the sum so authorised to be issued.

2. (1) Where the council of a county borough are licensed by the Postmaster-General to provide a system of public telephonic communication, they may defray the expenses of exercising the powers conferred by the license out of the borough fund or borough rate, and may borrow money for the purpose in accordance with the Public Health Acts, but any money so borrowed shall be borrowed on the security of the borough fund or borough rate, and the council may, subject to the provisions of the Telegraph Acts, 1863 to 1897, and of the license, exercise their powers under the license throughout the area for which it is granted, although part of that area may be outside the borough. (2) In the application of this Act to Scotland, a Royal or parliamentary burgh having a population of over 50,000, according to the last census for the time being, shall be substituted for a county borough, and the town council or commissioners thereof for the council of a county borough, and the police or borough general assessment or rate of the like nature for the borough fund or borough rate; and the council or commissioners may, with the consent of the Secretary for Scotland, borrow for the purposes of this section on the security of that assessment or rate, but subject to the conditions for the repayment of loans prescribed by the Public Health (Scotland) Act, 1897. (3) In the application of this section to Ireland, the Public Health (Ireland) Acts, 1878 to 1896, shall be substituted for the Public Health Acts.

3. This Act may be cited as the Telegraph Act, 1899, and may be cited with the Telegraph Acts, 1863 to 1897.

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MUNICIPALITIES AND TRADE UNIONS.

The good old axiom of minding your own business is now kept as an antiquated relic of common-sense in museums—it is almost unknown in the ordinary operations of business life. Probably the tendency of to-day is caused by a lack of real education. There exists just enough superficial smattering of reading to enable the holders to get through the halfpenny and penny dreadfuls, to enable them to see a direct result, but not to understand the total outcome of that result. The extension of the franchise has placed in the hands of this half-educated constituency the controlling power of election. It is almost a pity that the influence of the minority cannot be withdrawn for a time, and free play given to the whims and crudities of the majority. There will be lively times when that takes place. Was it not *Punch* that dubbed him king of the trippers who had the loudest voice? The policy of many municipalities is determined by the loudest voice, and in this case the loudest voice is that of the unions. Thus we witness on every side labour clauses being put into specifications, and not infrequently a refusal on the part of the contractor to sign the contract containing such a clause, and finally the municipality climbing down and waiving the clause. It is not a very cheering sight to see an authority placed in unenviable positions, yet little sympathy can be obtained, because the position has been brought about by their own action. Truly, the mills of the gods grind slowly though they grind surely, and the authorities that enter into a wrong concern may sooner or later expect to get between the millstones. Islington is the most recent example. It appears that the Vestry required not only the signature of a declaration as to payment of the trades union rate of wages, but also that contractors shall "cause a list of the rates of wages paid to workmen to be exhibited in such a place on or contiguous to the work as shall enable any workman engaged thereon to have free access to such list." Not only the contractors whose tender was accepted, but others intimated they could not enter into a contract under these conditions, and in the end the Lighting Committee reported in favour of suspending or waiving the Vestry resolution of March 20, 1898, and the modification of that of March 29, 1895. The ruling spirit that obtains the insertion of these clauses is the keeping up of wages. It never strikes a workman who aids in the agitation to keep wages above the natural average that in the end he pays part, if not the whole, of the surplus out of his own pocket, and so is none the better off. If he was at the expense of building his own cottage, and stipulated that the builders should have double wages, that would inevitably lead to the cottage costing more than otherwise it would do, and if he were afterwards to let that cottage, he must charge a higher rent than if the cost was less. Carry on this process all round, and it is easily seen that while the higher payments are compulsory, higher prices rule in the sales, and so the world wags on. From one point of view, if the cost price of all commodities was doubled to-morrow, the selling

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price would be more than doubled, leaving the original profit on the transaction. The process going on every day is not so simple as this, and if prices in any direction are raised unnaturally many people are indirectly affected who do not come within the ken of the individuals directly concerned in the transaction. Up to a point there is no reason why trades unions should not consider wages questions—that is part of their business, but when they in a measure compel authorities to stipulate for something that is unnatural, they exceed their province; and the authorities do not shine as wise folks in the matter. From another point of view, it does not matter to the contractor what conditions are laid down. He knows them beforehand and discounts their effect, obtaining the same pecuniary result as if he was allowed to carry out the work in his own way. He, in fact, is cynical enough to put aside principles for pelf. But there is little honesty in this way of looking at the matter. Surely the proper course of a municipal body, which at the best is merely a trustee, is to dispose of the public funds to the best advantage of the ratepayers. This is not done by imposing artificial restrictions upon contractors.

MUNICIPAL UNDERTAKINGS.

A return ordered by the House of Commons last August has just been issued, and should prove of exceeding interest at the present juncture. The return deals with the work of a reproductive character carried out by municipalities. The return relates to waterworks, gasworks, tramways, electric lighting, markets, baths, cemeteries, working-class dwellings, piers, and quays, with a small amount of miscellaneous work thrown in. The total amount of capital provided for these undertakings amounts to a little over eighty-eight millions of pounds, of which over eighty-three millions has been borrowed, of which, if we read aright, £11,700,000 odd has been paid off, leaving an outstanding capital account of £71,800,000 odd, against which there is a sinking fund of over three millions. On the other side of the account there has been an average annual income for the five years ending March 31, 1898—or, if the undertaking had not existed so long, so long as it had existed—of close on £8,900,000, the working expenses being £5,300,000, and the average annual net profit being £3,600,000.

Besides these collective figures the return enters into details, the details being tabulated so as to show as clearly as possible the actual state of the case on March 31, 1898. The first detailed statements of any interest to our readers is that of the Dover tramways, only opened in 1897, which shows a capital expenditure of £31,000, with a gross revenue of £8,000 and a net profit of £2,705, out of which was paid £1,582 on account of principal and interest. We need not at the present moment enter into lengthy extraction of these details, the next of which, however, concerns Tunbridge Wells electric lighting, which commenced in 1895 with a total capital of £31,275, of which £24,752 is the amount of capital borrowed and outstanding. The annual income is stated to be £5,800, and the working expenses £2,776, leaving a net profit of £3,024, of which £1,414 has been used in respective repayments and interest of capital.

FORTHCOMING EVENTS.

FRIDAY, MARCH 17.

Royal Institution.—At 9 p.m., "The Electric Fish of the Nile," by Prof. Francis Gotch, M.A., F.R.S.

SATURDAY, MARCH 18.

Royal Institution.—At 3 p.m., "The Mechanical Properties of Bodies," by Lord Rayleigh, M.A., D.C.L., LL.D., F.R.S. Sixth lecture of the series.

Institution of Electrical Engineers.—At 11 a.m., students' visit to the Langdon-Davies Electric Motor Company's works at 101, Southwark-street, S.E.

TUESDAY, MARCH 21.

Institution of Civil Engineers.—At 8 p.m., resumed discussion on "Water-Tube Boilers for Marine Engines," by Mr. J. T. Milton; and "Recent Trials of the Machinery of Warships," by Sir John Durston, K.C.B., R.N., M.I.C.E., and Mr. H. J. Oram, R.N., M.I.C.E.

WEDNESDAY, MARCH 22.

Society of Arts.—At 8 p.m., "Electric Traction," by Mr. Philip Dawson.

THURSDAY, MARCH 23.

Institution of Electrical Engineers.—At 8 p.m., "The Hissing of the Electric Arc," by Mrs. Ayrton; illustrated by experiments.

FRIDAY, MARCH 24.

Royal Institution.—At 9 p.m., "Transparency and Opacity," by Lord Rayleigh.

Physical Society.—At 5 p.m., "On the Criterion for the Oscillatory Discharge of a Condenser," by Dr. Barton and Prof. Morten; "The Minor Variations of the Clark Cell," by Mr. A. P. Trotter.

SATURDAY, MARCH 25.

Institution of Junior Engineers.—At 3 p.m., visit to the testing station of the British Fire Protection Committee, Hanover-gate, Regent's Park.

THE SULLIVAN GALVANOMETER.

An interesting addition, and one which should prove to be of considerable importance in connection with submarine cable signalling from ships to shore, has been made to the Sullivan Universal galvanometer in the shape of a special suspension frame and coil system, which can be fitted to the existing instrument without altering its form or design. With this addition good signals are obtained without receiving condensers on even the longest cables in the world. Reports, which have been shown us by the inventor, and which have been received from one of the great cable companies which has tried the modification on a submerged cable system nearly 3,000 miles long, testify in clear terms as to its success. The reports state, further, that signals obtained with ordinary galvanometers under the same conditions were almost imperceptible and quite unreadable, although far less battery power was used with the "Sullivan" than with the others. The result is attained by means of an alteration in the suspension and electromagnetic and mechanical damping of the coil system. There can be no doubt that this modification renders cable signalling with the Sullivan galvanometer a matter of great simplicity, and it would appear to be of special value under the rough and-ready conditions which at times prevail on board ship. The new suspension is said to be practically unbreakable, and therefore the instrument can be relied upon to work perfectly in all emergencies.

THE CITY OF LONDON ELECTRIC LIGHTING COMPANY'S WORKS AT BANKSIDE.

(Concluded from page 307.)

Coming now to the general arrangement of the plant this can be seen in Fig. 10, which gives, however, a some what prophetic plan of the Bankside works. For instance, three chimney shafts are shown in the illustration, while at

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present only two are actually built. In the same way the buildings of the western station, to contain the direct-current plant, have not risen much above the ground line. The engineers, however, expect to get them completed and

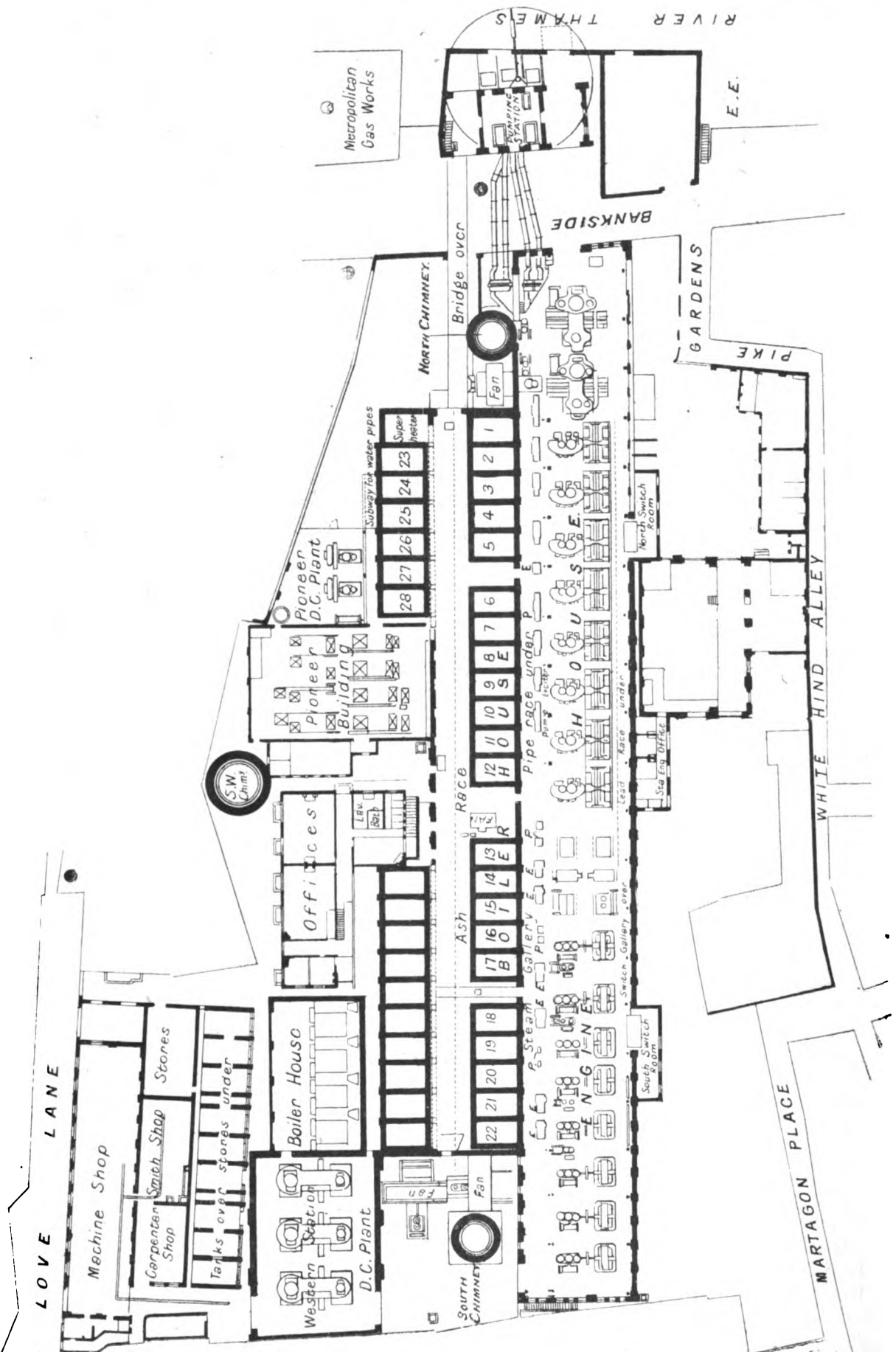

FIG. 10.—General Arrangement of Plant at the Bankside Electric Light Station.

to have the plant running before the autumn. This section of the works (Fig. 11) should also be consulted with the plan. From this it will be seen that there are two main flues, and that these are constructed under the boilers. The induced-draught fan at present fixed is placed by the southern chimney. It is of the Heenan and Froude type, and is capable of giving a 1in. draught when steam corresponding to about 10,000 h.p. is being developed by the boilers. Two more of these fans are on order, and they will help the station very much in the case of sudden fogs. From the elevation (Fig. 11) the arrangement of ash conveyor and also the coal conveyor can be seen. The

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use of an ash conveyor is a great convenience in keeping the boiler-house tidy, and coupled with the Vicar's mechanical stokers considerably lightens the work of the boiler-house staff.

The section of the station also shows the space left under the gallery for the exciters, marked E, and for the pumps, P. The pit under the floor in this side of the engine-house looks at first sight of ample capacity to contain the necessary pipes, but when seen now that four 26in. pipes are in place it is found to be not a desirable place to walk in. The general arrangement of this side is very economical as far as length of pipe required is concerned. The whole of the conductors between the alternators and switchboards and the station's end of the feeders come in a trench in the opposite side of the engine-house, where they are least liable to be damaged by workmen.

The high-tension cables from the central station go to 23 different sub-stations in various parts of the City. Through the kindness of Mr. F. B. Aspinall, the superintendent of the arc lighting and distribution, we were shown over three of these sub-stations. The arrangements at these have been most carefully designed in order that a limited space may be used to the best advantage. The sub-stations, as a rule, come in the vacant spaces available under public squares, and are accessible by means of square manholes in the footpaths. The first important detail in the arrangements of these stations is the provision for the safety of the men working on the high-tension system.

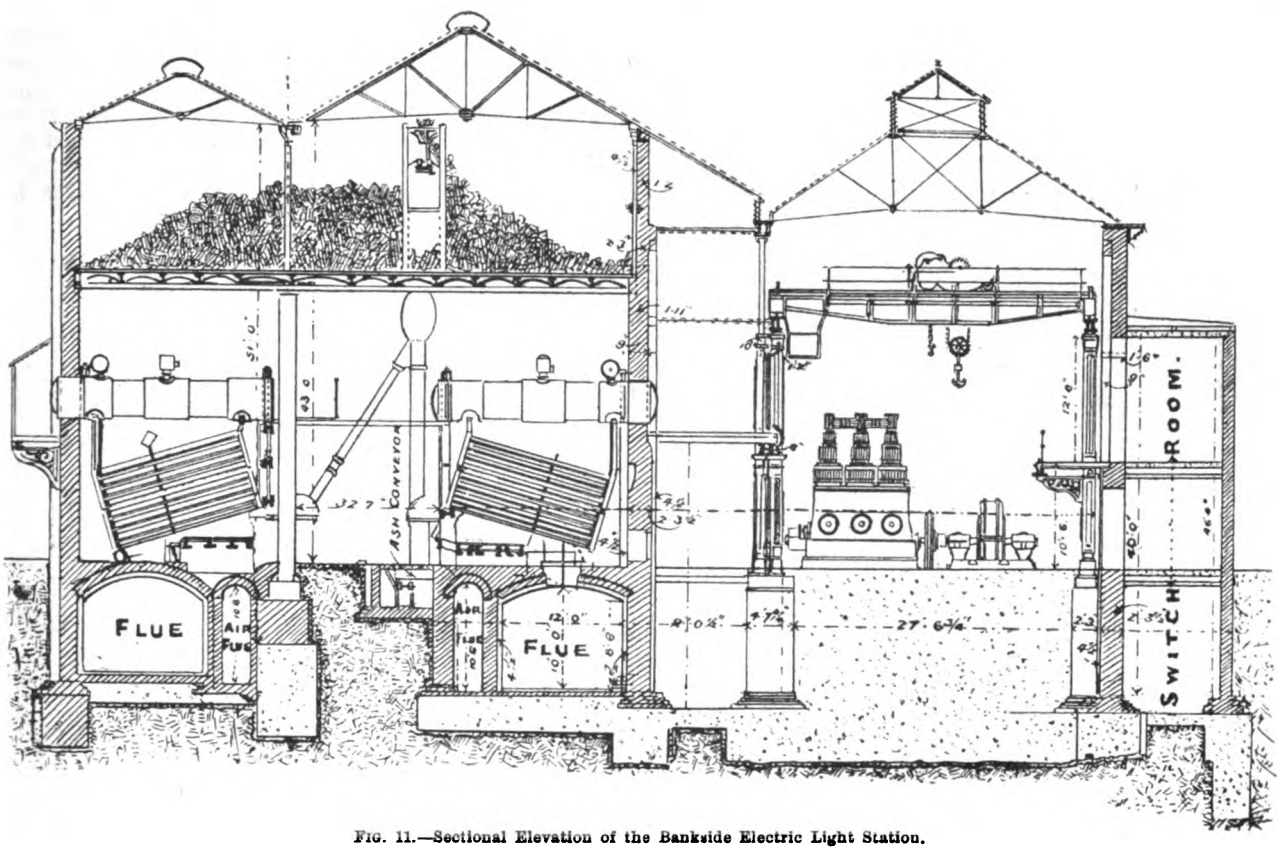

FIG. 11.—Sectional Elevation of the Bankside Electric Light Station.

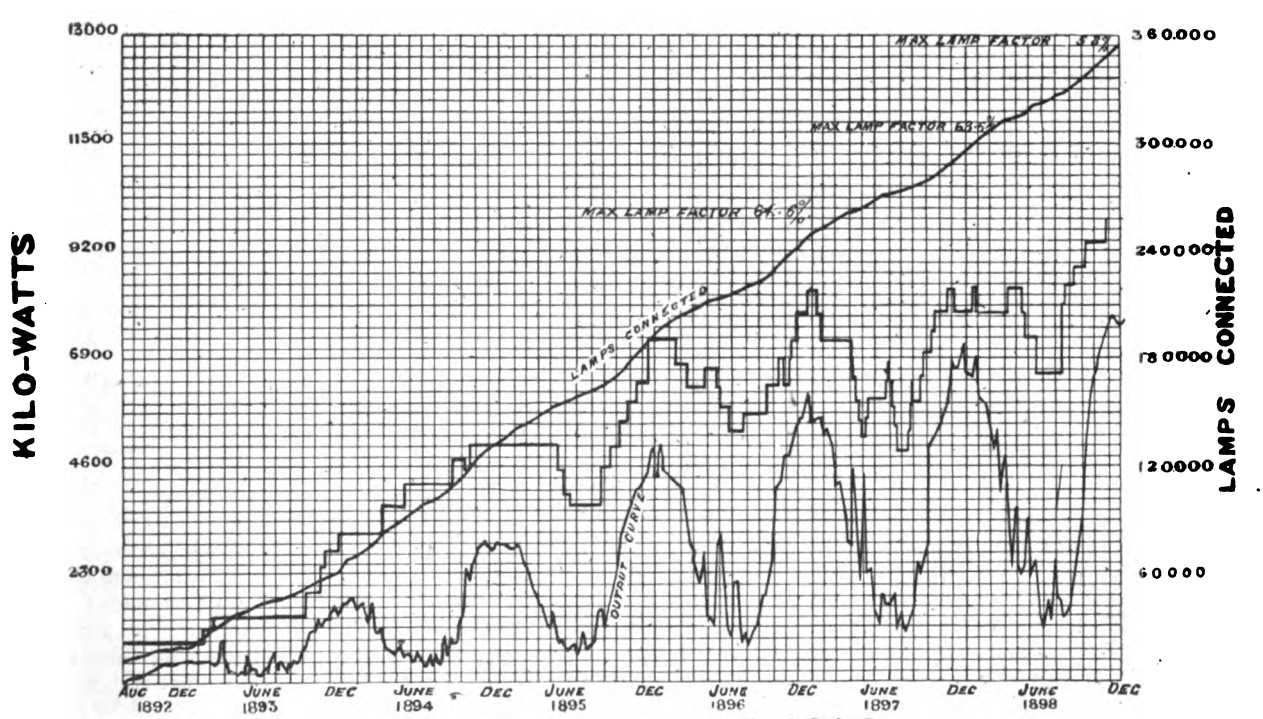

FIG 12.—The Progress Chart of the City of London Electric Light Company.

With such a large company as the City of London, which employs about 650 men, it is very important that a well-organised system of inter-departmental routine should be adopted in order that the employés in the one department may not inadvertently cause the death of those in another. In this way all the high-tension switches

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in the sub-stations are arranged to be easily locked in the off position, much in the same way as those on the feeder-boards in the Bankside station are. A requisition stating distinctly what repairs have to be effected is drawn up by the engineer for the mains, and is submitted for signature to the engineer-in-charge at the central station, the head of the testing staff, and the main superintendents. Having been seen by all these gentlemen, the keys locking the switches at either end of the high-tension cable are attached to the type-written form, and the man actually carrying out the work keeps this on his person. When his work has been completed, the form is handed to the head of the testing department, who certifies that the work has been properly completed. After that the keys are returned to the proper sources, and the main can be used. As a rule, two high-tension feeders are laid to each sub-station, and the sub-stations are also interconnected by means of a high-tension cables. In the ordinary working, however, each of the 23 districts is kept entirely distinct, so that faults may be localised easily and quickly. The low-tension networks in the districts are not interconnected. The general arrangement of the sub-station is somewhat as follows: All the transformers are placed under the floor in the water-tight basement; rings fixed to girders in the roof admit of these transformers being readily shifted. One wall is usually devoted to the high-tension feeders and inter-connectors, from which high-tension 'bus bars go round the sub-station to the various transformers. The low-tension 'bus bars, which are made of heavy laminated copper, are placed at a lower level round, say, three sides of the sub-station. The transformers are carefully adjusted, or, rather, selected of the same type, in order that they may divide the load well between them when in parallel. An ammeter in circuit of the master transformer is used to read the load going out from the station, this load being obtained by multiplying the reading of the current on the master transformer by the number of transformers in circuit. In some sub-stations attempts have been made to read the very large currents supplied by the whole of the transformers, but the result has not been very satisfactory. Telephonic communication is provided from each sub-station to the switchboard at Bankside, so that the men in charge can report quickly any trouble which may arise. The inspectors of sub-stations, who go round frequently at times of heavy load to put in transformers as required, have a certain number of sub-stations under their care. At present no automatic switching in or switching out of transformers is used. The transformers are mostly of the Thomson-Houston, Westinghouse, and Brush types. Ventilation of the sub-station is provided by electric fans discharging through a grating in the pavement. We were informed that in one district in London the young ladies engaged in the factories round have played havoc with the alternate-current motors driving these fans by standing over this grating in the summer to enjoy the electric breezes. The obstruction of the outlet so caused makes the motors fall out of step.

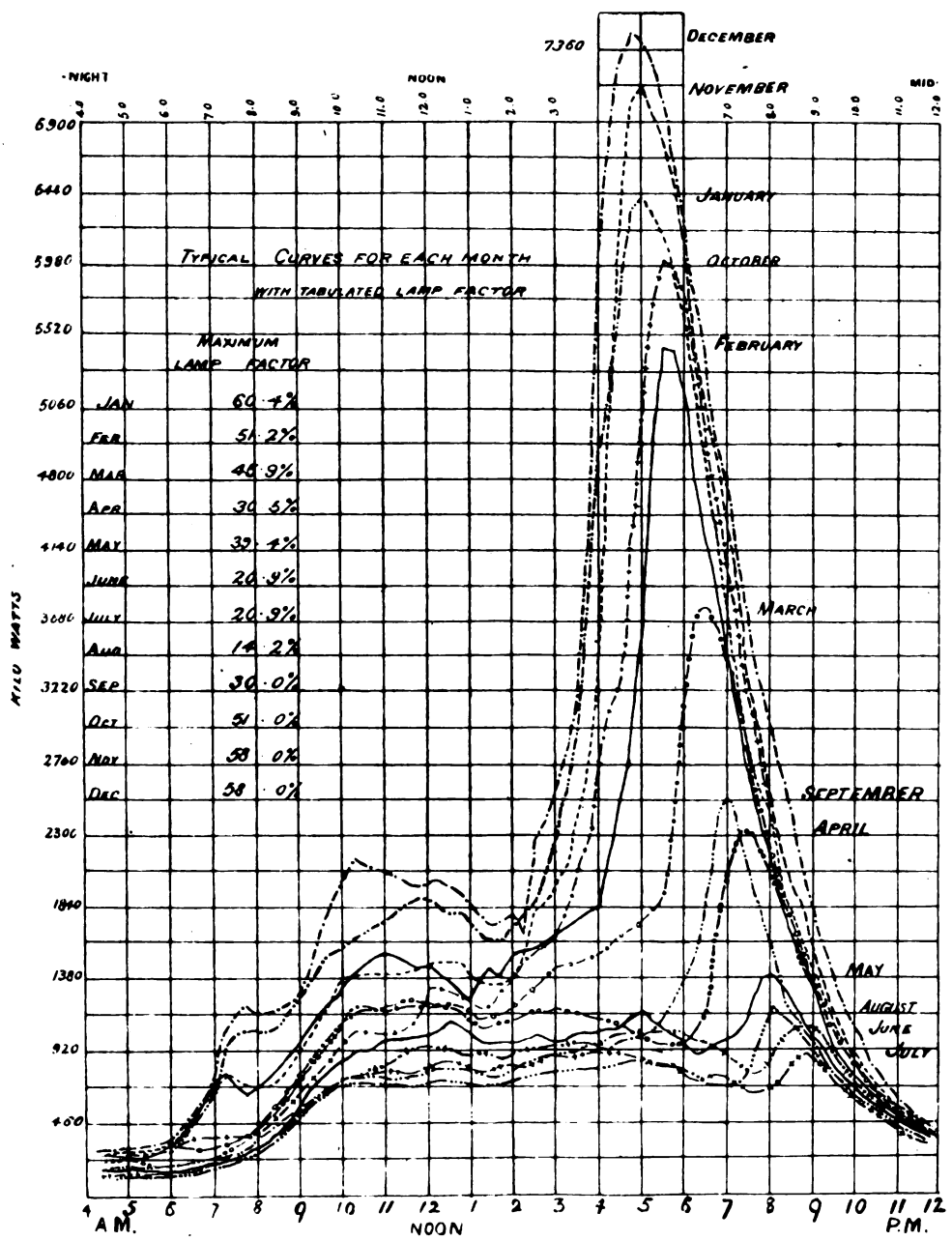

FIG. 13.—Typical Load Curves for each month of 1898.

Through the kindness of Mr. Frank Bailey, the engineer

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of the company, we are able to give the following curves, illustrating the progress of the demand for electric light and also the erratic nature of the load with which the company's engineers have to contend. In this respect Fig. 12 makes it clear that the company has not to complain of a falling off in the number of lamps connected in any year. The line of lamp connections from 1891 onward shows that, if anything, the rate of connection is increasing. The

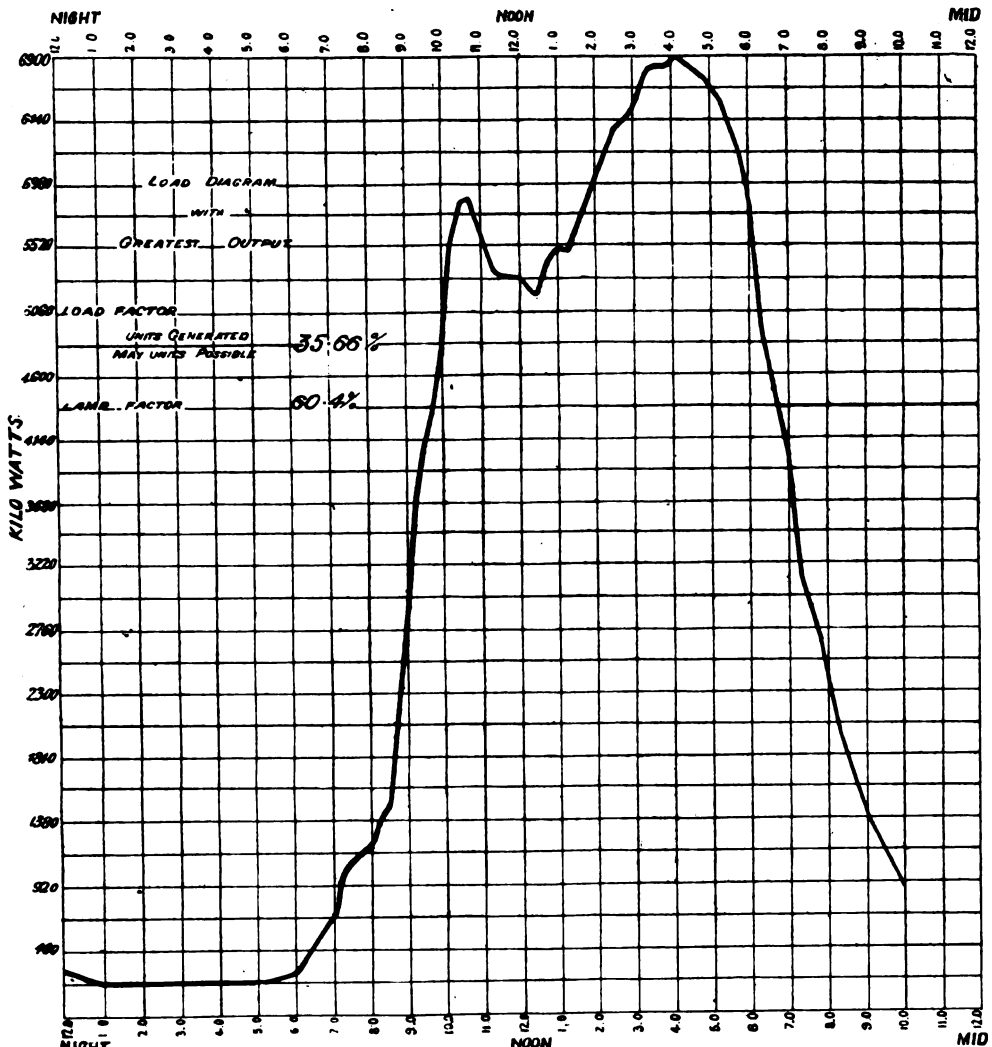

FIG. 14.—The Maximum Load Curve which was taken on Jan. 14, 1899.

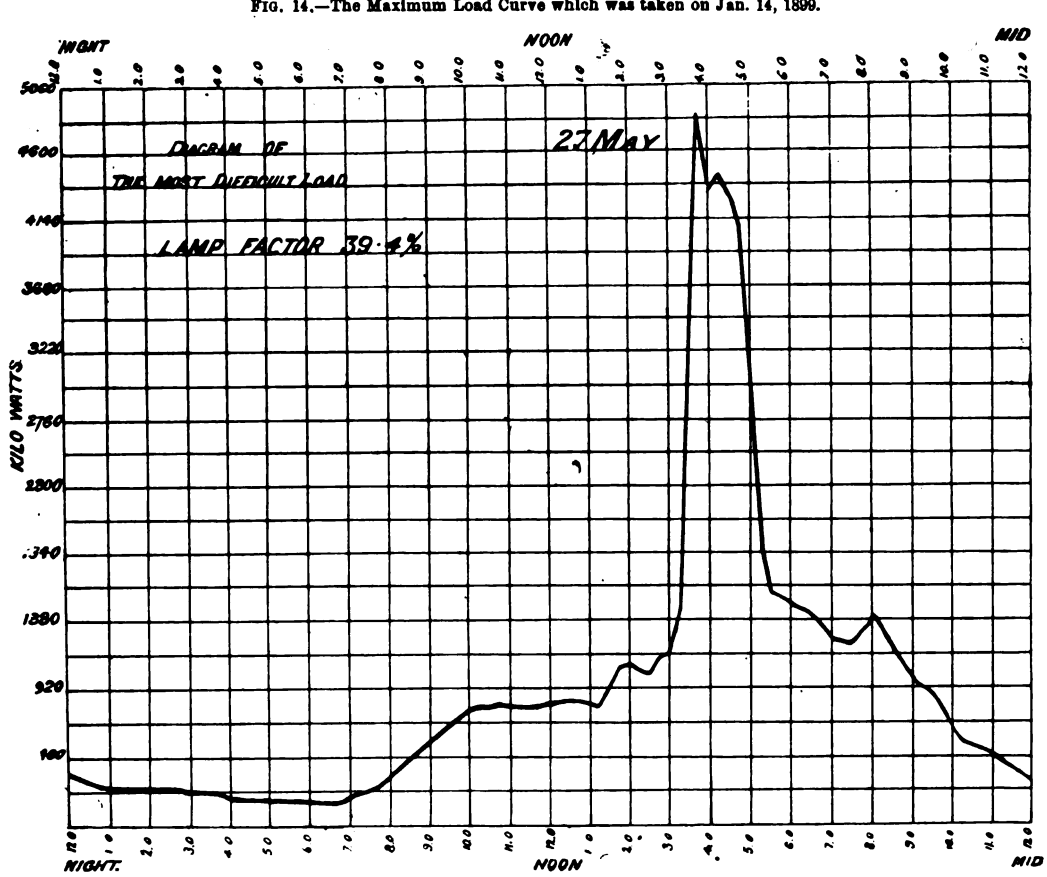

FIG. 15.—The Most Difficult Load Curve which had to be supplied in 1898.

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other curves show the maximum loads and also the output in units. The failure of these curves to make a higher peak in the autumn of 1898 was largely due to the want of the fogs, which usually cost the consumers large sums of money. We presume therefore that during the foggy days of this week the company has been turning coal into gold at a great rate. Fig. 13 shows a series of typical monthly curves taken on week days, for it must be remembered that the company has practically only five working days in the week, as the Saturday and Sunday loads are poor. These curves show what class of lighting the company has to do. The falling curves are most interesting, as it seems that certain offices which keep their employés late are responsible for certain portions of the falling curves each month. Thus, even in winter, some offices closing at 5 p.m. cause the maximum load to be at about 4.50 p.m., and after that there is a steady decrease as business ceases. It will also be seen that the day load is now a considerable one. This is the most valuable part of the curve, and we are sure that the new system of charging now in force will do much to add to the number of consumers using electric light in basements. Another feature derivable from the curves is that of the lamp factor, by which is meant the ratio of lamps burning at maximum load to the total number of lamps on circuit. This is very high, as in January no less than 60·4 per cent. of the lamps connected are sometimes burning simultaneously. We should say that this is the highest lamp factor in the kingdom, and it entails an exceptionally large amount of machinery to supply a given number of consumers. The maximum lamp factors, in percentages, varied as follows throughout 1898: January, 60·4; February, 51·2; March, 45 9; April, 30 5; May, 39·4; June, 20·9; July, 20 9; August, 14·2; September, 30; October, 51; November, 58; and December, 58. The largest load ever turned out in one day from Bankside was supplied on Jan. 14, 1898, and the load curve for that day is shown in Fig. 14. We do not remember that day as a dark one, but the curves show that it was the occasion of a special London fog. The load factor on that day reached the splendid total of 35·60 per cent., or to define the term, as is necessary owing to the various meanings associated with the expression load factor, the total output was 35·60 per cent. of the maximum possible output over the 24 hours.

The next curve, given in Fig. 15, shows the difficulty with which the engineers at Bankside have to contend. It was taken on May 27 last year, when the average load would lead one to expect a lamp factor of about 20 per cent. at the most. Owing to sudden darkness the load suddenly increased at 3.15 from 1,380 kw. up to 4,800 kw. Such an increase would break down the supply from any station if an ample reserve of boilers under steam were not kept ready, and yet this reserve is as a rule quite unremunerative. The lamp factor on the day in question rose to 39·4, but even this does not represent any adequate return to the company. It will be seen that the peak on this day was very thin, so that by the time a comfortable steam supply had been obtained it was not wanted. The last illustration (Fig. 16) shows the extreme curves, winter and summer, and the Sunday load curves, which are very poor. In conclusion, we have to express our thanks to the engineers who have so kindly shown us the works, including Mr. Frank Bailey, M.I.C.E. (the engineer to the company), Mr. F. H. Jackson (the assistant engineer), Mr. R. A. Chattock (the superintendent of the Bankside works), and Mr. F. B. Aspinall (superintendent of arc lighting and distribution).

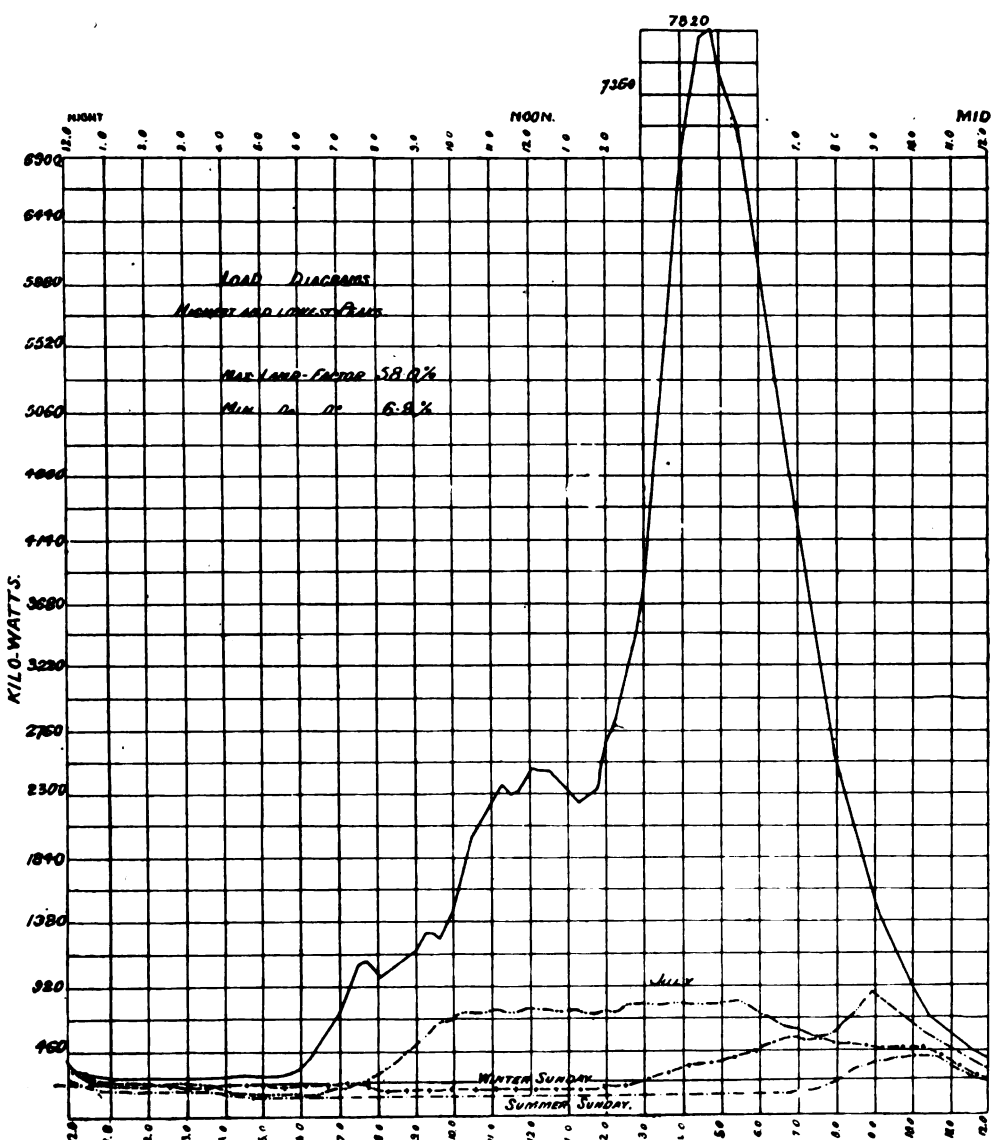

FIG. 16.—The Highest and Lowest Peaked Curves for Summer and Winter, 1898.

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QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

149. How can the dryness of steam be ascertained? Also, how would you tell if a boiler was passing water into the steam-pipes?—W. D. M.

150. Describe what you consider to be the best two methods of securing steam-tight joints on high-pressure steam-pipes.—P. T.

ANSWERS.

Question No. 143.—Can street arc lamps, carried by trolley poles, be satisfactorily worked from the tramway distributors or from the trolley wire, using the rails as return? Give any examples you know of, and the number of lamps in series.

Best Answer to No. 143 (*awarded* 10*s.*).—The great objection to the use of arc lamps on a traction circuit is that the voltage on the trolley wires is by no means constant. In fact, to get satisfactory results it will be absolutely necessary to run the lamps with a considerable resistance in series. This causes the lighting to be more expensive than usual, as a large amount of energy will be wasted in the resistances. The number of arc lamps which can be run in series on a traction circuit is varied by the range over which the voltage varies, but I should think that nine ordinary lamps or five enclosed arcs would be about the limit. In most English towns where electric tramways have been established arc and incandescent lamps have been placed on the poles, but these are supplied from the ordinary electric lighting mains. This is done to avoid the flickering of the lamps due to the variation of the voltage caused by cars starting. The flicker would perhaps be most noticeable on the incandescent lamps, as can be seen in any electric tramcar.—K. S.

Answer to No. 143 (*awarded* 5*s.*).—There is no reason why arc lamps should not be so worked. Given a certain current at a sufficient pressure, there does not appear to be any valid objection to employing the energy generated for any purpose that may be considered advisable. No example is needed to prove that either arc or incandescent lamps can be worked off the tramway circuit beyond the now familiar sight in towns where electric traction is in use, of the cars, stations, and offices of such companies being electrically lighted, both with arc and incandescent lamps and the result quite satisfactory. If it is intended to utilise the tramway system for lighting purposes, perhaps it might be better to lay a return cable right through, in addition to the rails, as a return. Indeed, of late there has been manifested a very strong desire on the part of tramway experts to instal a return cable, even though the current be employed for traction only, principally on account of the difficulty of providing a reliable and lasting rail bond, and of complying with the Board of Trade regulations. The objection that the supply is likely to be irregular on account of the great variation in the load can easily be met by the employment of secondary batteries to tide over difficult periods, but in practice these ought rarely to be required, as the engineer-in-charge knows, or at least ought to know, from experience of the daily and hourly records kept what the average requirements are, and be prepared accordingly. Assuming that the voltage for tramway purposes is 550 at the switchboard, and as 500-volt arc lamps are on the market, there does not seem to be any insurmountable difficulty in utilising the energy from either trolley or feeders for lighting purposes. Ordinary arc lamps by any good maker would be suitable, say, 10 in series. (The writer has frequently used three Brockie-Pell arc lamps, made for 50-volt circuits on a 500 volt one, for five or six hours without any ill effects, save a more rapid consumption of carbons.) Switches and resistances could be placed either in the lamp pillars for each individual lamp; or, perhaps, better still, regulating switches, resistances, etc., for a number of lamps could be banked in a sub-station underground, a dry cellar suiting admirably for this purpose; and in most of our towns these could be either rented or purchased at a very moderate figure. Two-hundred-volt arcs, two in series, once resistances are adjusted, will be found to work very well off either trolley or feeders. Where, from the length of the line, three-phase currents have to be made use of, lighting would, of course, be possible either by single transformer or sub-stations, with banked transformers or motor-generators.—W. H. M.

[Surely "W. H. M." is mistaken when he says that 500-volt arc lamps are on the market.—ED. *E. E.*]

Question No. 144.—What difficulties might arise from drawing electric light cables into disused gas-mains?

Best Answer to No. 144 (*awarded* 10*s.*).—If suitable, there does not appear to be any objection to disused gas-mains as conduits for electric cable. An objection has of late years been raised to the employment of rubber-insulated cable in iron conduits on account of condensation in the pipes destroying the insulation of the conductors—and this has been found very annoying in more than one locality—but there is always the option of ventilation, or of using paper-insulated cables, with an outer covering or sheathing of lead, which is not affected by condensation as rubber is. If disused gas-mains are to be made available it will first be necessary to locate manholes or drawing-in boxes at convenient distances, in order to get the cable in; and it is with this operation the chief difficulties may be expected. It is not necessary that gas-mains follow a straight line in every instance, and where they do not trouble arises in getting the draw-in wire into them. A judicious arrangement of the manholes or draw-in boxes may get over this and secure straight runs for the cable. How to get the draw-in wires into place presents the greatest difficulty for obvious reasons. A very ingenious method may at present be seen in operation in Dublin in connection with the tramway company's work, where, after the cable conduits are laid, a number of wooden rods with special gunmetal connections are arranged to fit into one another without the necessity of screwing or using a bayonet socket, and which cannot possibly become disconnected in the conduit except the wooden rod breaks. These rods are pushed in at the drawing-in boxes or manholes, and being made in convenient lengths, can be used by ordinary unskilled labour. When the end on the rod reaches the next box, the fact is signalled by a man on duty for that purpose, and the entire length can be left till it is wanted, or the draw-in wire attached to the further end of the rods, and these drawn backwards, each successive length being detached till all are withdrawn, and the drawing-in wire pulled right through. A bell-shaped cup with sharp edges is usually screwed firmly on to the first rod, and this is very effective in cutting away slight metallic projections which might injure the cable, and clearing away any other accumulations which might be injurious, and the discovery and location of obstacles as the rods are forced in.

As regards house connections, etc., some little difficulty may arise about the arrangement of service boxes for the houses, but this ought not to be very serious—nothing more than the electrical and mechanical engineer has to meet and overcome daily. Such difficulties, of course, depend on the circumstances of each case, and the system employed. It is not likely that the disused gas-pipe from the houses to the mains can be utilised except in the case of large establishments, where it may serve as a protection to the house service wires from the junction boxes to the house switch. There is no doubt that the task of adapting disused gas-mains for electrical purposes would be a labour of love to most electrical engineers, and that the one so fortunate as to find these would enter upon his task of conversion with

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commendable energy, even though the other side be inclined to remind him that "the owls in the story sang the praises of the good caliph who had destroyed cities that they might have a place to roost in."—W. H. MURPHY.

PHYSICAL SOCIETY.

At the ordinary meeting on the 10th inst., Prof. Oliver Lodge, F.R.S., president, in the chair, **Mr. A. A. Campbell Swinton** described and exhibited the Wehnelt current interruptor. A glass cell contains a large cylindrical negative electrode of lead, and a small positive electrode consisting of a platinum wire about $\frac{1}{16}$in. or $\frac{1}{8}$in. in length, in a solution of one part sulphuric acid to about five parts water. The platinum wire may project from the top of the shorter arm of a J-shaped ebonite tube, so that it can point upwards immersed in the solution; or it may be fused into a similar glass tube, but glass is apt to crack in the subsequent heating. Wehnelt's interruptor replaces the make-and-break apparatus of an induction coil; it also replaces the ordinary condenser of that apparatus. In its present form it requires rather a strong current. The resulting spark at the secondary terminals differs in character from the ordinary spark of an induction coil; it is almost unidirectional, and in air takes a V form—bright, continuous, and inverted—somewhat like a pair of flaming swords rapidly crossing and recrossing one another at their points. By blowing upon the V it breaks up, and then more nearly resembles the customary discharge of a coil. The sound emitted by the spark has a pitch that varies with the conditions of the circuit. As the self-induction of the circuit is diminished the spark-pitch rises; it becomes infinite when the self-induction vanishes—*i.e.*, the Wehnelt interruptor will not work in a circuit devoid of self-induction. As the applied potential difference diminishes, the spark-pitch diminishes. In Mr. Campbell Swinton's experiments, 25 volts was the minimum primary voltage at which his apparatus would work. The spark-pitch also varies with the length of the platinum wire electrode in the solution. If the circuit is closed by dipping this electrode into the solution, the apparatus will not work; the wire must be dipped in before closing the circuit. After working for about a quarter of an hour the action often ceases; this fatigue effect is not due to heating of the solution, for it is not obviated by keeping the temperature constant by a water bath. It is supposed that the oxygen generated at the platinum electrode forms a more or less insulating film which interrupts the current until absorbed by the surrounding water. The fact that oxygen is more easily absorbed than hydrogen may explain why it is necessary to connect the platinum electrode to the positive pole of the battery or dynamo. When the platinum electrode is dipped gradually into the solution, the wire gets red hot, and the interruptions do not take place. Again, when the apparatus stops from fatigue the platinum gets red hot. The action is further complicated by a series of small explosions and by the formation of a kind of electric arc at the platinum electrode. The coil exhibited was connected to the 100-volt electric light mains at Burlington House; in this case the potential difference at the terminals of the primary was 30 volts, and that across the interruptor 150 volts—a total of 180 volts—showing the effect of impedance. For Röntgen-ray work the apparatus would be very effective, but unfortunately the sparks produce great heating, so that the cathodes of tubes are melted. Mr. Campbell Swinton suggested that as the sparks were more nearly continuous than ordinary discharges, they might produce Hertz waves less rapidly attenuated than those now applied to wireless telegraphy; the trains of waves would also follow one another at shorter intervals than those from the sparks at present employed.

The President said he was rather surprised that the self-induction of the primary coil was not sufficient of itself to form the induction factor in the impedance necessary for perfect working. He would like to know how the apparatus behaved when an alternating current was used. Did the secondary coil become damaged by overheating? Did reversal of the current assist the recovery from the fatigued condition of the apparatus? The natural period of the circuit depended upon its capacity and its self-induction. There was undoubtedly capacity at the surface of the platinum electrode in the liquid; this capacity acted together with the auxiliary self-induction, and the self-induction of the rest of the circuit, in the orthodox way, and there was automatic adjustment of resonance to the frequency of the interruptions, probably by variations of the capacity at the electrode. The heating effect, when a wire was made to close a circuit with a liquid, was discovered many years ago.

Prof. G. M. Minchin thought that the usefulness of the apparatus would be greatly increased if it could be made to work with less current. He had himself succeeded with 12 applied volts, but not with 10 volts. As a tentative experiment he had used a horizontal lead plate, with disastrous effect, for the apparatus went suddenly to pieces. Explosions were frequently obtained, but they were not attended with much real danger. In a later and safer apparatus he used a platinum wire about $\frac{1}{8}$in. long, projecting from a glass tube, around which the lead plate was bent. There appeared to be a definite depth of immersion of this wire, at which the apparatus worked with minimum current. In his apparatus this critical position was when half the wire was below the surface of the liquid, the other half projecting into the air. He attributed the fatigue to the presence of gas about the electrodes, for he observed that a mechanical tap to the base of the apparatus restored the working condition.

Mr. Rollo Appleyard pointed out that the improved result at half immersion, observed by Prof. Minchin, taken together with the phenomena described by Mr. Campbell Swinton as to the effect of dipping the electrodes into the solution, suggested that the liquid immediately around the submerged part of the wire was at some instants in the spheroidal state. The breaking down of the spheroidal state would be facilitated by heat lost by the immersed part to the non-immersed part of the wire. The capacity for heat of the non-immersed part, and the degree of roughness or smoothness of the immersed part, would thus appear as factors in the explanation. No doubt the evolved gases were the primary cause of the interruption of current, but the wire having once become red hot the spheroidal condition would introduce a further cause of electrical separation between the wire and the liquid.

Prof. V. Boys asked whether it was the liquid or the electrodes that became fatigued. Experiments should be made to determine the effect of variations in the hydrostatic pressure round the platinum electrode.

Mr. T. H. Blakesley said that the rise of potential at the terminals of the interruptor proved that the arrangement possessed capacity. Such a rise of potential could not occur without there being capacity, any more than it could without self-induction.

Mr. D. K. Morris described experiments he had made with a Wehnelt interruptor, using a 1-kw. transformer with a transformation of four to five, intended for 10 amperes at 100 volts. The anode of the interruptor was designed to have an adjustable surface to correspond with the load on the secondary—a platinum wire at the end of a copper wire could be projected more or less through the drawn-out lower end of a glass tube containing oil. The best results with the interruptor were obtained with about 45 volts on the primary circuit. At this pressure, an average current of one ampere sufficed to give 125 (alternating) volts very steadily on the secondary. As measured by an electrostatic instrument, the "no load" loss was only 45 watts. The secondary could then be loaded up with lamps, provided that the exposed surface of platinum wire was proportionately increased. The energy delivered to the lamps, however, was not at any load much greater than 45 per cent. of that taken from the mains. By connecting the interruptor with a condenser of half microfarad the efficiency at small loads was increased to nearly 60 per cent. He had observed that the fatigue of the interruptor could be temporarily remedied by reversing the current.

Mr. C. E. S. Phillips asked whether Mr. Campbell Swinton had tried other liquids than dilute sulphuric acid. So far as his own experiments went, he had only obtained good results with that electrolyte.

Mr. Campbell Swinton, in reply, said that with the apparatus arranged in a simple circuit, an alternating current applied to the primary of an induction coil through a Wehnelt interruptor produced only about half the effect of the corresponding direct current—apparently only half the alternations got through. But if two interruptors were connected in parallel circuits, it was possible so to arrange them that one took one half and the other the second half of the alternations. It might therefore be possible to design an induction coil with two primary windings to correspond to the two interruptors so as to give an additive effect. The induction coil he had used had suffered no damage from the currents employed in the experiments exhibited. There was extremely little heating of the secondary. He could not with his apparatus restore the working condition by any mechanical disturbance of the interruptor. Hydrochloric acid failed, but a saturated solution of potassic bichromate gave fair results.

The **President**, in proposing thanks, said he did not agree with Mr. Campbell Swinton's remarks as to the chances of improving Hertzian telegraphy by the use of these interruptors. The rate of interruption with this apparatus was something like 1,000 per second, but the vibrations corresponding to Hertz waves were of the order 100,000 per second. The wave trains from oscillators excited by the new interruptor would still be a series of damped vibrations; the amplitudes would not be maintained. It might be advantageous to have sparks following one another so rapidly, but he doubted it. For Hertzian telegraphy the spark at the oscillator should "crackle." To produce the best effect, the air about the oscillator should be in a non-electric condition.

COMPANIES' MEETINGS AND REPORTS.

METROPOLITAN ELECTRIC SUPPLY COMPANY, LIMITED.

The shareholders of this Company held their twelfth ordinary general meeting at Winchester House, Old Broad-street, on Wednesday.

Sir James Pondor, M.P., presided, and after regretting the absence of Sir Eyre M. Shaw, owing to serious illness, went on to remark that since their last meeting they had had to deplore the loss of Dr. John Hopkinson, who, as one of their consulting engineers from the inception of the Company, had rendered them the greatest help. Their capital account had been increased by the issue of 22,500 shares, which were subscribed for at par by the holders of founders' shares in consideration of the cancellation of the rights of those shares. The founders' shares now ranked as ordinary shares, and without any special privileges attaching to them. The additional capital thus issued, upon which up to the end of the year £118,530 had been paid, had been almost entirely expended on mains and on their new Willesden works. Time would now be available for perfecting this important under-

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taking. They were now aiming for the completion of the first portion in the early part of the summer, so that the plant might be in thorough working order to cope with next winter's demand. Their expenditure on mains and on their normal extensions had been caused largely by the change they were gradually making in their system of supply. Having referred to the unfortunate fire at their Manchester-square works in the summer, and which considerably delayed them in their work, he alluded to the heavy item of parliamentary expenses, a portion of which was entailed in connection with their Willesden Act, and the remainder through their having been forced to defend, and successfully, their property in Marylebone. From the revenue account it would be seen that they had had a very considerable increase of business, though this increase was not altogether shown by the growth of revenue receipts, accounted for by the large reductions they had found it necessary to make in their rates of charge to customers. Besides the desirability of conciliating local authorities, they had to meet actual competition in some districts and to provide for a contingency of possible competition in others before the alteration in their system of distribution and the completion of their new generating works had placed them in a position to make this reduction profitable. The serious trouble brought about by the Welsh coal strike had also had an important share in the increase of expenditure. Having pointed out that they had sufficient funds in hand for immediate requirements, he said it would probably be found necessary to make some further issues of capital during the year. The number of lamps connected during last year was larger than in any previous year. This was accounted for in a great measure, no doubt, by the reductions they had made in their rates of charge, but there was no doubt that the use of electric energy was becoming more general and more a necessity every year. The Board agreed that it was necessary to build up the nucleus of a strong depreciation and reserve fund, and they looked forward to the time when the rate of dividend they paid last year would not only be again reached, but exceeded. He concluded by moving the adoption of the report and the payment of the dividends therein recommended.

Admiral Lord John Hay seconded the motion.

Mr. Conway Bishop said it appeared to him that the accounts of the Company always compared unfavourably with those of similar concerns. He contended that the whole success of the concern depended upon the economy that was exercised.

Mr. Young agreed with the opinion expressed by the previous speaker, and urged that what was wanted was not a small or a large business, but a profitable one.

Mr. Jeffreys said different results would certainly be expected by the shareholders in the future.

Mr. Newton considered the prospects of the Company very good indeed, and he agreed with the policy of the directors.

The **Chairman** having replied, and **Mr. F. Bailey**, the engineering director, having added a few observations, the report was adopted, and the proceedings closed.

HOUSE-TO-HOUSE ELECTRIC LIGHT SUPPLY COMPANY, LIMITED.

The eleventh ordinary general meeting of this Company was held last Friday at Winchester House, E.C.

Mr. William Page, managing director, presided, and, in moving the adoption of the report, congratulated the shareholders on the satisfactory growth of the Company's business, and on the fact that they were able to pay a dividend on the ordinary shares of 6 per cent. for 1898, as compared with 4 per cent. the previous year. Their gross receipts amounted to £24,906 and their expenditure to £10,840, leaving a net profit of £14,066. The introduction by them of the free-wiring system had increased the number of their consumers at a rapid rate, and there could be no doubt that a large proportion of their fresh business was the result of that system. Many people were deterred from having the electric light in their houses because of the heavy initial cost, and that was especially the case where the occupiers were only tenants. The directors were in negotiation with the authorities of Kensington—a portion of Kensington being their area—with a view to public street-lighting. It had been decided to fit up half a dozen street lamps there, and supply them with current for nothing for 12 months, and that might lead to a considerable amount of business in the future. At the close of 1898 they had 80,301 lamps connected, being an increase of 13,937 during the year, while their customers numbered 1,777, against 1,416 at the close of the previous 12 months. Alterations and additions to their plant and mains had been made at a cost of £19,423. Certain of the plant having been superseded had been sold at a loss, but the directors considered that the proportion of such loss chargeable to the current year had been quite provided for by the extra sum placed to the credit of depreciation account. They always had new plant on order, that being due to their growing business. Their stations were large enough to accommodate the equivalent of an extra 2,000 h.p., which was nearly enough to double their present output, so that they did not require to look out for a new station just yet.

Mr. W. F. Leese seconded the motion, and the report was adopted.

BRITISH INSULATED WIRE COMPANY, LIMITED.

The third ordinary general meeting of the shareholders of this Company was held at the works, Prescot, on Wednesday afternoon. Mr. W. Marriner Brigg, chairman of the board of directors, presided, and there was a good attendance of shareholders.

The **Chairman**, in presenting the report and accounts, which were adopted, congratulated the shareholders on the substantial progress which the Company had made. Orders continued to come in very satisfactorily, and they were now in the position that in the middle of the third month of the year they had sufficient orders in hand to occupy their works for the whole year provided their total output did not exceed that of the past year, though that was not at all likely. They had every reason to look forward to a still more successful future. They had found it desirable to go in for a still further extension of their works, and that extension was already commenced. They had also arranged for a quotation of the Company's shares on the London and Manchester Stock Exchanges. They had from time to time written off considerable amounts, aggregating some £70,000 as against depreciation, and in every way the Company was in an excellent position.

In accordance with the directors' proposal, a further dividend of 10 per cent. on the ordinary shares, making 15 per cent. for the year, was declared. Messrs. J. E. Pearson and Thos. Snape, the directors who retired by rotation, were re-elected, and Messrs. Chalmers and Wade were unanimously re-elected auditors.

A cordial vote of thanks to the chairman was carried with acclamation.

BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY COMPANY.

The second ordinary general meeting of the Bournemouth and Poole Electricity Supply Company, Limited, was held on the 13th inst. at Winchester House, Old Broad-street, E.C.

Mr. Aymor H. Sandorson (chairman of the Company), who presided, said that there was an application before the Board of Trade for the transfer of the undertaking now held by the Bournemouth and District Company to their Company; and as they now held the whole of the shares in the Bournemouth and District Company, they had every reason to think that the Board of Trade would grant the application. After the transfer had been effected their administrative expenses would be considerably decreased.

The report of the directors, together with the balance-sheet and statement of accounts at Dec. 31, 1898 (as published in our last issue), were then adopted.

BRITISH ELECTRIC TRACTION COMPANY, LIMITED.

Directors: Sir Charles Rivers Wilson, G.C.M.G., C.B. (chairman); the Right Hon. Lord Rathmore; the Hon. Sir Charles William Fremantle, K.C.B.; John Smith Raworth, M.I.C.E.; Emile Garcke, M.I.C.E. (managing director).

Report of directors (with abstract of accounts) to be presented to the shareholders at the third ordinary general meeting of the Company, to be held at Donington House, Norfolk-street, Strand, London, W.C., on Saturday, March 18, 1899:

During the past year the directors have issued 10,000 6 per cent. cumulative preference shares of £10 each at £12. 10s. per share, and £100,000 debenture stock at £116 per cent. The whole of the premiums (after deducting expenses), amounting to £29,135. 15s. 8d., have been placed to a reserve fund, and this amount has, since the close of the year been invested in consols. Since the closing of the books, further issues have been made of 20,000 preference shares and £100,000 debenture stock. The proceeds of these issues will be brought into the next account. The subscribed share and debenture capital is now: £300,000 in ordinary shares of £10 each, £300,000 in 6 per cent. cumulative preference shares of £10 each, £200,000 in 5 per cent. perpetual debenture stock — total, £800,000. The whole of the present authorised share capital of the Company having been subscribed, the directors recommend that powers be taken to increase the nominal capital of the Company by the creation of 60,000 shares of £10 each; and notice is given herewith of an extraordinary general meeting of the shareholders to consider, and, if deemed advisable, to pass, the necessary resolutions. The gross profits, including £9,804. 9s. 6d. brought forward from last year, but without taking into account the aforesaid premiums of £29,135. 15s. 8d., amount to £77,999. 14s. 7d., and, after deducting the proportion of general expenses chargeable to revenue, and also the expenses incurred in connection with schemes not proceeded with and written off, and interest on debenture stock, there remains a net profit of £67,778. 13s., which the directors propose should be applied as follows: remaining portion of preliminary expenses written off, £5 879. 1s. 8d.; reduction of goodwill account, £5,000; interim dividend at the rate of 6 per cent. per annum paid on preference shares to Aug. 15, 1898, £1,195. 16s. 8d.; dividend at the rate of 6 per cent. per annum on preference shares due Feb. 15, 1899, accrued to Dec. 31, 1898, £2,252. 1s.; dividend at the rate of 6 per cent. on the ordinary shares for the past year, £18,000; carry forward to next account, £35,451. 13s. 8d. Arrangements have been made for the adoption of electric traction in various localities. In some cases agreements have been entered into for the purchase or leasing of existing tramway undertakings, while in others parliamentary powers or orders under the Light Railways Act have been secured or applied for. Some of these arrangements have been made in co-operation with other parties. The total amount expended on works and in negotiations and promotions (after deducting the costs of undertakings which have been sold or transferred, and after writing off expenses incurred in respect of schemes or contracts not proceeded with) is £157,730. 17s. 7d. These matters are more particularly referred to in the

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appendix to this report. The Company holds shares and debentures (which cost £420,731. 2s. 11d.) in a large number of existing tramway and analogous companies, and in some instances the majority of shares, with a view to the further development of the Company's business and the adoption of electric traction. An income of £11,853. 15s. 10d. has been derived from investments, but a large proportion of the amount appearing under this head in the balance-sheet was not so employed until the latter part of the year. In order to include the results of the working and the accounts of the associated companies, which are generally made up to Dec. 31 in the annual report and accounts of the Company, the directors propose that in future the accounts of the Company should be made up to March 31 in each year, and that the annual meeting should be held as soon thereafter as possible. The directors who retire this year are the Right Hon. Lord Rathmore and Mr. John Smith Raworth, and both are eligible for re-election. Mr. Fred. W. Smith, F.C.A., retires, and is eligible for re-election.

BALANCE SHEET.

Liabilities.	£	s.	d.
Capital—30,000 6 per cent. cumulative preference shares of £10 each, and 30,000 ordinary shares of £10 each	600,000	0	0
Issued: 10,000 6 per cent. cumulative preference shares of £10 each, fully paid	100,000	0	0
30,000 ordinary shares of £10 each, fully paid, £300,000; less instalments in arrear, £28. 10s.	299,971	10	0
	399,971	10	0
Debenture stock—£100,000 5 per cent. perpetual debenture stock, £100,000; less instalments in arrear, £40	99,960	0	0
Creditors (including £25,000 owing to the B.E.T. (Pioneer) Company, Limited, in respect of the purchase of its undertaking)	68,635	6	7
Reserve fund—amount of premiums received on issues of preference shares and debenture stock, less expenses	29,135	15	8
Profit and loss account—dividend on preference shares accrued to Dec. 31, 1898, £2,252. 1s.; proposed dividend on ordinary shares for year ended Dec. 31, 1898, £18,000; balance carried forward to next account, £35,451. 13s. 8d.	55,703	14	8
	£653,406	6	11

Assets.	£	s.	d.
Expenditure on parliamentary and other rights, lands, and buildings, permanent ways, electrical equipments, rolling-stock, surveys, etc., including a proportion of general expenses charged in connection with the various contracts and undertakings	157,730	17	7
Debentures in shares in associated and other companies, at cost (including £24,940 in the British Electric Traction (Pioneer) Company, Limited), £420,731. 2s. 11d.; parliamentary and other deposits—cash and consols, at cost, £3,477. 15s.; loans to associated companies and others, £11,450	435 658	17	11
Sundry debtors	6,693	10	6
Goodwill account as at Dec. 31, 1897, £15,000; amount written off at Dec. 31, 1898, £5,000	10,000	0	0
Preliminary expenses account as at Dec. 31, 1897, £5,879. 1s. 8d.; amount written off at Dec. 31, 1898, £5,879. 1s. 8d.	0	0	0
Cost of licenses, and of testing and developing new systems of electric traction	7,986	15	9
Office furniture and fittings as at Dec. 31, 1897, £693. 10s. 3d.; additions during year 1898, £631. 9s. 9d.	1,325	0	0
Cash on current account and in hand	34 011	5	2
	£653,406	6	11

Cr. PROFIT AND LOSS ACCOUNT.	£	s.	d
General expenses—proportion of these not chargeable to contracts and undertakings, including expenditure on undertakings not proceeded with, and written off	8,903	5	8
Debenture stock interest—interest paid on Oct. 1, 1898, £309. 11s. 8d.; add proportion of interest due April 1, 1899, accrued to Dec. 31, 1898, £1,008. 4s. 3d.	1,317	15	11
Balance carried down	67,778	13	0
	£77,999	14	7
Preliminary expenses—balance of account written off	5,879	1	8
Goodwill account—amount written off	5 000	0	0
Preference share dividend—dividend paid on Aug. 15, 1898	1,195	16	8
Proportion of dividend due to Feb. 15, 1899, accrued to Dec. 31, 1898, £2,252. 1s.; proposed dividend on ordinary shares for the year ended Dec. 31, 1898, at the rate of 6 per cent., £18,000; balance carried forward to next account, £35,451. 13s. 8d.	55,703	14	8
	£67,778	13	

Dr.	£	s.	d.
Balance brought forward from Dec. 31, 1897	9,804	9	6
Profits on contracts and undertakings and other income	56,237	11	9
Interest and dividends on loans, deposits, and investments	11,853	15	10
Transfer fees	103	17	6
	£77,999	14	7
Balance brought down	£67,778	13	0
	£67,778	13	0

SMITHFIELD MARKETS ELECTRIC SUPPLY COMPANY, LIMITED.

An extraordinary general meeting of this Company was held on Friday, the 10th inst., at Winchester House for the purpose of considering resolutions making certain alterations in the articles of association.

Mr. J. Browne Martin presided, and, in moving the resolutions, pointed out that the object of the proposed alterations was to bring their articles into conformity with the requirements of the Stock Exchange. It must appear, he thought, to every shareholder of the Company that it was most requisite they should get Stock Exchange quotations. Otherwise, however valuable their property might be, it was more or less a lock-up.

Mr. A. A. Knight seconded the adoption of the resolutions, which were unanimously agreed to.

In reply to one or two questions, the Chairman said that the business of the Company was progressing in every way satisfactorily—it was increasing. The issued capital was subscribed for nearly twice over. Unless something occurred to justify such a course, there was no immediate intention of making a further issue of shares.

Mr. E. Schenk said, as some of the shareholders might be aware, the Board were applying for powers to extend the Company's operations to the City. Already about 8,000 signatures, including those of 87 insurance companies, had been secured to a memorial in support of this proposal.

ISLE OF MAN TRAMWAY AND ELECTRIC POWER COMPANY.

The report of the general undertaking of this Company states that the amount available is £11,506, out of which it is recommended to pay dividends of 6 per cent. on the preference and ordinary shares (absorbing £9,900), and to carry £1,000 to reserve, and the balance to profit and loss account. The directors announce the acquisition of the valuable water rights to be used for generating electricity and other purposes requiring power, and an expert has reported that by these means 500 h.p. can be constantly obtained for eight months of the year. The Board are advised that by harnessing this power they will be able to generate and accumulate electricity to work electric and cable systems and do whatever may be required, enabling the steam plant to be shut down eight months in the year, thereby effecting considerable saving. The report of the Isle of Man Tramway and Electric Power Company Separate Undertaking (Laxey and Ramsey section) announce a profit of £71. 11s. 9d., which is proposed to be carried to profit and loss account.

DOVER ELECTRICITY SUPPLY COMPANY, LIMITED.

Directors: Sir W. H. Crundall, J.P. (chairman); C. W. Bagshawe, J.P.; R. Percy Sellon, M.I.E.E.; B. H. Van Tromp. Consulting engineer: A. J. Lawson, M.I.E.E.

Report of the directors (with abstract of accounts) presented at the fifth annual general meeting of shareholders held at the offices, Dover, on March 15:

Further capital expenditure, amounting to £7,714. 1s. 9d., has been incurred during the year in order to meet increased demand for current by the installation of additional plant and mains. The result of the year's trading shows that steady progress has been made, the gross profit of £1,127. 17s. 5d earned in 1897 having been increased to £2,133. 7s. 11d., after setting aside a sum for the formation of a depreciation reserve. A still more favourable result would have been shown but for the increased cost of fuel arising out of the Welsh coal strike. It will be seen that the gross profit is more than absorbed by interest charges, but the directors have pleasure in stating that by the issue of the balance of the ordinary share capital arrangements have been made to pay off the loans on which the larger part of these interest charges arise. The profits of the current year will thus, after meeting debenture interest, be available for the payment of dividend to the shareholders. During the year applications have been received for the equivalent of 2,407 8-c.p. lamps, thus increasing the connections at Dec. 31 to approximately 12,500 lamps, exclusive of the supply of power to the Corporation tramways, which now reaches a maximum of 250 h.p. daily. A contract has been entered into for the supply of current for a term of years, for both lighting and power, to the contractors for the National Harbour works. The demand for current for the Corporation electric tramways is steadily increasing, and the service gives general satisfaction. On July 1 last a modifications of the Company's tariff was introduced, based on a maximum of 7d. per unit for a period of 1½ hours per day, and 3d. per unit thereafter. This reduction has given general satisfaction, and

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is resulting in a steady accession of business. The retiring directors are Sir William Crundall and Mr. B. H. Van Tromp, who, being eligible, offer themselves for re-election. The auditor, Mr. R. H. Marsh, chartered accountant, also retires, and is eligible for re-election.

REVENUE ACCOUNT, YEAR ENDED DEC. 31, 1898.

Dr.				£	s.	d.
Generation of Electricity.						
Fuel	£2,396	15	5			
Oil, waste, stores, and water	114	11	2			
Superintendence	71	5	0			
Salaries and wages	907	11	1			
Repairs and maintenance: buildings, £13. 0s. 1d.; boilers and heaters, £90. 5s. 2d.; engines and condensers, £52. 19s. 7d.; alternators and exciters, £16. 1s. 5d.; electrical instruments, £10. 19s. 11d.; tools and other machinery, £14. 0s. 9d.; accumulators, 10s.; traction plant, £126. 8s. 7d.	324	5	6			
Station lighting	71	9	4			
Works' sundry charges	70	6	10			
Engineer's office expenses	2	16	0			
				3,959	0	4
Distribution of Electricity.						
Superintendence	60	0	0			
Salaries and wages	128	14	7			
Repairs and maintenance: mains and street works, £8. 6s. 11d.; transformers and transformer stations, £23. 10s. 11d.; apparatus on consumers' premises, £11. 3s. 11d.	43	1	9			
				231	16	4
Public Lamps.						
Trimming	73	19	6			
Repairs	18	9	10			
Carbons	73	3	6			
				165	12	10
Rents, Rates, and Taxes.						
Rents	4	9	1			
Rates and taxes	132	10	4			
				136	19	5
Management Expenses.						
Directors' fees and head office salaries	318	14	2			
Stationery, advertising, and postage	76	13	7			
Travelling and sundry charges	70	6	2			
Office expenses	91	1	4			
Auditors	40	0	0			
				596	15	3
Law charges, insurance, and royalties				61	2	3
Depreciation—buildings, plant, etc.				400	0	0
Balance to net revenue account				2,133	7	11
				7,684	14	4

Cr.	£	s.	d.
Sale of current by meter and otherwise	6,156	12	11
Meter rentals	144	0	10
Public lighting	1,182	6	3
Sundry trading	126	9	4
Transfer and registration fees	0	5	0
Pupils' premiums	75	0	0
	£7,684	14	4

GENERAL BALANCE SHEET.

Dr.	£	s.	d.
Capital account—share capital issued	24,300	0	0
4½ per cent. debentures	25,000	0	0
Sundry creditors: County of London and Brush Provincial Electric Lighting Company, Limited, advance, £24,500; general, £5,063. 11s. 2d.	29,563	11	2
Depreciation and renewal fund account balance	166	0	0
	£79,029	11	2

Cr.	£	s.	d.
Capital account	70,484	5	0
Stores: coal. £57. 15s.; oil and waste, £20. 5s. 4d.; general, £643. 18s. 8d.	721	19	0
Sundry debtors: current supplied, £2,291. 7s. 4d; general, £436. 18s.	2,728	5	4
Preliminary expenses	652	2	2
Experiments' account	202	2	3
Cash at bank	137	14	4
Cash in hand	2	1	9
Balance from net revenue account	4,101	1	4
	£79,029	11	2

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated, B.T. units			514,340
Quantity sold	Public lamps	83,459	423,057
	Traction	179,844	
	By contract	3,780	
	Private consumers by meter	155,974	
Quantity used on works			10,437
Total quantity accounted for			433,494
Quantity not accounted for			80,846
Number of public lamps			40
Total maximum supply demanded (kw.): lighting, 200; traction, 155			355

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Edinburgh.—The Corporation invite tenders for water-tube boilers by April 3.

Plymouth.—The Corporation invite tenders for 12 months' supply of transformers and arc lamp carbons by 23rd inst.

Tynemouth.—The Corporation are prepared to receive tenders for the various electrical plant. Tenders by noon on April 15.

Southport.—The Corporation offer for sale two Browett and Lindley engines and Mather and Platt alternators. Tenders by March 21.

Barking.—The Urban District Council are prepared to receive tenders for the supply and erection of various plant. Tenders by 12 o'clock noon on March 27.

Bury.—The Electric Lighting Committee invite tenders for the supply and erection of one Lancashire boiler, with steam and other pipes. Tenders by March 20.

Peterborough.—The Corporation are prepared to receive tenders for the supply and erection of the plant for the municipal electricity works. Tenders by April 20.

Madrid.—The Public Works Department are inviting tenders for the building of an electric tramway in the city. Applications must be sent in by p.m. on April 14.

Southend-on-Sea.—The Corporation are prepared to receive tenders for the temporary transfer of their powers under the Southend Electric Lighting Order, 1891. Tenders by April 6.

Aberdeen.—The Corporation are prepared to receive tenders for the supply and erection of materials for the equipment of their George-street and Woodside tramway route. Tenders by March 29.

Derby.—The Electric Lighting Committee are prepared to receive tenders for the supply and erection of an overhead hand crane at their electric station, Sowter-road, Derby. Tenders by 30th inst.

Stockport.—The Corporation invite tenders for the supply, erection, and maintenance of 36 arc lamps. Specifications, etc., may be obtained from Mr. S. Meunier, engineer, Stockport (£1. 1s). Tenders by March 23.

Rothesay.—The Electric Lighting Committee of the Town Council are prepared to receive tenders for the supply and erection of various plant for the electric lighting of the burgh and harbour. Tenders by noon on March 27.

Halifax.—The Corporation invite tenders for the supply of 100 telegraph poles (creosoted), 20ft. in length and 5½in. diameter at the small end, delivered at the depôt, Victoria Reservoir, Gibbet-lane, Halifax. Tenders by 20th inst.

Poplar.—The Guardians invite tenders for steam turbines and dynamos (direct coupled), electric motors, battery of accumulators, electric cables, wiring, and fittings, main switchboard, and distribution boards. Tenders by March 22.

Belfast.—The Belfast Harbour Commissioners require tenders for the construction and erection of two overhead tramways on the Queen's Quay, Belfast. Specification, etc., may be obtained from the harbour engineer, Mr. G. F. L. Giles. Tenders by 27th inst.

Sunderland.—The Corporation are prepared to receive tenders for the annual contracts for (*a*) indiarubber-covered cables; (*b*) cast and wrought iron pipes and street service boxes; (*c*) stoneware casings and bearers; (*d*) house fuse boxes. Tenders by noon on March 30.

Stockport.—The Committee of the Stockport Sunday School invite tenders for the efficient electric lighting of the whole of their premises from the town supply. Tenders to be submitted to Mr. W. B. Leigh, hon. secretary, Committee Room, Stockport Sunday School, not later than March 24.

Dublin.—The Great Northern Railway Company (Ireland) invite tenders for the construction of about 2¾ miles of tramways through fields, etc., from the Bailey Post Office to Howth Station. Specifications (£2. 2s.) may be obtained at the office of the Company's Engineer-in-Chief, Amiens-street Terminus, Dublin. Tenders by 27th inst.

Aberdeen.—The Corporation are prepared to receive tenders for the following: (1) two Babcock and Wilcox boilers; (2) one 180-kw. steam dynamo, engine to be of Messrs. Bellis's or Messrs. Willans and Robinson's make, with steam and exhaust pipes; one 75-kw. balancing set. Tenders to Town Clerk, marked "Tender for Electric Plant," by April 5.

Lewes.—The Corporation invite offers from responsible companies or persons willing to establish an electricity supply undertaking under and subject to the provisional order of 1898. Particulars may be obtained at the offices of Mr. F. J. Warden-Stevens, Connaught Mansions, 34, Victoria-street, Westminster, S.W., or at the office of the Clerk, Town Hall, Lewes, on deposit of £5. 5s. Tenders by March 24.

New Brompton.—The Gillingham Urban District Council invite tenders for wiring and fitting technical institute for electric light, and furniture for new additions. Drawings can be seen and specifications obtained on application to Mr. Frederick Smith, architect, Bank-chambers, High-street, New Brompton. The sum of £1. 1s., to be returned on receipt of a bona fide tender, is required with the application. Tenders by 23rd inst.

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Beckenham.—The Urban District Council invite tenders for the construction of a dust destructor to be worked in conjunction with the electric lighting station proposed to be erected by the District Council in Arthur-road, Beckenham. Contractors tendering are to fully describe and specify in detail their proposed installations, which are not to include chimney shaft, inclined roadway, boilers, or roofing, but must be complete in all other respects. Preliminary plans and particulars, together with forms of tender, may be obtained at the office of Mr. John Angell, engineer to the Beckenham Urban District Council, on deposit of £1, which will be returned on receipt of a bona fide tender. Tenders, endorsed "Tender for Dust Destructor," to Mr. F. Stevens, clerk, by 4 p.m. on 27th inst.

Shanghai.—The Shanghai Municipal Council invite tenders for a concession for constructing and working about 23 miles of electric tramways on the trolley system in the streets of Shanghai. The special attention of tenderers is drawn to the fact that the tender (if any) recommended by the Council will require ratification by the ratepayers. Plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary-axe, London, E.C., on a Bank of England note for £100 being deposited with Messrs. Pook and Co., which sum will be retained by the Council, and deemed to be forfeited unless a bona fide tender be made by the depositor. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China (telegraphic address Dynamo, Shanghai; "ABC," fourth edition, and "Engineering" codes used). Sealed tenders, endorsed "Tender for Tramway Concession," must be sent to Mr. J. O. P. Bland, secretary, Council-room, Shanghai, China, and received by 12 noon on June 30.

Doncaster. — The Corporation invite tenders for the supply and delivery of the following articles, together with the fixing thereof at the electrical generating station in Bath-fields, Doncaster, or elsewhere within the borough, as may be indicated, according to conditions, plans, and specifications to be seen or obtained as follows—namely (*b*) three mild-steel Lancashire double-flued boilers; (*c*) three sets of steam dynamos, likewise two sets of larger steam dynamos, condensing plant, and other necessary adjuncts, likewise a six-ton overhead traveller; (*d*) electric storage battery of 136 cells, with a capacity of 750 ampere-hours, with stands and other adjuncts; (*e*) electrical instruments and other apparatus; (*f*) underground armoured cables, street boxes, and other appliances, laid and fixed, in the streets as required. Specifications, etc., may be seen and copies had at the office of Mr. James N. Shoolbred, C.E., 47, Victoria-street, London, S.W., or at the office of the Borough Surveyor, Doncaster, on payment of £2. 2s. for each of the various sections, or £5 for the entire set, which amounts will be returned on receipt of a bona fide tender. Tenders by 28th inst.

RESULTS OF TENDERS.

West Hartlepool.—The Town Council have accepted the Callender Cable Construction Company's tender for mains, etc.

Ayr.—The Town Council have accepted the tender of Mr. W. Watson, amounting to £53, for the erection of a sub-station between the fountain and Millar-road.

Richmond.—Messrs. Handley and Shanks, electrical engineers, Cork and Dublin, have secured the contract for the electric lighting of the Richmond Lunatic Asylum, Dublin.

Burnley.—The tender of Messrs. Williamson and Joseph, Limited, Northampton Works, Northampton-grove, Canonbury, has been accepted for the switchboard for the Burnley station.

Liverpool.—The City Council have accepted the tender of the India Rubber and Telegraph Works, Silvertown, E., for supply of two motor-generators at £980 each, and of two compensators at £380 each.

Aberdeen.—The Gas and Electric Lighting Committee of the Town Council have accepted the tender of Messrs. Bolton and Sons, Staffordshire, for an extra supply of copper strip required for the electric mains, at £638. 8s.

Barrow.—The tender of Messrs. Gradwell and Co., Limited, for the supply of counter, desk, testing-table, bench table, door and frame, two cupboards, stokers' lockers for the electricity works, amounting to £56. 5s. 9d., has been accepted by the City Council.

South Croydon.—Mr. W. Howard Tasker, M.I.E.E., consulting engineer, has received the following tenders for the electric lighting of Emmanuel Church, South Croydon:

Planet Electrical Engineering Company	£385	0	0
Belshaw and Co.	303	0	0
Moody Bros.	263	12	0
Bergtheil and Young	255	0	0
Brush Electrical Engineering Company, Limited (accepted)	230	0	0

Ealing.—The Urban District Council have received the following tenders for alternators:

British Thomson-Houston Company, Limited	£9,031	8	6
Crompton and Co.	9,449	0	0
Electric Construction Company	10,354	0	0
Ferranti and Co.	11,760	0	0
Mather and Platt (Belliss engines)	9,954	0	0
Mather and Platt (Willans engines)	9,878	0	0
Mather and Platt (Browett-Lindley engines)	9,315	0	0
Siemens (Browett-Lindley engines)	9,600	0	0
Siemens (Belliss engines), accepted	9,300	0	0

BUSINESS NOTES.

Stafford.—A small extension of the electric light mains is proposed.

Stock Exchange.—The market in electric shares has been steady during the week. Few transactions were recorded.

Partick.—An enquiry was held yesterday into an application of the electricity company for powers to light the town.

Twickenham.—The London United Company's application for an order will receive the support of the District Council.

Glasgow.—The City Council have agreed to purchase the undertaking of the Kelvinside Electricity Company for £37,000.

Bacup.—A committee of the Town Council is conferring with representatives of the Rawtenstall Council on the electric lighting question.

Mirfield.—The report of the engineer with regard to the electric lighting of the township will be considered by the District Council next week.

City and South London Railway Company.—Letters of allotment for the issue of £375,000 ordinary share capital were posted on Wednesday.

Leatherhead.—The Urban District Council have resolved, upon the advice of Messrs. Handcock and Dykes, to adopt an electric lighting scheme.

Royal Electric Company of Montreal.—The usual quarterly dividend of 2 per cent., being at the rate of 8 per cent. per annum, has been declared.

British Columbia Electric Railway Company. — The net earnings for the month of January were 14,009dol., as against 9,999dol. for the corresponding period.

Wallsend.—The Urban District Council will present a petition in favour of the Bill of the Walker and Wallsend Gas Company for electric lighting powers in the district.

West India and Panama Telegraph Company.—The receipts for the two weeks ended Feb. 28 show an increase of £320 as compared with the corresponding period.

Removal.—We are informed that Messrs. Gillies and Hornidge, electricians and engineers, Haggerston, have taken City offices at Albert-buildings, 49, Queen Victoria-street, E.C.

Peterhead.—The Town Council are enquiring into the cost of fixing electric bells at different parts of the town for the purpose of notifying any fire to the members of the brigade.

Bristol.—The Town Council have accepted the report of the Electrical Committee recommending the purchase at £2,500 of property for the extension of the electric light station.

Hampton Wick.—A committee of the District Council has been appointed to enquire from Kingston as to whether they would extend their electric cable to Hampton Wick on terms to be agreed upon.

Middlesbrough.—Mr. A. E. Meade King, M.I.C.E., held an enquiry on Wednesday into an application of the Corporation to borrow £36,000 for electric lighting purposes. The application was opposed.

Fulwood.—The Preston Guardians had decided to have an electric light installation at Fulwood Workhouse, but a committee is now considering an offer for current from the National Electric Supply Company.

Woking.—A report has been presented to the Council upon the purchase of the electric light undertaking. The suggested purchase price is £15,000, and an additional £5,216 will have to be expended at once.

Swansea Docks.—At the last meeting of the Streets Committee of the Swansea Corporation it was decided to offer the Harbour Trust £12. 10s. for the supply of three electric lights up to, but not above, Padley's Quay, on the North Dock.

Coatbridge.—The Council have appointed a committee to co-operate with a committee of the Airdrie Town Council as to the prospects of a scheme to form a trust for the purpose of constructing a tramway in the burghs of Coatbridge and Airdrie.

Warrington.—The deputation of the Town Council has visited the Llandudno and Chester electric stations. The committee's recommendation to adopt the site at Howley instead of the gasworks site, as previously proposed, has been adopted.

Swansea.—The Works and Sanitary Committee of the Corporation have disapproved of the plan of the new generating station which the electric traction company proposes erecting, because the proposed building will project beyond the frontage line.

Belfast.—The Corporation Bill, which includes an application for power to construct tramways, came before a statutory meeting of ratepayers on Tuesday. The meeting was a pretty stormy one, and in consequence of what passed a *plebiscite* is to be taken.

Grimsby.—The Chairman of Committees in the House of Lords has reported that the opposition to the Great Grimsby Street Tramways Bill has been withdrawn. It has therefore been referred to the consideration of the Committee on Unopposed Measures.

Saltburn.—The Urban District Council have consented to the laying of underground wires by the Cleveland and South Durham Assets Company with respect to the installation of electric lighting for public purposes in Saltburn, at a nominal charge of 6d. per year.

Wakefield.—The Electric Lighting Committee's report shows that the revenue for the past year has been £2,318, and the total cost £1,135, leaving a gross profit of £1,183, or, after deducting

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£1,054 for interest and sinking fund, a net profit of £129 for the first year.

Aberdeen.—At a meeting of the County Council on Saturday it was unanimously agreed to grant permission to the Great North of Scotland Railway Company to carry across the public road the electric tramway formed between Cruden Bay and the railway hotel entrance.

Sunderland.—It is stated that the United Service Tramways Company have decided to apply to the Commissioners for permission to lay down an electric light railway from Roker to Houghton-le-Spring, tapping places like Fence Houses, Penshaw, and Newbottle.

Hyde.—The Oldham, Ashton, and Hyde Electric Tramway Company having declined to pay the £500 promised towards the cost of improvements at "Ring o' Bells" corner, the Town Council has taken legal proceedings against the company to enforce payment.

Eastbourne.—An unofficial conference is to take place between two members of the Electric Lighting Committee and two of the principal shareholders of the electric lighting company on account of the rejection by the shareholders of the Corporation's offer of £20 for every £10 share.

Ayr.—A proposal has been made on the part of the contractors that they should take back one of the low-speed engines and substitute a high-speed one, as the other engine would be sufficient for the night and day load, and would run in parallel with any of the high-speed engines.

Blackburn.—The Board of Trade on the 14th inst. approved of the new electric tramway system, and the town clerk has been informed that formal authority to commence running would be given at once. A reduction of fares from 2d. to 1d. will be made on certain sections of the line.

County of London Electric Lighting Company, Limited.—The directors have decided to recommend the payment of a dividend on the preference shares of the Company at the rate of 6 per cent. per annum, less income tax, for the six months ended Dec. 31, 1898, carrying forward £5,774.

"London Gazette."—The first meeting *re* the estate of F. Marson (trading as F. Marson and Co., Leicester) will take place on the 21st inst., at 12.30, at the office of the Official Receiver, 1, Berridge-street, Leicester. The public examination will be held April 7, at the Castle, Leicester.

Halifax.—The Commercial-street to Skircoat Green branch of the tramways was opened to the public last week. With regard to the Booth Town route, the Tramways Committee are hoping, if everything continues satisfactory, to have the line ready for the Board of Trade inspection by Easter.

Plymouth.—A Local Government enquiry has been held into the borrowing of £9,000 for the erection of a dust destructor at Prince Rock. As electrical power would be generated at the same time, a saving of £350 would be really effected. The cost of the destructor would be £4,253, building £3,622, and land £1,125.

Barrow.—The County Council will at their next meeting discuss a report of Messrs. Kincaid, Waller, and Manville on an extension of the electric lighting plant sufficient to cope with the supply for next winter. There are now 67 consumers on the books, and additional 25 meters, indicators, etc., are to be obtained at about £250.

Huddersfield.—The Town Council on Wednesday adopted the minutes of the General Purposes Committee, including a report by Mr. K. F. Campbell, the borough engineer, for the conversion of the present steam haulage of tramcars to the electric overhead system, and recommending borrowing the £100,000 required for the purpose.

Wolverhampton.—At the last meeting of the Town Council the Lighting Committee recommended that the charge for a supply to all churches and chapels shall as from April 1 next be 4½d. per unit, and that to consumers of electrical energy to the extent of 35,000 units annually and upwards the charge shall be at a uniform rate of 4d. per unit.

Chester.—The Town Council on Wednesday resolved to lay arc mains and distributing mains for the supply of public and private lighting in various streets at an estimated cost, including lamps, of £1,500; and to have electric lighting adopted in 81 lamps in a number of streets in which mains were already laid at an estimated cost of £530.

Leicester.—The financial statement of the electric lighting department, presented to the Town Council on Wednesday, states that in regard to the profit and loss account there was left a balance of net profit for the half-year of £2,199, as against £1,031, being an increase of £1,168. The present half-year would see an end of the deficit of £649, and a good profit in hand.

Manchester.—The Tramways Committee of the City Council have under consideration a report on the subject of through routes prepared by the secretary of the department, Mr. J. M. M'Elroy. The report deals only with the existing routes. In the next session of Parliament the committee will apply for a provisional order authorising the construction of a number of new lines within the city.

The Electrical Company, Limited.—We are informed that owing to increased demand for their goods this Company has established, in addition to their branch at Brighton for the South Coast, a branch in Manchester at 21, Corn Exchange-buildings, Fennel-street, for the Lancashire, Yorkshire, Nottinghamshire, Staffordshire, Cheshire, and Derbyshire districts. Mr. A. V. Ward has been appointed manager.

Llandudno.—Sir Courtenay Boyle on Tuesday presided over an enquiry into the proposed light railway to Colwyn Bay. The company have agreed to eliminate the word "mechanical" in the order, and to substitute the word "electrical." It was intimated that the Board of Trade would confirm the order of the Light Railway Commissioners.

Leith.—At the statutory March meeting of the Edinburgh and Leith Gas Commission it was stated that, notwithstanding the fact that there was now electric light in Leith, the increase of gas was much greater proportionately than in Edinburgh, being last month 6,658,000 cubic feet. As was the case with Edinburgh, the introduction of electric lighting had had the immediate effect of increasing the demand for gas.

West Riding County Council.—The minutes of the Law and Parliamentary Committee, which were approved on Wednesday, advised that although the Light Railway Commissioners had made an order authorising the construction of a light railway between Leeds and Bradford—a scheme which conflicted with tramway proposals of the Leeds and Bradford Corporations—the County Council should not further interpose.

Montrose.—At the meeting of the Town Council on Tuesday the Treasurer's Committee recommended the approval of the clause of proposed articles of association of the Angus Electric Light Company, Limited, regarding the appointment of *ex officio* directors. The registered office of the company will be in Montrose, and the meetings will be held in Montrose. There is no salary provided for the *ex-officio* director.

Leeds.—The City Council have resolved to borrow £150,000 in order to complete the electric lighting station on the lines originally laid out. A large part of this expenditure has already been incurred, and the output has thereby been increased to nearly double its former capacity. It is now estimated to last to December, 1900. For the proposed Britannia Mills station £25,000 is provided for buildings and £33,000 for mains and machinery.

"Specification."—The third number of this work (published by the *Builders' Journal and Architectural Record, etc.*, London, 5s.) has just been issued as a double number. It is now illustrated, and contains several new sections. Under the heading "Electrician," we find lighting, lightning conductors, telephones, electric lifts, specification clauses, fire office regulations, special risks, London Building Acts, Board of Trade regulations, and a very handy little glossary of electric terms.

Hornsey.—The Lighting Committee's report to the Vestry at its last meeting stated that the Westminster Electric Supply Corporation, Limited, had written making proposals for a company to take over the provisional order for electric lighting granted to the Council and confirmed in the last session of Parliament. The letter has been acknowledged. Pending the experiments with incandescent gas, the committee have not taken any steps towards putting the order into operation, but the matter is under consideration.

London County Council.—The Council have agreed to lend the St. Luke's Vestry £1,000 for the erection of a dust destructor, and the Battersea Vestry £2,851 for land on which to extend their electric lighting generating station. A report of the solicitor has notified the receipt of the Treasury sanction to the periods proposed for the repayment of the following loans: Hampstead Vestry, loan of £2,560 for electric lighting installation, 42, 30, and 10 years; St. Pancras Vestry, loan of £30,000 for electric lighting installation, 42 years.

Appointments Vacant.—The Folkestone Electricity Supply Company has a vacancy for an electrician-in-charge.—The Water and Lighting Committee of Shrewsbury are prepared to receive applications for the post of assistant electrical engineer at their electricity works.—The Corporation of Devonport invite applications for the appointment of an electrical engineer.—A clerk of works is required for the electricity works of the Barnsley Corporation, at £150 a year. Particulars of the above vacancies will be found in our advertising columns.

Dundee.—Mr. E. Manville, who was recently appointed electrical consulting engineer in connection with the proposed extension of the tramway system, has visited the proposed new line from the centre of Dundee to the neighbourhood of Downfield, *vid* the steep ascent at Constitution-road. It was pointed out to Mr. Manville that the Council desired to have his opinion as to whether electrical traction or a cable system would be most suited for this particular extension, in view of the steepness of the gradient. Mr. Manville is preparing a report upon the question.

Whitehaven.—At the last meeting of the Town Council the Mayor, in moving the confirmation of the minutes of the Water and Lighting Committee, explained the advisability and advantage, in connection with the electric lighting, of increasing the voltage. Additional conductors, if laid, would cost £2,500, whilst the cost of the high voltage would only be £920. After the Royal assent to their Bill the Council would apply to the Board of Trade for borrowing powers to light Kells and Harras. Some members also spoke in favour of a refuse destructor being established.

Coventry.—The Electric Lighting Committee reported to the City Council on Tuesday that they had come to the conclusion that under the system of charges for electric light adopted in 1895 the scale pressed unduly upon a certain class of consumers, and thereby restricted consumption. After enquiries they had come to the conclusion that the full price of 6d. per unit should be charged only on a consumption equivalent to one hour's use per day instead of two, and that all further consumption should be charged at the rate of 3d. per unit. The report was adopted.

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Weston super-Mare. — At Tuesday's meeting of the Urban District Council Mr. C. Brereton appeared before the Council with a view of inducing the Council to withdraw their opposition to the provisional order sought to be obtained by the Weston-super-Mare Electric Tramways Company. It was explained that the promoters were prepared to eliminate the Oxford and Regent street portions of their scheme, and also the overhead system. The matter was referred to a special meeting of the Council.

Wallasey Tramways Bill.—This Bill, which seeks to empower the Wallasey District Council to extend the Wallasey tramways, which they propose to acquire under statute and to work by electricity, and other works, came before Lord Poltimore's committee on Wednesday and Thursday. From the evidence, it appears that the District Council propose to construct a number of new lines in the district between Seacombe and New Brighton. Opposition to this part of the Bill came from the Wirrall Railway Company, which had not for the past two years run trains on their Seacombe and New Brighton line.

St. Pancras.—The Officers' Committee of the Vestry have issued a report proposing that, in regard to future appointments to the office of engineer-in-charge of the King's-road station, the salary be fixed at £200 per annum, increasing by annual increments of £20 to a maximum of £300 per annum, without residence, and that the salary of Mr. P. N. Hooper, the present engineer-in-charge at the station, be increased by £20 at the expiration of one year from the time when he was appointed to this position, and further increased £20 annually until he reaches the maximum salary of his office.

Barnsley.—The Town Council have appointed a Tramways Committee to consider the advisability of introducing a system of tramways into Barnsley. The corner-stone of the electric lighting station in connection with the Town Council's scheme for supplying electric light and energy was laid last week by Councillor Brady, chairman of the Parks and Lighting Committee. The premises now being erected from designs of the borough surveyor are situate in Beckett-square, and will house an installation capable of supplying 6,000 8-c.p. lamps, and are being built in such a way as to be capable of indefinite extension.

Tonbridge Wells.—All the public bodies in the borough have passed resolutions similar to that of the Town Council, which expresses the opinion that any proposal which does not enable a municipality, having a population of less than 50,000, to provide a municipal telephonic system, will operate prejudicially to the full development of the telephonic system throughout the country, and they consider that any urban district which is prepared to undertake the supply of telephonic facilities for a reasonable and sufficient area, should be placed in the same position as that in which it is proposed to place the larger municipalities.

New Maldon.—A sub-committee has been appointed to consider the tramway question. With regard to the electric lighting, which was discussed at last week's meeting, it appears that the Board of Trade discourage the idea of extending their order as to Kingston so that current could be supplied to Maldon. The matter has been referred to a committee. It is stated that if the tramways company had a charging station in the place they might make use of that for their electricity. The Clerk, however, has stated that they would not have a charging station nearer than Hammersmith, and from that station 20 miles of line could be worked.

Bradford.—The half-yearly statement adopted by the City Council on Tuesday stated that in regard to the electricity works the total income had been £13,011, as compared with £10,842 for the corresponding half-year. The total expenditure had been £10,519, as against £7,942, the increase being due to the higher charges for interest and sinking fund. The profit for the year had been £2,491, as against £2,891, being a decrease in the net profit of £407. The consumers now numbered 850, against 649. The trade profit was £4 5s. 7d., and the net profit £1. 7s. per cent. The whole trade profit for the year was £7. 4s. 9d. per cent. The statement and minutes have been adopted.

Walsall.—The Town Council have informed Messrs. A. Dickinson and Co., of Birmingham, with regard to a proposal for the construction of a light railway from Perry Barr to Walsall, that the Council would be prepared to support any application which might be made for an order under the Light Railways Act authorising the construction of such railway, provided that satisfactory clauses were inserted for the protection of the rights and interests of the Council, and arrangements were come to with the promoters by which, in the event of the Council acquiring the tramways within the borough, so much of the light railway as would be situate within the borough boundary should be sold to the Council on reasonable terms.

Bangor.—At a special meeting of the Urban District Council held last week for the purpose of considering the proposed local electric tramway scheme, Dr. R. H. Todd, solicitor, appeared on behalf of the promoters, Messrs Drake and Gorham, of the Bangor and Donaghadee Electric Tramway Company. Mr. Frazer, C.E., said they intended to erect centre poles and light with electricity. Ultimately it was agreed that the promoters and the Council should fix the terms on which the town would be supplied with electric light, and that if any misunderstanding should arise the matter would be referred for settlement to an arbitrator to be appointed by the Board of Trade. A resolution approving of the scheme was unanimously adopted.

Diary.—We have received from Messrs. Davenport and Sons, of Davenport's Brewery, Birmingham, a copy of their diary for 1899. It is very neatly bound, and of a convenient size for the pocket. It contains a large amount of useful information of the kind likely to be often required. Sport takes a very prominent place in it, items of interest in all branches being given. The standard wire gauge and various other tables useful to engineers are given. We have in it also information as to licensing, and also the postal regulations and foreign money tables. We unfortunately omitted to note this interesting little publication before, it having been overlooked. However, "better late than never," and the diary is none the less worthy of being obtained even now.

Shoreditch.—The Lighting Committee of the Vestry reported last week that they had considered a report from the chief engineer on the advisability of lighting the Haggerston district by electric arc lamps. The number of lamps required to light the principal streets will be about 40. The chief engineer also advised that as the whole of those streets, with the exception of Brunswick-street, Haggerston-road, and Goldsmith's-row, were now having conduits laid down them, that conduits be laid down in the other streets at the same time. The cost of laying the necessary conduits and supplying and fixing the arc lamps complete will be about £2 750. The committee recommended that the necessary steps be taken to have the work proceeded with. The report was adopted *nem. con.*

Greenock.—The question of the Greenock and Port Glasgow Tramways Company's proposal to take over the line and to use electrical traction was discussed at a special meeting of Greenock Police Board on Saturday. A resolution was passed to the effect that, being unable to agree to the terms offered by the Greenock and Port Glasgow Tramways Company for a renewal of the lease, and in view of the tramway company's Bill coming before the Committee on Private Bills in the House of Lords on an early day, it was urged that the Police Board prepare its case against the Bill. A committee to carry on the opposition to the tramway company's Bill was appointed, and left for London on the 12th inst. Representatives of the promoters have also arrived with their witnesses, several of whom are stated to have been secured in Port Glasgow and Gourock.

William James Glover and Co., Limited.—An issue of additional capital is announced, required by this Company for extension of their present wire-drawing and rope-making business at St. Helens, and for equipment of a large factory at Warrington, where they will carry on the manufacture of electric wires and cables and general rubber goods. The Company will be in the unique position of being able to manufacture electric cables direct from the raw material, thereby saving the intermediate profits of the wire drawer and the rubber cleaner and mixer. The Company will also have the benefit of a management which has already proved its efficiency and success in the past. The electric cable business is in a very vigorous condition, the demand being unprecedented, in spite of this being the dull season for these goods. For further particulars we refer readers to our advertising columns.

Manchester Electricity Undertaking.—The Town Council resolved on Wednesday that application be made to the Local Government Board for sanction to borrow the further sum of £500,000 for the purposes of the electricity undertaking of the Corporation. In answer to enquiries, it was said that it was absolutely impossible to say how much money the Electricity Committee would require in the future. The business of the department was increasing by leaps and bounds, and a public want had to be supplied. The main reason for asking for the money now was that the Local Government Board were very slow in their procedure. The committee had been waiting now for some months for the last loan, which had been sanctioned, and the object in regard to the loan now asked for was to "take time by the forelock."

Rochdale.—The Guardians have adopted the minutes of the Electric Lighting Committee stating that they had agreed upon the draft specification prepared by Messrs. Crews and Handford, electrical engineers, for installation of electric light at the workhouse, and recommended that advertisements for tenders be issued. Mr. Crews (who attended the meeting) stated that his firm were of opinion that it would be far more economical for the Guardians to erect a new engine and boiler house on spare land near the school buildings for lighting the workhouse with electricity than it would be for them to make use of the existing engine and boiler house at the workhouse, as such houses could not be used for electric lighting plants without costly structural alterations having first to be made. The committee agreed to this. The probable cost is £1,000.

Birkenhead Tramways.—A committee of the House of Lords, Lord Poltimore in the chair, on Tuesday commenced to consider the Birkenhead Corporation Bill. By the Bill the Corporation take powers to acquire by agreement the interests in the tramways of their lessees, the Birkenhead United Tramway, Omnibus, and Carriage Company, Limited, whose lease expires on Dec. 31, 1900, and of the Wirral Tramways Company, whose lease expires on March 10, 1916, and to work these by electricity supplied from their present generating station. The Bill also proposes the construction of a number of new tramlines and the construction, at the cost of £14 300, of a new street commencing by a junction with Argyle-street South and terminating at the junction of Holt-hill and Whetstone-lane. The Birkenhead United Tramway Company have agreed with the Corporation, and although they petitioned against the Bill, they did not instruct counsel. The Wirral Tramways Company, whose property the Corporation do not intend at present to acquire, also petitioned against the Bill, and were represented by Mr. Pope, Q.C., and Mr. E. H. Lloyd. The counsel for the promoters were Mr. Littler, Q.C., Mr. Fitzgerald, and Mr. Squarey.

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Darfield.—Major Cardew, R.E., Local Government Board inspector, held an enquiry on the 14th inst. into the application of the Urban Sanitary Authority for powers to supply electricity for public lighting and other purposes. Mr. Short (instructed by Mr. C. J. Tyas, clerk of the District Council) supported the application, and Mr. T. E. Ellison (instructed by Messrs. Sanders and Nicholson, Wath) represented the opponents, the owners of Mitchell Main, Darfield Main, and Oaks Collieries, the Midland and Great Central Railway Companies, and Mr. T. Wilkinson. The Council proposed to adopt a scheme by which electric light can be supplied at a cost of £12,000, and urged that the light would be the best and cheapest for the district, both in regard to public lighting and private consumption. The case for the opponents was that the light could not possibly be brought into the district to pay, and if light was needed they could obtain gas from the Wombwell Gas Company, who had power to supply Darfield.—*Yorkshire Post.*

London Tramways.—The Highways Committee of the London County Council have been considering the question of what extensions of the Council's tramways systems on both sides of the river are desirable and expedient, and have come to the conclusion that it would be of advantage if the Council were to make use of some of the provisions of the Light Railways Act in order to develop the tramway system in the suburban areas around London, and that the Council should endeavour to enter into arrangements with the county councils of those districts with a view to joint action being taken which may result in the construction of an extensive system of locomotion. They think that if such arrangements could be come to, they would not only materially increase the earning capacity of the Council's tramways, but be of great benefit to the adjoining districts by affording easy and cheap means of transit to and from the central parts of London. They have asked the Council for powers to prepare and submit schemes for this purpose, and to negotiate with the other authorities with a view to joint action being taken.

Dewsbury.—At a recent meeting of the Dewsbury Co-operative Society, Mr. W. Webb, the president, read a comparative statement with reference to the consumption of gas and electricity at the central stores. He stated that during the 12 months ending June, 1895, the cost of gas consumed was said to be £216. 16s. 11d. That was the last full year when they had gas in the stores. For the year ending December, 1898, the cost of electricity was £453. 12s. 9d., or an increase of £236. 15s. 10d. It should be taken into consideration, however, that the consumption of electricity was greater than usual last year, owing to the large hall being used for the drapery department. Against the increase they must remember they had a better light; that the rooms were kept cleaner, and more comfortable to work in; that they had not to allow the same amount of depreciation with the electric light as with gas; and the premises were healthier. The decorations in the large hall would keep fresh three times longer with electricity than they would if the hall was lighted by gas. Taking all these things into consideration, he thought there was little difference between the cost of gas and electricity. They were endeavouring to secure a reduction in the price of electricity.

Islington.—At the meeting of the Vestry to-day it will be proposed that the Electric Lighting Committee be instructed to report as to the desirability of extending the electric light to the following roads: Hornsey-road (to parish boundary). Stroud Green-road, Crouch-hill, Blackstock-road, Gillespie-road, Drayton-park, Newington-green-road (to parish boundary in Newington-green), Mildmay-road, Mildmay-park, Balls Pond-road, and to bring up estimates of the respective costs to the Vestry. The Parliamentary and General Purposes Committee will submit a report on the application by the Vestry of St. Pancras for permission to lay mains in York-road and Brecknock-road, stating that they are of opinion that inasmuch as the Vestry of St. Pancras has no power to lay mains outside their statutory area, the Vestry has no power to grant the permission asked for; and the committee recommend that while they are of opinion the Vestry of St. Pancras should be so informed, attention should be drawn to the fact that an opportunity may be offered by the London Government Bill for the readjustment of the boundaries of the two parishes, in which case the Vestry would be willing to combine with that of St. Pancras with a view to getting rid of difficulties similar to the one in question.

Leeds Tramways.—According to the *Leeds Mercury*, electric cars will probably be running in July on the Chapeltown and Headingley routes. Rapid progress is being made with the extensions to the electric generating station at Crown Point. The existing premises are being more than doubled in size, and next week workmen will be busy putting the roof on to the new portion. When this is done the two apartments will be thrown into one. This will form one of the finest engine-rooms in the country. The size of it will be about 100ft. by 88ft. Built of red brick, with a more or less ornamental main entrance in the Calls, the structure will not be unattractive. The interior is lined with glazed bricks, and this gives the place a very light and cleanly appearance. The existing plant consists of two boilers, two 400-h.p. engines, and a couple of dynamos. These are duplicates, and have only been used together on special occasions, when the traffic on the Roundhay or Kirkstall routes has been exceptionally heavy. The additional plant will include four new boilers (two of which are already in position), two 1,200-h.p. engines, and further dynamos. When all is finished the station will be able to supply power sufficient to run something like a hundred electric cars. Messrs. Gould are doing the building work, Messrs. Fowler have the contract for the engines, Messrs. Greenwood and Batley that for the dynamos, and Messrs. Clayton, Son, and Co. are supplying the boilers. The city engineer is superintending the carrying out of the work. At a meeting of the Leeds Tramways Committee on Monday, it was decided to appoint a traffic manager to control the outside work in connection with the tramways department. The chairman (Mr. Smithson) and the general manager (Mr. Wharam) were requested to draw up a report as to the nature of the duties of such official, and to submit the same at an early date to a special meeting of the committee. It was reported that the receipts from the cars during last month amounted to £8,390, as compared with £5 885 in the corresponding period of last year, an increase of £2,505.

PROVISIONAL PATENTS, 1899.

MARCH 6.

4845. Improvements in apparatus for registering the supply of electricity. Ludwig Zahn, 10, Friedrichstrasse, Berlin.

4863. An improved indestructible insulator for electric engineering purposes. William Cook and William Kinzett, Springfield Works, Crabbs Cross, near Redditch.

4878. An improved case for electrical transformer connections, also applicable to street electric light standards. George Wilkinson, 73, St. Stephen's-road, Upton Park, London. (Complete specification.)

4879. A new or improved electric battery cell and elements therefor. Anthony Strong Frazer and George Alexander Smith, 73, St. Stephen's-road, Upton Park, London.

4931. Means for generating and impressing semi-cycles of electromotive force on electric circuits for telegraphic and other purposes. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Albert Cushing Crehore and George Owen Squier, United States.)

MARCH 7.

4941. Improvements in the governing of electric motors. Justus Eck, 5, Priory-road, Bedford Park, London.

4954. Improvements in electric clocks. Joseph Butcher, Prince's-chambers, Wolverhampton. (Complete specification.)

5010. Improvements in or relating to electrical incandescent lamps. Ernest Francis Moy and Percy Henry Bastie, 433, Strand, London.

5030. Improvements in control apparatus for electric hoists and elevators. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (An Irew Ellicot Maccoun, United States.) (Complete specification.)

5041. Improvements in dynamo-electric machines. William Brooks Sayers and Mavor and Coulson, Limited, 46, Lincoln's-inn-fields, London.

5042. Improvements in dynamo-electric machines. William Brooks Sayers and Mavor and Coulson, Limited, 46, Lincoln's-inn-fields, London.

MARCH 8.

5096. An electric opera, field, or marine glass. Henry Frank Purser, 33, Hatton-garden, London.

5099. Storage plates for accumulators and process for the manufacture of the same. Erhard Goller, 70, Chancery-lane, London.

5100. Improvements in and relating to methods for charging accumulators. Vivian Bolton Douglas Cooper and Eustace Ridley, 70, Chancery-lane, London. (Complete specification.)

5104. Reinforcement of electrical waves and avoidance of loss by straying reflection, etc., by means of a condenser. Ferdinand Braun, 322, High Holborn, London.

5111. A new or improved electrically-operated gas-tap and apparatus for lighting at a distance. Gustav Schünemann and Otto Rieder, 115, Cannon-street, London. (Complete specification.)

MARCH 9.

5130. Improvements in electrical time switches. John Grice Statter, 68, Victoria-street, London.

5151. An improved envelope for electrical conductors. Frank Brimson Cox, 10, St. George's-crescent, Liverpool.

5167. An economic carbon for arc lamps. Maurice Patrick MacInnerny, 29, Falkner-street, Liverpool.

5190. Improvements in telephone switchboards. James Martin Overshiner, 18, Buckingham-street, Strand, London. (Complete specification.)

5191. Improvements in lighting electric lamps. Charles Curwen, 70, Palace-chambers, Westminster, London.

5197. Improvements in electrical power station switches. Henry White Bowden and William James Allbright, 16, Union-court, Old Broad-street, London.

5200. Improvements in the manufacture of porous diaphragms for electrolytic apparatus. Trevenen James Holland and Arthur Pillans Laurie, 6, Bream's-buildings, Chancery-lane, London.

5217. Improved construction of commutators for dynamos and electromotors. James Burke, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

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5199. Improvements in electrolytic decomposing apparatus. Trevenen James Holland and Arthur Pillans Laurie, 6, Bream's-buildings, Chancery-lane, London.

5211. Improvements in electric incandescent lamps. Andrew Hartman Miller, 53, Chancery-lane, London.

5229. Improvements in apparatus for making and breaking high-potential electric circuits. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edward M. Hewlett, United States.) (Complete specification.)

MARCH 10.

5249. Automatic motor-starting switch. Percy Watson, 12, Watson-street, Aberdeen.

5250. Automatic electric brake. Claude William Hill, 80, Manchester-road, Oldham.

5255. Improvements in electrical switches. Robert Frederick Hall, 24, Temple-row, Birmingham. (Complete specification.)

5262. Improvements in electrical tumbler and other switches. Robert Frederick Hall, 24, Temple-row, Birmingham.

5279. Improvements in electric cables. Joseph Arthur Lovel Dearlove, 4, Great Winchester-street, London.

5296. A method of distinguishing electric and other switches in the dark. George Seymour Fort and Alethea Fort, 12, Union-court, London.

5322. Improvements in or in connection with apparatus for the production of ozone by electricity. Joshua Henry Lamprey, 7, Staple-inn, London.

MARCH 11.

5341. Improvements in tumbler switches for electrical purposes. Alfred Watson, 24, Temple-row, Birmingham.

5356. Improvements appertaining to electric arc lamps. Harry Bennett, 17, Hanover-street, Keighley.

5392. Improvements in controlling switches for electric motors. Hardman Arthur Earle, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

5398. Improvements connected with electric traction. Emile Bede, 4, South-street, Finsbury, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1898.

331. System of conducting electricity for propelling, heating, lighting, and telephoning from railway vehicles. Libbey.

4004. Switches for altering the speed and direction of revolution of electric motors. Edwards and Beevor.

4306. Electrodes for secondary batteries. Northey.

4441. Electric motors. Duncan. (Date applied for under International Convention, Jan. 14, 1898.)

6633. Apparatus for indicating the charge in a secondary battery. Cooke and Ireland.

7470. Effecting electrolysis. Wise. (Solvay and Co.)

7471. Electrolysis. Wise. (Solvay and Co.)

7569. Electric furnaces. Lake. ("Volta," Société Anonyme Suisse de L'Industrie Electro-Chimique.)

7586. Magnetic separators. Clark. (The Metallurgische Gesellschaft A. G.)

7700. Protecting shields for incandescent electric lamps and the like. Dewar.

8142. Systems of electrical distribution. Lamme. (Date applied for under International Convention, Sept. 18, 1897.)

8348. Electrical measuring and indicating instruments. Heap.

9002. Apparatus for the manufacture of potassium, chlorate, or sodium chlorate by electrolysis. Brock, and the United Alkali Company, Limited.

9122. Direct-call telephone systems. Oppenheimer.

10710. Dry battery. Weiss.

14902. Telephone cables. Saunderson.

16754. Coin-freed apparatus for the automatic delivery of electric current. Bieberstein.

20814. Mirrors and arc lamps for searchlights. Barbier.

21550. Systems of control for electric motors and railway trains. Potter. (Date applied for under International Convention, March 17, 1898.)

21551. Controlling electric motors and electrically-propelled railway trains. Rice. (Date applied for under International Convention, March 26, 1898.)

24559. Electrically-propelled road vehicles. Morris and Salom.

24949. Regulating transformer for rotary-phase current or polyphase-current installations. Siemens Bros. and Co., Limited. (Siemens und Halske Atkien-Gesellschaft.)

26251. Construction of electrical transformers with ventilating passages. Blathy.

26334. Electric switches. Ferguson and S ump.

26351. Galvanic elements or batteries. Wetter. (Maas.)

27613. Electric fuseholders. Howard.

1899.

102. Means for reducing battery electrodes. Willard.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1899.	Corresponding week 1898.	Increase or decrease.	Total receipts for half-year. 1899.	1898.
		£	£	£	£	£
Birmingham Tramway	Mar. 11	3,775	3,279	+ 496	37,575	34,632
Blackpool and Fleetwood Tramroad	,, 11	212	—	—	1,676	—
Bradford City Trame	Feb. 5	145	—	—	6,733‡	—
Bristol Tramways and Carriage Co.	Mar. 10	2,459	2,259	+ 200	—	—
City and South London Railway	,, 12	1,072	1,077	- 5	12,179	11,796
Dover Tramways	,, 11	147	100	+ 47	1,430	1,048
Dublin U.T., elec. cars	,, 10	930	659†	+ 271	8,439	6,886†
Dublin S.D. Electric Tramways	,, 10	625	378	+ 247	6,071	3,930
Halifax Corporation Tramways	,, 8	301	—	—	9,729*	—
Liverpool Overhead Railway	,, 12	1,364	1,330	+ 34	14,273	14,824
South Staffordshire Tramways	,, 10	588	533	+ 55	5,934	5,789

* Since June 30, 1898. † Including horse cars. ‡ Since July, 1898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	23½-24½
Bournemouth and Poole Electric Supply, Limited, Ord.	10	13-13½
—— 4½ per cent. Cum. Pref.	10	10⅞-11⅛
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	17⅛-18⅛
—— 6 p. c. Cm. Pf., 30,001-40,000 (all paid)	10	18½-18⅝
—— 5 per cent. Perpetual Debenture Stock	100	125-127
Brush Electrical Engineering, Limited, Ordinary	2	1⅞-2⅛
—— Non. Cum., 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	101-104
Callender's Cable Company, Debentures	100	114-117
—— Ordinary	5	12½-13½
Central London Railway, Ordinary	10	9½-10½
——	8	7½-8½
—— Pref. Half-Shares	8	3½-4
—— " "	5	4½-4⅝
Charing Cross and Strand	5	11½-12½
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	8½-9½
—— 4½ per cent. Debentures	100	114-116
City of London, Ordinary	10	19½-20½
—— " 90,001-100,000	10	19-20
—— 6 per cent. Cumulative Pref.	10	15-16
—— 5 per cent. Debenture Stock	100	124-129
City and South London Railway, Consolidated Ordinary	100	70-72
—— Ordinary	3	4⅞-5⅛
—— 4 per cent. Debenture Stock	100	133-135
—— 5 per cent. Pref. Shares	10	14½-15½
—— " " '96	10	14-15
County of London and Brush Prov. Elec. Light Co., Ord.	10	12-13
—— " " No. 30,001-40,000	10	12-13
—— 6 per cent. Cum. Pref.	10	14½-15½
Crompton and Co.	3	3½-3⅝
—— 5 per cent. Debentures	—	98-101
Crystal Palace District, Ordinary 5 per cent. Stock	100	130-135
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2½-2⅝
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	98-100
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5½-5⅝
Electric Construction, Limited	2	2½-2⅝
—— 7 per cent. Cumulative Pref.	2	3-3½
—— 4 per cent. Perp. 1st Mort. Deb.	100	103-106
W. T. Henley's Telegraph Works, Ordinary	10	27-28
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	113-116
House-to-House Company, Ordinary	5	9-10
—— 7 per cent. Preference	5	9½-10½
Imperial Tramways, Limited	6	24½-25½
India Rubber, Gutta Percha, and Telegraph Works	10	22-23
—— 4 per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	13-14 xd
London Electric Supply, Ordinary	3	3½-4
—— 6 per cent. Pref.	5	6½-7
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	104-106
Metropolitan Electric Supply, Limited, Ord., No. 1-62,500	10	16½-17½
—— " No. 62,501-85,000	4	12½-13½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-121
National Telephone, Ordinary	5	4½-5
—— 6 per cent. Cum. First Pref.	10	13-15
—— 6 per cent. Cum. Second Pref.	10	13-15
—— 5 per cent. Non. Cum. Third Pref.	5	4½-5
—— 3½ per cent. Deb. Stock, Red.	100	99-101
Notting Hill Electric Lighting Company, Limited	10	16½-17½
Oriental, Limited, 1879	3	1½-1⅝
—— £5 Shares	5	7½-7⅝
—— £4½ Shares, New	4½	6½-6⅝
Oriental Telephone and Electric Company	1	⅝-¾
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6½-7½
Royal Electrical Company of Montreal	½	160-180
—— 4½ per cent. First Shares Mortgage Debentures	100	107-109
South London Electric Supply, Ordinary	3	2½-2⅝
St. James's and Pall Mall, Limited, Ordinary	5	16½-17½
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	40-44
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	100	109-112
Westminster Electric Supply, Ordinary	5	15½-16½

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NOTES.

The Soudan.—The extension of the telegraph line through the Soudan is being rapidly proceeded with. Already a station is opened in the vicinity of Abu Harraz, which is situated on the Blue Nile, about half way between Khartum and Gedaref.

Telegraph Extension.—The Eastern Extension Telegraph Company announce that their Manila-Panay cable has been extended to Iloilo, thus establishing direct cable communication between Manila and Iloilo. The company's cable connecting the island of Negros with Iloilo has also been reopened for public traffic.

The Marylebone Electric Lighting Bill.—The Electric Lighting Committee of the Vestry of St Marylebone recommends that the Electric Lighting Bill should be withdrawn, as the parliamentary agents have reported that there was no reasonable chance of it passing, in view of the opposition of the Board of Trade and the Chairman of Committees. It will be remembered that this Bill did not comply with the standing orders of the House of Commons.

Marconi's Lecture.—The repetition of Mr. Marconi's paper on "Wireless Telegraphy," given at Exeter Hall last week, was attended by a large and appreciative audience. We were pleased to see that Mr. J. W. Swan, president of the Institution of Electrical Engineers, was able to take the chair at this meeting, and that he seemed considerably better for his enforced sojourn in warmer climes. By doctor's orders, Mr. Marconi was forbidden to deliver the lecture himself, and hence it was read for him.

The Kensington Order.—The electric lighting provisional order of the Vestry of the parish of St. Mary Abbotts, Kensington, now before the Board of Trade, is about to be withdrawn, owing to a satisfactory understanding having been come to between the Vestry and the various electric lighting companies in their district. An agreement has been made that electricity for public lighting shall be supplied at 2½d. per unit, and as soon as this is signed and sealed the Vestry's provisional order will be withdrawn.

Obituary.—The electric fish which was exhibited at the Royal Institution on Friday night in connection with Prof. Francis Gotch's lecture on "The Electric Fish of the Nile" is no more. At the commencement of the discourse it was as lively as could be wished. When Prof. Gotch had finished his lecture, however, the audience pressed round the tank in which it lay, and everyone was anxious to get an electric shock by touching its body. This so exhausted it that before the next morning it had departed this life. We understand that the electric fish was borrowed from the Liverpool Aquarium.

The Franklin Institute.—At a meeting of this institute, held on March 15, Mr. E. G. Acheson, of the Acheson Graphite Company, Niagara Falls, read a paper on graphite and its artificial manufacture. He explained that the artificial production of pure graphite in the electric furnace—in which it was, until recently, occasionally found as an accidental by-product—has now become established as a regular branch of manufacture on the commercial scale. Mr. Acheson, who is the inventor of the process, described it fully, and exhibited specimens of the product. This new process is a highly interesting outgrowth of the carborundum industry.

Telephone Competition.—We notice that the New Mutual Telephone Company, of Manchester, has not yet abandoned the idea of being allowed to compete with the National Telephone Company in that city. The Postmaster-General has not given any hope to the representatives of the company, but they expect to gain their object by obtaining assistance from the Chancellor of the Exchequer. A deputation is to await on this gentleman, and the Corporation of Manchester were invited to send representatives to form part of this. They, however, decided that it would be much better not to be represented.

Iron and Steel Institute.—As announced in our issue of the 3rd inst., the annual meeting of this institution is to be held at the Institution of Civil Engineers, Great George-street, Westminster, on May 4 and 5, when the president-elect, Sir William Roberts-Austen, K.C.B., will deliver his inaugural address. The following gentlemen have kindly promised to read papers: Prof. J. O. Arnold (Sheffield), Mr. H. Bauerman (London), Mr. E. Disdier (Bilbao), Mr. A. P. Head (London), Baron H. von Jüptner (Donawitz, Austria), Prof. H. Louis (Newcastle-upon-Tyne), Mr. Bertrand S. Summers (Chicago), and Prof. Wiborgh (Stockholm).

Incredulity or Ignorance.—A contemporary has expressed itself as somewhat incredulous as to the truth of a remark of ours about a gravitation theory ere the time of Newton. We congratulate our contemporary upon its implied desire to be illumined. Hitherto its investigations have been confined to geological matters, wherein no one doubts its iconoclastic ability or envies its perspicacity in constructing mud pies. In this particular instance we humbly suggest a course of reading of Albiruni. A reviewer, quoting the English translations, says: "Here is Newton's law of gravitation in the very words in which it is generally found in modern school-books."

Accumulators for Traction.—The exhibition of accumulators suitable for driving motorcars which is to be opened in Paris in April, is likely to be a success if the number of accumulator makers who will be represented are a criterion. We have seen the list of them made up before it was finally closed, and count, at least, a score of entries. We also notice that the exhibitors hail from all parts of Europe. Thus nine of the makers come from France, two from Vienna, three from Germany, two from London, two from Italy, etc. We trust that all those entering will submit their accumulators to the searching trials that are to be made, and that, as a result, much useful information as to what can be really done by means of these as reservoirs of power will be finally determined.

Coal Testing.—One of the latest applications of the Röntgen rays is to test coal. It is stated by the *Journal* of the Franklin Institute that carbon in all its forms is quite transparent to these rays, while the substances—silica and the silicates—which constitute the ash or incombustible constituent are opaque to them. By placing a lump of coal between a Crookes tube and a fluorescent screen, it is stated that all the slag and clinker-forming portions of the fuel can be detected. M. Cuoriot, on whose authority this statement is made, has tested in this manner anthracite and bituminous coal, lignite, coke, and artificially-prepared briquettes. In these tests rough lumps of coal 1⅛in. to 2in. thick may be used, with an exposure of five minutes, and with a coil giving a 10in. spark.

Municipal Telephones.—It will be remembered that the limit proposed by Government for deciding whether towns may undertake the equipment of a municipal telephone exchange is 50,000 inhabitants. Certain places which have taken a very active part in the telephone agitation would be debarred by this limit from individual action, and hence we are not surprised to see that the Government is to be asked to either remove or lower the inhabitant qualification. One of these towns is Tunbridge

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Wells, at which place a special meeting of the Town Council was recently held at which the whole question was keenly debated. A deputation from the various local bodies was received, and eventually it was decided to petition Parliament to allow smaller towns to undertake a municipal telephone supply.

Post-Office Retirement.—Following the retirement of Mr. W. H. Preece comes that of Mr. J. Doherty, who will, however, continue to hold until April 17 the post of superintending engineer of the north-western district. Mr. Doherty's career as an expert telegraph engineer commenced in 1852 under the late Mr. W. T. Henley, when he was engaged on the telegraphic system between Manchester and Liverpool, the work being carried out for the Magnetic Telegraph Company. Mr. Doherty subsequently had considerable experience both in Canada and in Egypt, after which he rejoined Mr. Henley at his cable works at North Woolwich. Mr. Doherty entered the Government service when the telegraphs were taken over in 1870. He has had charge of the whole of the north-western district for a great number of years, and has succeeded in keeping the telegraph system over that wide area well up-to-date.

The Sheffield Tramways.—We have recently had sent to us illustrations of a new design in smoking cars, which are being made for the electrical tramway system at Sheffield. These cars were designed by Mr. A. L. C. Fell, the electrical engineer to the Corporation, and are being built at Birkenhead. The car, which is a single-deck one, is divided into three parts, of which the centre only is enclosed. This centre compartment will accommodate 14 non-smoking passengers, and there are seats on each open platform at the end for four smokers, while standing room is provided for four more. Thus the complete complement will be 16 smokers and 14 non-smoking passengers. From what we can see from the illustrations, there is a division between the platform on which the driver stands and that provided for the smoking passengers. As a protection against rain, the windows of the fixed framework at the sides of the open platforms can be raised.

Labour Clauses.—We note from the agenda of the Islington Vestry that the Electric Lighting Committee have determined to recede from the position they have taken up with respect to labour clauses in their contracts. It will be remembered by our readers that friction arose in connection with the proposed contract for the extension of the buildings of the electric lighting station. The tender which was recommended for acceptance was practically disqualified by the fact that the firm in question would not accept the labour clauses as drafted by the Vestry in 1895. As a result, it is proposed by the Electric Lighting Committee to modify these clauses very considerably by removing all penalties, and also by dispensing with the schedule of wages hitherto required to be exhibited on the works. We are exceedingly glad that the shoe has pinched, and we trust that in future other local authorities will find that absurd labour clauses are not to the advantage of either the working classes or the ratepayers.

Organ-Blowing.—We notice in the columns of the *Electrical Review*, of New York, a good illustration and description of an automatic organ-blower, which is worked from single-phase alternate-current mains. The motor runs at a speed of 1,800 revolutions per minute, and drives the crank which works the blower at a speed of 45 strokes per minute. The reduction is obtained by means of a treble threaded worm gear. An interesting feature in the arrangement is the introduction of a friction gear consisting of two discs between the motor and the worm. The pressure between these discs is regulated by the position of the bellows. When these are full of wind the two discs are apart, and the motor is running quite loose. In this way there is no difficulty with stopping or starting the motor, and it is said that the discs have not given trouble in consequence of the frictional losses when getting up speed. This is due to the light weight of the parts of the gearing which have to be accelerated.

Circuit Breakers.—Mr. M. C. Canfield contributes an article to *The Engineer* of New York in favour of the invention of a new circuit breaker. He claims that the present types of automatic cut-outs often causes a large amount of unnecessary trouble, owing to the fact that they act too quickly. For instance, he says that a slight fault on one feeder which should be isolated by the circuit breaker on that feeder often causes a number of dynamo circuit breakers to go off, thus interrupting the whole supply. In consequence, he advocates the construction of circuit breakers for the dynamo panels of a switchboard with a time lag, so that they will not act until the load has been on them for a slightly longer time than is necessary for the opening of the feeder circuit breakers, thus giving them a chance to act and clear the trouble without throwing out generators if the short-circuit is a heavy one. If the feeder circuit breaker fails to open, the generator breakers will do so and clear the generators. If trouble occurs within the house, the generator circuit breakers will still clear it, although not quite as quickly as with the present type.

The Pros and Cons. of the Electrical Profession.—In a recent issue, the *Electrical World* of New York reproduces a discussion which took place at the Electrical Club of the Young Men's Christian Association, Chicago. It seems that this discussion centered on the inducements the electrical profession offered to those who cared to embark on such a course of study, and also on what branches were the most alluring financially. In order to obtain as comprehensive an idea as possible on the subject, a circular letter submitting a number of questions was forwarded to electricians of acknowledged repute in the United States. One of these questions was, Which pays the best, the technical side or the business end of the profession? All the answers were in favour of the last part of the query, though it was argued that if happiness is aimed at, the vocation which confers this was, after all, the one which pays best. In reply to the question, Can a young man become an electrical engineer without obtaining a college education? it was contended that undoubtedly he can, though a college education must be a most important adjunct. It was added that 99 people out of 100 have to unlearn what they have learned at college, but that having really learned how to learn, they are in possession of an acquirement of the highest value.

Electric Lighting in Queensland.—Regularly each year we receive the financial report of the Rockhampton Gas and Coke Company, Limited, Queensland. It will be remembered that this company runs an electric lighting department, and this year we are glad to hear that that department has reached the profit-earning stage. The report states that "for a considerable period the directors have had under consideration an extension of plant in both sections (gas and electric lighting), rendered necessary by increase of business, but deferred taking definite steps until the company obtained an Order in Council under the Electric Light and Power Act of 1896, which they have much pleasure in announcing has at length received the sanction of his Excellency the Governor in Council for the full term of 42 years. The company's position in connection with the supply of electricity for Rockhampton and its suburbs being thus assured, the directors have decided upon issuing debentures on the London market." As this is so, there should be some

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orders for electric lighting material to be placed by the company.

Cape-to-Cairo Telegraph.—The visit of Mr. Cecil Rhodes to Germany and his interviews with the Emperor William have done much to further the prospects of this line being completed in the near future. The German Secretary of State for Foreign Affairs (Herr von Bülow) explained on Tuesday last in the Reichstag the general terms under which the proposed telegraph line was to be carried through German territory. It will be built at the expense of the Trans-African Telegraph Company, and the portion in German territory will be maintained by the German Government at the company's cost. The line must be completed within five years, under the agreement. The company also binds itself to lay down at its own cost, in addition to the through wires, another separate line between the two stations in Rhodesia situate nearest to the German frontier on the one hand and British East Africa on the other, this wire to be used for the telegraph traffic of German East Africa, and to be the property of the German Government. The cost of keeping up this latter wire is undertaken by the German Government. At the end of 40 years the through line is to become the property of the German Government.

Amalgamations.—The *Electrical World* of New York has followed up its leader on combinations in electrical enterprises, to which we referred recently, by a most startling announcement in its issue for March 4. This announcement is to the effect that from March 11 the *Electrical World* and the *Electrical Engineer* will be issued weekly as one publication, under the title of *Electrical World and Electrical Engineer*. The editorship will be held conjointly by Mr. T. Commerford Martin and Mr. W. D. Weaver. Mr. J. M. Wakeman will be responsible for the business management, with Mr. A. C. Shaw. The combined journal will claim, we presume, the same advantages as other large combinations; and there are, of course, obvious advantages to the reader and to the advertiser provided that the new journal really combines in one the energy and push of the two separate publications. Mr. W. J. Johnson, who has been for so many years responsible for the development and growth of the *Electrical World*, will retire from the journal which he has raised to its present high pitch. We must confess that the amalgamation takes us very much by surprise, but we wish our conjoint contemporary every success in the future.

Electric Train-Lighting.—The use of the electric light for trains is rapidly on the increase, and the simpler types of apparatus have gained much ground in the last few years. We notice in the columns of the *Electrical World* of New York a description of a system of train-lighting patented in America by Mr. P. Kennedy, which has been used by the Canadian Pacific Railway for their train service. It seems to us, however, that the apparatus is not so good as others which have been developed on this side of the Atlantic. It consists of a small dynamo driven from one of the carriage axles by a wheel and pinion. This dynamo is supported much in the same way as the motors of tramcars are. With the gearing as arranged the speed of the dynamo varies directly with the speed of the train, and hence regulating gear has to be provided to keep a constant voltage independent of speed. This is done by regulating the field of the dynamo by means of an arrangement driven by a small motor. From the views seen of this apparatus, we do not fancy it is likely to give general satisfaction after extended use, on account of its complication and the great vibration to which everything on the train is subjected. In the same way, we do not think that regulating the field is good for the purpose unless long runs at nearly constant speed are usual on the routes.

The London County Council and the Telephones. As we almost expected, the London County Council are not reconciled to the idea of allowing the telephones in their district being under Government. At least, the Highways Committee are not, as this committee last Tuesday had the following resolutions on the agenda: "(*a*) That, in the opinion of the Council, the telephone in the London area of the National Telephone Company should be managed by the Council, the Corporation of the City of London, and the local authorities of districts outside the administrative county of London but within the London telephone area. (*b*) That, in the opinion of the Council, application should be made to the Postmaster-General by the Council, the Corporation of the City of London, and the other local authorities of districts within the London telephone area of the National Telephone Company, for a license under the Telegraphs Act, 1892, for the establishment of a telephone service in respect of that area. (*c*) That the clerk of the Council do, in conjunction with the town clerk of the City of London, draft an application to the Postmaster-General for the license above referred to; and that such draft application, when prepared, be submitted to the Council for approval." The consideration of the recommendations was, however, postponed.

Institution "Journal."—We have received from the Institution of Electrical Engineers Part 138 of vol. xxviii. of the *Journal* of the Institution. In the commencement of this issue of the *Journal* there is a long paper by Messrs. W. Duddell, Wh.Sc., and E. W. Marchant, B.Sc., on "Some Experiments on Alternate-Current Arcs by Aid of Oscillographs." The paper takes up 91 pages of the *Journal*, and we are glad to see a footnote stating that it will be discussed at a meeting at some future date. From a cursory glance one sees there is an enormous amount of original work in the paper, and the design of the oscillograph itself is worthy of special attention. It consists, briefly, of a galvanometer with a coil made of two turns only, which are placed very closely together in an exceedingly strong field. With this construction the authors have succeeded in obtaining a galvanometer coil with a very small period of vibration and small moment of inertia. In this way the coil is able to follow the wave form of the E.M.F. curves of alternators under varying conditions. As to the effects observed in the arc lamp itself, we trust to be able to return to the subject shortly. Another paper in this volume is contributed by Mr. E. K. Scott, and is entitled "Notes on Electric Traction by Three-Phase Alternating Currents." This consists of a description of several lines equipped by Messrs. Brown, Boveri, and Co., of Baden, at Lugano, Zermatt, Jungfrau, and other places. The papers on wiring rules, and their discussion, complete this issue of the *Journal* of the Institution.

Electric Power in Papermaking Industries.—We gather from the columns of our New York namesake that the electric driving of wood-pulping machinery in the United States and Canada is greatly on the increase. At present it is estimated that nearly a million horse-power produced by electricity is used annually for this purpose. Such an extensive application opens up great possibilities for the employment of the electric current for numerous uses, and reiterates the necessity for the electrical engineer to become acquainted with the laws and practice of hydraulic engineering. Many important and difficult questions have to be considered and numerous intricate problems solved in the most economical employment of various classes

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of water powers. Electric generators and motors, water-wheels, governors, pipe and power house construction, all have received considerable attention. In fact, to such an extent have they been perfected that in the Cumberland Mills, for example, an efficiency of 77 per cent. is obtained—that is, for every 100 h.p. mechanical output of the turbines the motors deliver 77 h.p. to the machinery at the paper mills. But it appears that the difficulties presented by the hydraulic end of enterprises have not received the same successful consideration as the above-mentioned apparatus, and have, therefore, not been satisfactorily solved. To prove this we need only refer to the difficulties experienced of late at the Lachine Rapids plant with "frazil" ice, and the trouble experienced with ice at Niagara, both of which are described in this issue. It does seem as if precautions could be taken to prevent such interference with the continuous operation of electric plants, and these troubles emphasise the fact that hydraulic engineering can no longer be excluded from the scope of a complete electrical engineering education any more than civil and mechanical engineering.

"The Electrical World."—In the last individual issue of this New York journal on March 4 the history of its own progress is referred to in a leading article. The paper commenced under the name of the *Operator* in 1874, and since that date it has made sure and steady progress until it has become the leading American journal in electrical matters. As Mr. W. J. Johnston has been connected with it during the whole of that time, we cannot but attribute its success to his untiring industry. In the same issue, a *résumé* of the progress made in the various electrical engineering problems during the last 25 years is reviewed by various writers. Thus Messrs. Houston and Kennelly contribute an article on "Alternating Currents 25 Years ago and to-day"; Mr. R. W. Hope writes on "The Rise of the Stock Reporting Telegraph"; Mr. J. E. Selden on "Some Reminiscences of the Morse Printing Telegraph." Mr. Thomas Henning's article is entitled "Twenty-Five Years Ago," and it gives some interesting facts on general progress in electrical matters. Mr. Eugene F. Phillips contributes some of his recollections of 25 years of wire manufacture. Beyond these features, which are all worthy of careful reading, a number of other writers have forwarded very short articles or reminiscences of striking incidents intimately connected with electrical science. Any mention of the last issue of the *Electrical World* as an individual paper will not be complete without calling attention to Mr. Carl Hering's digest of current electrical literature. This digest has been for years one of the most valuable features of the paper, and in spite of the time it has been running it is easy to see that continual improvements are being made in its arrangements. Perhaps the most valuable point associated with the digest is the fact that Mr. Carl Hering does not hesitate to express personal expert opinions in condensing articles from various sources. The illustrations which have been added are a comparatively new feature, and are exceedingly valuable in many instances.

Resistance to Traction.—In a recent issue we published Mr. Lundie's formula for train resistance, and since then Mr. G. W. Knox, of the electrical and engineering departments of the Chicago City Central Railway Company, has contributed to the *Street Railway Journal* of New York the results of certain tests he made some time ago with a view of determining when it was time to replace a badly-worn rail. He found that these results varied very considerably. For instance, on a badly-worn rail with an average speed of 8·6 miles per hour the drawbar pull per ton was found to be 37·5lb.; on another test made on the same kind of rail with a speed of 10 miles per hour a drawbar pull of 40lb. was found, while a third test with a speed of 12·9 showed a drawbar pull of 43·8. Mr. Knox also gives the results of his tests with nearly new rails, and here it was found that with an average speed of 8·8 miles per hour the drawbar pull per ton was 24·2lb., as compared with another test with the same kind of rail, when with a speed of 11·4 the drawbar pull was 30lb. So widely do these results vary, as will have been seen, that Mr. Knox is doubtful whether it is possible to adopt any given formula for train resistance, no matter how carefully determined. Again, in the majority of cases the joints of steam railroad rails are very poor and irregular in the matter of alignment. In his opinion this difference alone would vary the results very materially, to say nothing of the variations which would be caused by "spongy" sub-grades, etc. While admitting that Mr. Lundie deserves great credit for working out his formula in the way he has, and while admitting that the method he used gives an accuracy which has not hitherto been obtained, Mr. Knox points out that the formula was nevertheless the results of observations obtained on the South Side Elevated Railway, a track with ideal conditions in regard to a solid road-bed, and well aligned and rigid joints and rails, such as are rarely found with surface steam railways. Mr. Knox is of opinion that it is false economy to try to operate a street rail after it becomes badly worn.

Alternate-Current Effects.—The facts collected by Messrs. Edwin J. Houston and A. E. Kennelly for their article on 25 years' progress in alternate-current working in the *Electrical World* (New York) are very interesting. As regards ancient history we do not propose to consider the article, but some useful deductions are drawn as to the use of alternate currents for long-distance transmission. For instance, the authors say that the self-induction effects on such long-distance lines have not been so serious as was expected in the early days. Thus, the impedance effect of a pair of large parallel copper wires (000 A.W.G.) at an intervening distance of a foot, and with a frequency of 40 cycles, is about 1·43, representing an impedance of about 43 per cent. in excess of the ohmic resistance, but by no means all the extra apparent resistance produces drop of pressure in the conductors, and none of it causes waste of energy. Moreover, the effect can be reduced as greatly as desired by subdividing the conductors. The self-inductive effect has not, as yet, proved a serious difficulty. Moreover, it has been found that impedance in the lines leading to the rotary converter actually improves the regulation and behaviour of that apparatus. Speaking of high voltages now being introduced in America, 40,000 volts is said to be the present limit for commercial purposes. Still, the authors state that the full working advantage of this pressure has not yet been secured, and that the pressure itself is rare. Moreover, apart from the difficulty of protecting this system from lightning, it is found that at and above such pressures there commences to be a new loss of power along the transmission lines, due to convective electric discharge. When this convective discharge is powerful, the wires emit a phosphorescent glow that is visible at night. It may be expected, however, that further study and research will indicate means for obviating or minimising this difficulty, and meanwhile much remains to be accomplished before the full commercial range due to 40 kilovolts can be availed of. The radius of commercial transmission at such a pressure should be at least 100 miles.

Printing by Electricity.—An interesting contribution on the application of electric power to printing presses appears in the *Electrical Engineer* of New York. In it the author, Mr. Charles A. Dresser, traces the developments which have of late taken place in electrically-equipped printing plants. Formerly a single motor was

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used either geared or directly connected to the main shaft of the press, and being controlled by an ordinary speed controller operated by hand presented many of the difficulties of the old friction-clutch mechanical method. But in the special design of electrical arrangements to suit the requirements of electrical printing gear referred to by Mr. Dresser in his description of a recent motor installation in a Chicago daily newspaper office we find that each press is equipped with two electric motors, the first being a 5-h.p. six-pole motor, having a maximum speed of 200 revolutions, and suspended on the press at right angles to the main driving shaft. On the shaft of this motor is an automatic friction clutch and worm, which engages with a brass gear wheel situated on the main shaft of the press. The speed of the press at the maximum speed of this 5-h.p. motor is 10 revolutions per minute. Each of the motors is operated from a speed regulator which has mounted on its face one compressed-air cylinder and one dash-pot cylinder and a contact lever, which is connected to both cylinders. At four different points on the press are located four-way compressed-air cocks, which are in turn connected by piping to the cylinders on the rheostat. These compressed-air cocks are normally in a vertical position. The main power for each press is derived from a 40-h.p. slow-speed multipolar motor geared to the press by a single-reduction gear, and located under the press in the basement of the press-room. Having furnished further details affecting the general arrangement of the plant, the author refers to the economical considerations involved. With a minimum of attention is a maximum of effective results, the labour-saving item alone totalling up to a considerable sum annually; while the output of the press is increased 20 per cent. over the old mechanical drive. With regard to accelerated speed, it is claimed that the two presses in operation can give 20 minutes' start to any other two presses in the building, and can beat them, although more men are employed, in printing off an edition.

Electric Fish at the Royal Institution.—On Friday evening Prof. Francis Gotch delivered a lecture at the Royal Institution on "The Electric Fish of the Nile." Of the varieties of fresh and salt water electric fish which are to be met with in various parts of the world, the lecturer dealt almost exclusively with the former, two specimens of which he had with him, and from which several of the audience at the close of the lecture found no difficulty in obtaining electric discharges. Reference was made to the biological difficulties which presented themselves in trying to conceive the conditions that could ever have determined the evolution of the electric organ; while as to the actual seat of the electrical charges themselves, he, for his own part, believed it to be the nerves. In these Nile fish, of which he preferred to speak, the electric discharge was from the head to the tail, and the fish was able to regulate this by being the possessor of a unique kind of central nervous system, though it was unable to send the nerve stimulus more than 10 or 12 times a second, and would not be able to continue doing this for more than half a dozen times owing to exhaustion of the central system. With its own kind the mouth of this fish was his principal weapon, but it attacked small fish of other kinds both by means of its mouth and by administering electric shocks. It would not do this, however, in order to get a meal—this would cause him too much exhaustion. A fish of this kind contained no less than two million cells, the formation and action of which he illustrated by the aid of a column of discs and by means of a lantern and screen. For purposes of analogy, these minute cells might be compared to the old voltaic pile, and the possession of such a force might be compared with the use of firearms by man. It formed at once a ready means of attack and defence, and could be modified in its force according as existing circumstances demanded. It was safe to say that no large fish was ever likely to make the mistake of encountering such a foe twice. Allusion was made to the really higher intelligence possessed by this fish than was usually attributed to fishes generally, and much amusement was created by the recital of a curious incident that happened when one of these Nile electric fish was kept in captivity with a roach. The latter was noticed to attack its food with eagerness, but at the same time to become more emaciated. Its companion, on the contrary, although indifferent to the food offered it, appeared to be thriving. It eventually transpired that the last-named fish obtained the whole of its food in a half-digested condition at the expense of the roach by the artful administration of electric shocks.

Northern Society of Electrical Engineers.—The sixth annual dinner of this society took place at the Grand Hotel, Manchester, last week, under the presidency of Mr. S. Z. de Ferranti, and, in response to the toast of his health and of the success of the society, Mr. Ferranti made special reference to the progress of the electrical industry in this country during recent years. He said we could now congratulate ourselves that instead of being behind other nations we were in a satisfactory condition of forwardness. In matters of electric lighting and traction America had by virtue of its peculiar local conditions gone far ahead, while in our own country the fact that the towns were well supplied with gas had in the past been against the general introduction of public electric lighting. It was, however, not because we had been too well served that we had not gone ahead in electric tramway matters, but principally because legislation had deterred people from investing their money in such undertakings. Owing to the tendency for municipalities to monopolise that kind of work, electric traction had not made the headway it otherwise would have done. There were several things that affected the industry of those present, and one of the most serious was the great disadvantage that sprang from the evils of Socialism. Municipalities were more and more supplying the ratepayers with everything they desired, and one of their latest ventures was in the direction of electric lighting. The municipalities claimed to have been very successful in electric lighting work, but how was it possible to fail to make a success of an excellent business when it was coupled with a monopoly? Another very objectionable feature of municipal action was the practice of inserting special labour clauses in contracts, which regulated the hours of labour, the rate of wages, the methods as to how the masters should deal with their men, and as to how they should conduct their business generally. By heeding the demands of the trades unions the municipal representatives were simply buying votes by the use of public money. Only that day he had a contract offered to him by the committee of a town council, who made it a condition of acceptance that they should have the right to call up any of his workmen to discuss the method in which he (the speaker) conducted his business. How, he asked, were English manufacturers to compete with those of foreign countries when they were subject to such conditions? We were free-traders, but we ought to have free-trade in this country, and engineers should not be fettered and forced to artificially raise the price of the work they performed. The remaining toasts included the health of the retiring president, Mr. J. S. Raworth, who was unavoidably absent, and for whom Mr. Fawcus replied, and "Electrical Industries," proposed by Mr. Clirehugh and acknowledged by Mr. Edward Cowan.

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NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

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CLV.

The improvement in question has been carried into effect in the "accumulators for electric automobiles," now constructed by the Société pour le Travail des Métaux. These batteries are a very modified form of the "R" "Chloride" accumulator. The curves C (Figs. 2 and 3) cutting the curves S at a point where the time ordinate is a little over 7, is much flatter than the latter, and the flattening of the curve is precisely the improvement that was required. The curves show us that, although the capacity of the cell represented by S is higher than that of the cell corresponding to C when the time of discharge is more than 7½ hours, the contrary is the case for lower periods of discharge. They also show that, for the period of discharge somewhat over seven hours, both of these "Chloride" cells yield over six ampere-hours per pound of plate, or four ampere-hours per pound of cell. If the time of discharge be four hours, the curves indicate that the battery C will have a capacity about 8 per cent. higher than that of the battery S. The real superiority of the former cell, however, consists in its increased durability and mechanical resistance to rough usage. The normal period of discharge of the battery C is 3½ hours.

In the table published by M. Reyval in *L'Eclairage Electrique* of Dec. 31, 1898, it is stated that a kilowatt (or Board of Trade unit of *power*) is obtained with 48 kg. of plates or 68 kilos of battery, and that a kilowatt-hour (or Board of Trade unity of *energy*) is obtained with 171 kilos of plates or 242 kilos of battery. But this the reader should be able to recognise as an obvious mistake if the time of discharge be over one hour, or, indeed, if it be over ·2 hour. The specified period of discharge is 3½ hours. Now, whenever the period of discharge is over one hour, the weight of plates, or of battery, giving one watt, or 1 kw., or any other unit of *power*, must necessarily be greater than that giving one watt-hour or one kilowatt-hour, or any other unit of energy or work. With a given weight of any battery, energy, power × time is, as we know, constant when time of discharge is given; and since $\text{time} = \frac{\text{energy}}{\text{power}}$, power must then also be constant. Thus the weight (M) of battery that will give the power $\left(\frac{\text{energy}}{\text{time}}\right)$ corresponding to the time (θ), will yield that power during the time θ. And thus the weight of battery that will give the power during unit time—*i.e.*, that will give the energy supplied during one hour (watt-hours, horse-power hours, or kilowatt-hours) – will be $\frac{M}{\theta}$, a value that is less than M when θ is greater than unity.

The above values must be transposed: the kilowatt is obtained with 171 kilos (376lb.) of plates, or 242 kilos (532lb.) of battery; and the kilowatt-hour, with 48 kilos (106lb.) of plates, or 68 kilos (150lb.) of battery.

CLVI.

The curve next in order (Figs. 2 and 3) is that for the Faure-King (E.P.S.) cell. According to the company's most recent list, the rate of discharge and the capacity per pound of battery for a five-hour discharge are:

$$\frac{\text{Amperes}}{\text{lb.}} = \cdot 89, \text{ and } \frac{\text{Ampere-hours}}{\text{lb.}} = 4 \cdot 43.$$

The rate of charge is the same as that of discharge. The specific gravity of the acid used is, as heretofore, 1,190; the percentage of H_2SO_4 being 26. In a 23-plate cell there are 11 positive (peroxide) plates, and the maximum rate of charge is given as 55 amperes—that is, the rate of charge per positive plate is $\frac{55}{11} = 5$ amperes. But if this be the maximum, it is difficult to understand the "special charging instructions" issued with this cell, giving the precautions to be taken when it is first charged for use. "The rate of the first charge," we are told, "should not exceed two amperes per positive plate—that is, for a 15-plate section (in which the number of positive plates is $\frac{n-1}{2} = 7$) the current for the first charge would be 14 amperes, and so on. The first charge should be continued (approximately for 40 hours) until the specific gravity (after having fallen) has risen again *(sic)* to 1,200. After a first discharge of about three amperes per positive plate, the second charge may be given at a rate of about three or four amperes per positive plate, after which the charges *may be about six or seven amperes per positive plate*, and the battery may then be used at the listed rates." If five amperes per positive plate be the maximum rate of charge, one might suppose that charges of six or seven amperes per positive plate, after the second charge, might have a detrimental effect

The normal density of current for this battery may be taken at about

$$\Delta = \cdot 041.$$

Thus the above instructions may be stated generally as follows: The density of current for the first charge should not exceed $\Delta = \cdot 0164$, and this density should be maintained approximately for 40 hours. The second charge may be given with a current density of from ·0246 to ·0328, and after this charges may be given under a current density of from ·0492 to ·0574.

The E.P.S. traction cell has been, and doubtless is, undergoing the changes consequent upon a process of evolution; so that the following description of it in Mr. Treadwell's book published last year is possibly not altogether applicable at the present time. "The weight, as compared with the E or E K type, has been reduced fully one-half. A grid very similar in form to the ordinary E.P.S. grid is used. This pasted 'grid' is first wrapped in a cloth of silicated asbestos (asbestos being a silicate of calcium and magnesium, is naturally 'silicated'; but the expression probably means 'treated with sodic silicate or water glass') and then placed in a close fitting envelope of perforated celluloid. The envelope is held to the plate by means of celluloid pins."

On the last occasion that I made enquiries about this cell the celluloid had been, *pro tem.* at least, replaced by ebonite.*

According to Prof. Ayrton, the watt-hour capacity of the Faure-King cell for an eight-hour discharge varied from 8·6 to 10·2.† The ampere-hour capacity would (dividing by 1·9) be from 4·52 to 5·37.

CLVII.

In view of the traction competition which commences at Paris, under the patronage and direction of the Automobile Club of France, on the 10th prox., everything relating to the "Fulmen" storage battery is just now of special interest. For in the automobile hackney carriage competition which took place in Paris last summer, four batteries of this construction—viz., B_{13}, B_{15}, B_{17}, and B_{21}—had the whole field to themselves; and it must be admitted that they acquitted themselves admirably during the nine days over which the competition extended. But the question of durability remains open. "It would have been interesting," says the report of the committee for carrying out this competition, "to ascertain the effect of the variations in the rate of discharge on the inner constitution of the accumulators subjected to such treatment. But the duration of the trials has been too brief to afford information in this direction. Not one of the Fulmen accumulators broke down, and this is all that can be said." But, by Article 7 of the programme for the competition to take place this year, "the competition tests will, as a rule, be continued as long as may be necessary to render all the batteries unserviceable. The tests will, however, be discontinued after the expiration of six months." From this, by the way, it is tolerably evident that the committee for the accumulator competition do not expect that any of the competing batteries will remain in action for six months. But then it must be considered that, with the

* *Journal* of the Institution of Electrical Engineers, vol. xxvi., p. 745.

† *Idem*, p. 693.]

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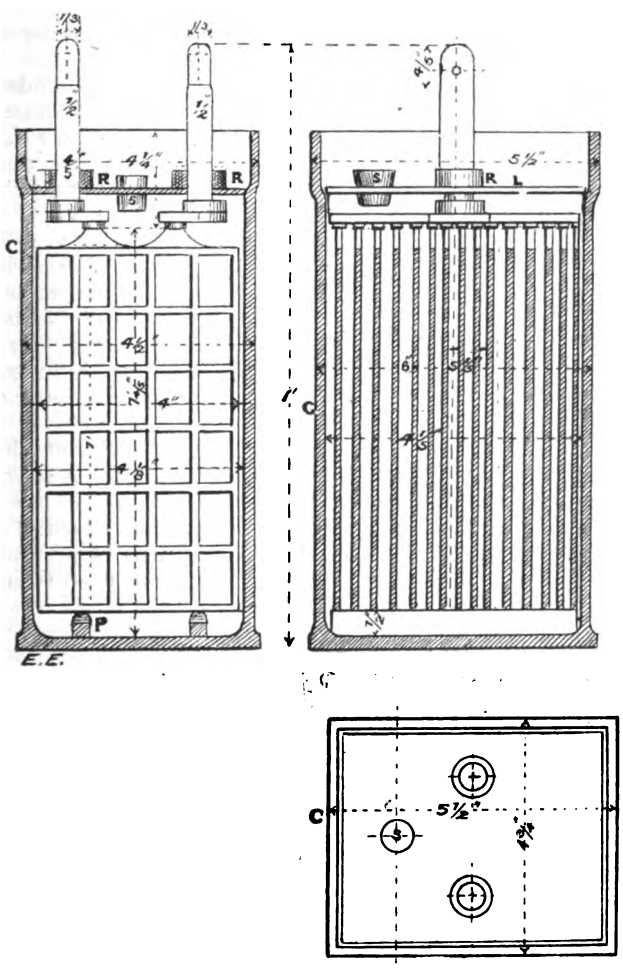
exception of Sundays—which happen to be the "days of rest" separating the periods of six days mentioned in Article 9 of the programme—the cells will be almost continuously at work. This is evident from Article 11, which provides that "During the intervals of rest between discharge and charge, which intervals are never to exceed two hours, the competitors, or their representatives, shall be authorised to inspect their batteries, to maintain the strength of the electrolytic solution, and to clean the elements; but they will not be allowed to change any plate or add anything to it."

The Tommasi traction battery has been described under Sections XC. and XCI. Its main features were an *embedded* grid acting merely as a conductor and an envelope of perforated celluloid. The Fulmen accumulator (Tommasi system) used for traction has been described as weighing 16½lb., as having a normal rate of discharge of 2·27 amperes per pound of cell, and the specific capacity of 6·63 ampere-hours per pound of cell. But the Fulmen cell (B_{15}) which is here illustrated, and which was employed in the carriage competition, is of an essentially different character, and, in spite of the success it has achieved hitherto, it appears to be of a decidly retrograde character.



The present cell weighs somewhat over 20lb. At the normal period of discharge of five hours, the rate of discharge is 1·23 amperes per pound of cell, and the capacity is 6·00 ampere-hours. In the drawing, P represents a pad on which the plates are supported, the upper portion of which is of soft and the lower of hard rubber. S is a stopper of soft rubber, which closes the aperture through which the electrolyte is introduced. R is a ring of soft rubber which surrounds the projecting terminals; L is the lid, of semi-hard rubber, and C is the flanged ebonite cell or receptacle. It may here be mentioned that receptacles of celluloid were emphatically condemed by the committee for the carriage competition as being far too liable to accidental combustion, with production of asphyxiating fumes, from short-circuits and other causes. In this cell the elements are not enclosed in any envelope. But what concerns us most is that we have here, in lieu of an embedded conductor, an external double grid of antimony alloy, the very attenuated bars of which are of triangular section, and serve to support the small plates or pastilles of active material. No doubt the abolition of the perforated envelope is a good thing; but this advantage does not compensate for the manifold disadvantages of an external grid. The light grids, not being embedded or otherwise protected—*i.e.*, being directly in contact with the electrolyte, are under the conditions most favourable to local action—are oxidised by the charging current, which they divert from the active material, thus reducing the efficiency of the cell, and must necessarily be destroyed by corrosion with comparative rapidity. The support they afford to the active material is, therefore, of a somewhat temporary character.

It may be said that, if the perforated envelope be dispensed with, the active material *must* be otherwise supported in order to obviate disintegration of the active material, more especially in the case of the peroxide element. But, as I have frequently stated during the last two years, I cannot admit that this is the case. In my own laboratory, and probably elsewhere, are to be seen experimental peroxide plates composed of a light conductor embedded in a compound of peroxide of lead, which has resisted repeated endeavours to effect its disintegration. The Fulmen accumulator of the present type has undoubtedly scored a great success, but there are grave doubts as to its durability; and, moreover, an inspection of its time curve, F (Figs. 2 and 3, pp. 67 and 68), shows that even in nine or ten hours it has by no means reached its maximum capacity—a double-edged fact, very favourable to the cell from the point of view of a lengthened period of discharge, but showing also that it is imperfectly designed for such a period of discharge as five hours, and that contact with the active material, or the access to it of the electrolyte, or both these desiderata, are insufficient from the point of view of high rate of discharge.

FOREIGN TELEPHONY.

BY ALFRED R. BENNETT.

At the instance of Mr. Provand, M.P., the Foreign Office in November, 1897, instructed our representatives in the chief Continental countries to obtain replies to 23 questions touching the telephone service. The intention was apparently to bring up to date some of the chief points treated in the writer's book, "The Telephone Systems of the Continent of Europe." The idea was good, but has been frustrated to a great extent by the slovenly manner in which the work has been carried out. Whether this is due to the unwillingness of foreign administrations to disclose their business or to the indifference of our representatives it is impossible to say, but the fact remains that the really precise and valuable reports are in the minority. For instance, the French Government, instead of answering any of the questions asked, handed the British representative in Paris (who appears to be a certain M. Gosselin) a paper showing the number of trunk lines which terminate in the eight chief towns. This our representative gravely transmits to the Marquis of Salisbury, who, instead of reprimanding M. Gosselin for allowing himself to be put off in such a childish manner, complacently prints it with the rest in the Parliamentary Report (Commercial No. 1, 1899) just published.

The best answers are from Germany, and they really constitute a valuable account of the position of telephony in that country at the end of 1897. The rates throughout Germany are £7. 10s. per annum for communication within a city or town, and £2. 10s. extra if the suburbs are included. Suburbs, however, frequently comprise towns 20 and even 50 miles away, Chemnitz being reckoned a suburb of Leipzig, and Mayence and Rudesheim suburbs of Frankfort-on-Maine. In the case of Berlin, the £7. 10s. rate covers all the city proper, an area containing 1,677,304 inhabitants. In Wurtemberg, the rate is only £5 per annum, even in such an important city as Stuttgart.

Light is thrown upon the much disputed point of the cost of construction of telephone lines. Here are some German figures.

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Town.	Number of instruments at work, September, 1897.	Capital cost per line.
Berlin	36,650	£22 0 0
Hamburg	13,561	23 0 0
Leipzig	5,289	19 2 0
Frankfort-on-Maine	5,053	22 18 0
Cologne	4,701	19 12 0

This corresponds well with experience in the United Kingdom, National Telephone denials notwithstanding; and effectually disposes of the old and sedulously-fostered delusion that the cost of telephone exchanges increases enormously with, and out of all proportion to, their size.

Norway sends good returns for Christiania and Bergen. At the end of 1896 the former city had 6,475 and the latter 1,800 subscribers, or 1 in every 31 and 1 in every 38 inhabitants respectively. In Christiania the maximum subscription is £4. 8s. 10d. per annum, which covers 6,000 calls, extra ones being charged at the rate of 11s. 2d. per 1,000. The capital cost of each line has been £12. 4s. In Bergen the annual subscription is £3. 14s. 6d., and the capital cost per line has been £13. 4s.

Finland also sends interesting particulars. Helsingfors, with a population of 80,000, had 2,800 subscribers, or 1 in 28·5 inhabitants. To appreciate these figures, it must be borne in mind that if London with its 5,600,000 people were telephoned to an equal extent, it would possess no less than 196,491 subscribers! The rate in Helsingfors varies from £5 to £5. 12s. per annum. By paying the capital cost of the line and instrument the subscriber may enjoy the reduced subscription of £3. 10s.

But Stockholm, that bugbear of our non-progressive telephonists on this side of the North Sea, out-distances even Helsingfors in the race for telephonic distinction, for with a population of 271,166 it possessed, at the end of 1896, 19,369 subscribers, or 1 to every 14 inhabitants! Equally telephoned, London would boast 400,000 subscribers instead of the present 12,000 or so! A pleasant fact, upon which the Post Office engineers to whom is to fall the distinction of giving the Metropolis a telephone service worthy of the name may well be congratulated. And so, too, may the British manufacturers of electrical apparatus, whose dreams only a short month since could scarcely have projected such fascinating possibilities.

After Scandinavia, Finland, and Germany, the remaining reports savour of the commonplace. Holland furnishes two examples—Amsterdam and Rotterdam—of exchanges owned and worked by municipalities. They are both of recent origin, being at the date of the return, November, 1897, only one year old; Amsterdam, with a uniform yearly subscription of £7. 10s., had 2,150 lines; and Rotterdam, where the tariff is £7. 10s. for offices and £5. 10s. for residences, had 1,320. The remark of the British Consul at Amsterdam, that he is informed that "German material is likely to have the preference in future, that country having made more progress in electrical and telephone construction than England," is one that may well be laid to heart by those who, like certain contemporary electrical prints, still pretend to think that the controllers of our telephone service in the past have deserved well of the country. Throughout these reports one reads of apparatus being obtained from America, France, Austria, Germany, Belgium, Holland, Norway, Sweden—from England, never.

Italy's telephonic pretensions are but modest. Rome, with 480,000 people, has 2,102 subscribers, or 1 to 228, while Florence possesses only 1 to 277. The tariff in Rome is £6. 14s. and in Florence £6. 8s. per annum.

For Switzerland the returns are very imperfect. No change of moment in tariff or regulations has occurred since Jan. 1, 1896, but the number of subscribers has continued to grow, and now reaches 4,400 in Zürich and 3,533 in Geneva.

Austria possesses an exchange of moderate size at Vienna, where 10,573 subscribers in a population of 1,400,000 give one telephone to every 132 souls. This is attained on a yearly subscription of £8. 6s. 8d., which is increased for subscribers located more than 1¼ miles from an exchange at the rate of £2. 2s. per half mile. Outside Vienna telephonic development has made but small headway.

There are no reports from Hungary, Spain, Russia, Denmark, or Portugal, while that from Belgium is a jumble of small value.

To the Continental reports is annexed a brief one from New York, giving some details of the telephone service in that city, although the Consul says that the New York Telephone Company, being a close corporation, is unwilling to depart from its principle of publishing no details of earnings or expenses. It seems that the company operates over 62½ square miles, with a population of 1,500,000. As there are 20,937 subscribers, the proportion of telephones to people is 1 to 71·6, much better than anything we have to show in this country at present, but still a long way behind Sweden, Finland, and Norway. The New York tariff is given as £18 for 600 calls, £24 for 1,000 calls, and £29 for 1,500 calls, the charge for extra calls not being stated.

The return also contains much useful information as to materials used in construction, and rates of wages and hours of workmen and operators, in the various countries.

INSTITUTION OF ELECTRICAL ENGINEERS.

Wireless Telegraphy.

BY G. MARCONI, MEMBER.

(Concluded from page 342.)

The results I have referred to also show that the distance at which signals could be obtained varied approximately with the square of the distance of the capacities from earth, or perhaps with the square of the length of the vertical conductors. This law has since been verified by a careful series of experiments and found correct, and has furnished us with a sure and safe means of calculating what length the vertical wire should be in order to obtain results at a given distance. It is well to know that the said law has never failed to give the expected results across clear space in any installation or experiment I have carried out, although it usually seems that the distance obtained is slightly in excess of what one might expect. I find that with parity of other conditions a vertical wire 20ft. long at the transmitter and receiver is sufficient for communicating one mile, 40ft. at each end for four miles, and 80ft. for 16 miles and so on. An installation is now working over a distance of 18 miles with a vertical wire 80ft. high at each installation station. Prof. Ascoli has confirmed this law and demonstrated mathematically, using Neumann's formula, that the inductive action is proportional to the square of the length of one of the two conductors if the two are vertical and of equal length, and in simple inverse proportion of the distance between them. Therefore, the intensity of the induced oscillation does not diminish with the increase of distance if the length of the vertical conductors is increased in proportion with the square root of the distance. That is, if the height of the wire is double, the possible distance becomes quadrupled. Should it be necessary to rig up an installation at a distance of, say, 32 miles, such as is about the distance between Folkestone and Boulogne, it is easy to find that a vertical wire 114ft. long would be quite sufficient for that purpose. Such laws are applicable only when apparatus properly constructed is employed. With apparatus in which some or several improved details are omitted I find it quite impossible to obtain anything like the results above mentioned. If, say, the impedance coils, *k″ k″*, are omitted the distance (other conditions being equal) is reduced to almost half its original value.

I must also call your attention to such cases as when obstacles like hills or mountains, or large metallic objects, happen to intervene between the places between which it is desired to establish communication. With all other forms of Hertzian transmitters and receivers with which I have experimented I find it to be quite impossible to obtain any results if a hill, mountain, or large metallic object intervenes in any way between the two stations. I am not aware whether any satisfactory results have been obtained by others where such obstacles have intervened,

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but when the vertical wire system is employed it becomes easy to telegraph between positions screened from each other by hills or by the curvature of the earth. In such cases it seems to be a marked advantage if the aerial conductor is thick or if a capacity area is placed at the top of it. I am rather doubtful as to the correct explanation that can be given to this effect. I think there can be very little doubt as to the complete opacity, to electric waves, of a hill three miles thick, or of, say, several miles of sea-water. A solution of this difficulty might be given by attributing the results to the effect of the diffraction of such long waves as those radiated by a conductor 100ft. long, but in that case it is difficult to explain why other forms of Hertzian transmitters and receivers, also giving long waves, do not act when such obstacles intervene. A way out of the difficulty may be arrived at if we suppose that the electrical oscillations are transmitted to the earth by the earth wire, E, of the transmitter and travel in all directions along the surface of the earth till they reach the earth wire of the receiving instrument, and by travelling up the said wire to the coherer thus bring about its action. This was the first explanation I came to during my early experiments. I, however, do not wish to say that I hold entirely to this view at present, although I have not yet found any other perfectly satisfactory explanation of the phenomena. It is well also to note that a horizontal wire, even if supported at a considerable height from earth, seems to be of little or no practical utility in increasing the range of signals. If, say, a vertical wire 30ft. long is employed at both stations, and to the top of this is added a horizontal length of 300ft., as shown in Fig. 6, the

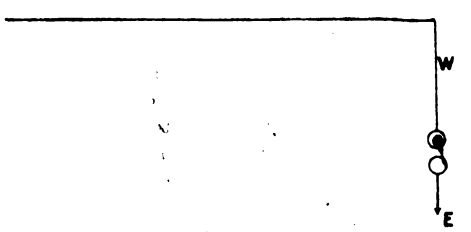

FIG. 6.

distance obtained is greater with the vertical wire without the horizontal length than it would be if both were employed. These results show that with this system it is not sufficient to use a horizontal radiating or collecting wire, as such a wire would be of no utility for long-distance signalling. I believe that the exceedingly marked advance made by the adoption of the vertical conductor is due to the fact that the plane of polarisation of the rays radiated is vertical, and that, therefore, they are not absorbed by the surface of the earth, which acts as a receiving conductor placed horizontally. As the maximum effect is obtainable when the conductors of the transmitter and receiver are parallel, this makes it necessary to have a vertical conductor connected to one pole of the coherer.

Before proceeding to describe the results obtained under various conditions by means of what we may call the vertical wire system, I think it desirable to bring before you some observations and results I have obtained with a system of Hertzian wave telegraphy, which was the first with which I worked, and in which parabolic reflectors are used to control the propagation and intensify the effects obtained when comparatively short electric waves are employed for signalling. As in ordinary optics, so also in the optics of electromagnetic oscillations, it is possible, as has been shown by Hertz, to reflect the waves radiated from the oscillator in one definite direction only. This can be done, as you know, by using convenient reflectors, similar to those used for projectors, but preferably, for economical reasons, made of copper or zinc, instead of silver amalgam or silver. Except when very small radiators of the Righi or Lebedew type are employed, it is desirable to use cylindrical parabolic reflectors, and it is with reflectors such as I here exhibit that the trials to which I am alluding have been carried out. The advantages obtainable by their use are obvious. In any other system intended for the transmission of telegraphic signals by means of electric waves through space, the waves have been allowed to radiate in all directions, and would affect all suitable receivers within a certain radius, which, of course, is dependent on the power of the radiator or transmitter and on the sensitiveness of the resonator or receiver. It is, however, possible, by means of syntonising arrangements, to prevent, to a certain extent, messages affecting instruments or receivers for which they are not intended, and therefore to select any receiver by altering the wave length of the transmitter. By means of reflectors it is possible to project the waves in one almost parallel beam which will not affect any receiver placed out of its line of propagation, whether the said receiver is or is not in tune or syntony with the oscillation transmitted. This would enable several forts, or hill-tops, or islands to communicate with each other without any fear of the enemy tapping or interfering with the signals, for if the forts are on small heights the beam of rays would pass above the positions which might be occupied by the enemy. An illustration of the possibility of directing these waves can be shown by the action of the receiver, which in this case rings a bell only when the radiator in the reflector is directed towards it. These results are much more marked in an open space than in a lecture theatre, as the walls, gilt hangings, etc., tend to reflect the rays in all directions, and may alter the results. In experiments carried out over a distance of 1¾ miles, I noticed that only a very small movement of the transmitting reflector was sufficient to stop the signals at the receiving end, which could only be obtained within a latitude of 50ft. to the right or left of what was believed to be the centre of the beam of reflected radiations. There exists a most important case to which the reflector system is applicable—namely, to enable ships to be warned by lighthouses, light-vessels, or other ships, not only of their proximity to danger, but also of the direction from which the warning comes. If we imagine that A is a lighthouse provided with a transmitter of electric waves, constantly giving a series of intermittent impulses or flashes, and B a ship provided with a receiving apparatus placed in the focal line of a reflector, it is plain that when the receiver is within range of the oscillator the bell will be rung only when the reflector is directed towards the transmitter, and will not ring when the reflector is not directed towards it. If the reflector is caused to revolve by clockwork or by hand, it will therefore give warning only when occupying a certain sector of the circle in which it revolves. It is therefore easy for a ship in a fog to make out the exact direction of point A, whereby, by the conventional number of taps or rings, she will be able to discern either a dangerous point to be avoided or the port or harbour for which she is endeavouring to steer.

I have not up to the present attempted to signal any greater distance than about two miles with reflectors, but I am of opinion that across clear space it will be quite possible to obtain satisfactory results at far greater distances, especially if the reflectors are accurately made any larger than those I have used. By means of the same apparatus exhibited here I have succeeded in signalling over a distance of 2½ miles, without, of course, the use of any real "base" lines, which were supposed to be essential for any distance greater than a few feet. It was by means of reflectors I obtained the results over 1¾ miles mentioned by Mr. Preece at the British Association meeting of 1896. I have, however, dedicated more time to the other system—*i.e.*, the vertical wire system. A station at Alum Bay, Isle of Wight, and another at Bournemouth, the distance between them being 14½ miles, were erected at the beginning of last year in order to test the practicability of the system under all conditions of weather, and also to afford an opportunity of proving that "wireless telegraphy" was not a myth, but a working reality. I believe some details of the special conditions of these stations would be of interest. The installation at Alum Bay is in the Needles Hotel, and the Bournemouth station (which has lately been transferred to the Haven Hotel, Poole, thereby increasing the distance to 18 miles) was at Madeira House, South Cliff. At each station a pole 120ft. high was used, which supported the aerial conductor, usually a stranded conductor of $^{7}/_{20}$ copper wire insulated with rubber and tape

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A 10in. induction coil is used at each station, worked by a battery of 100 Obach cells "M" size, the current taken by the coil being at 14 volts from 6 to 9 amperes. The spark discharge takes place between two small spheres about 1in. in diameter, this form of transmitter having been found more simple and more effective than the Righi oscillator I had previously used. The length of spark is adjusted to about 1 cm.; this, being a much shorter spark than the coil can give, allows a good margin over for any irregularity that might be caused by the break. No care is ever taken to polish the spheres, *d d*, at the place where the spark occurs, as the results seem decidedly better with dull spheres than with polished ones. The first tests were made between the Isle of Wight and a steamer, the height of the mast on the boat being about 60ft. Readable signals were obtained up to a distance of 18 miles from Alum Bay. During the course of these experiments, I had the pleasure of the company and assistance of Captain Kennedy, R.E., who was good enough to draw a map showing the course of the steamer. It has apparently been thought that weather or varying conditions of atmospheric electricity may interfere with or stop the signals transmitted by this system, but experience of over 14 months of continual everyday work has brought me to the conclusion that there is no kind of weather which can stop or seriously interfere with the working of such an installation. We have given demonstrations to several eminent scientists, who came down and wanted a show, often when we did not expect them, but on no occasion have they found any difficulty in the work of transmitting and receiving messages between the two stations. In September of last year, in consequence of the expiration of our lease at Madeira House, Bournemouth, we transferred that station, as I have said, to the Haven Hotel, Poole, thereby increasing the distance to 18 miles. Experiments and tests are carried out daily between the two stations, the improvement in apparatus having allowed us to reduce the height to 80ft. at each end. An average of fully 1,000 words are daily transmitted through the ether each way. In the spring of last year Lord Kelvin inspected our station at Alum Bay, and he was kind enough to express himself as highly pleased with what he saw. He sent several telegrams to his friends, including Mr. Preece, and Sir George Stokes, and insisted on paying 1s. royalty on each message, wishing in this way to show his appreciation of what was done, and to illustrate its fitness at that time for commercial use.

We are now working at experiments directed towards still further reducing the height necessary for a given distance, and also a good deal on syntonic systems. In May of last year Lloyds desired to have an illustration of the possibility of signalling between Ballycastle and Rathlin Island in the North of Ireland. My assistants, Mr. Kemp and the late Mr. Glanville, installed the instruments at Ballycastle and at Rathlin Island. The distance between the two positions is 7½ miles, of which about four are overland and the remainder across the sea, a high cliff also intervening between the two positions. At Ballycastle a pole 70ft. high was used to support the wire, and at Rathlin a vertical conductor was supported by the lighthouse 80ft. high. Signalling was found quite possible between the two points, but it was thought desirable to bring the height of the pole at Ballycastle to 100ft., as the proximity of the lighthouse to the wire at Rathlin seemed to diminish the effectiveness of that station. At Rathlin we found that the lighthouse-keepers were not long in learning how to work the instruments, and after the sad accident which happened to poor Mr. Glanville that installation was worked by them alone, there being no expert on the island at the time. Following this, in July, we were requested by a Dublin paper, the *Daily Express*, to report from the high seas the results and incidents of the Kingstown Regatta. In order to do this we erected a land station, by the kind permission of the harbour-master at Kingstown, in his grounds, where a pole 110ft. high was placed. A steamer, the "Flying Huntress," was chartered to follow the racing yachts, the instruments being placed in the cabin. The height of the vertical wire attainable by the mast was 75ft. A telephone was fixed from our land station at Kingstown to the *Express* office in Dublin, and as the messages came from the ship they were telephoned to Dublin, and published in succeeding editions of the evening papers. The relative positions of the various yachts were thus wirelessly signalled while the races were in progress, sometimes over a distance of 10 miles, and were published long before the yachts had returned to harbour. During the several days the system was in use between the tug and the land station, over 700 messages were sent and received, none requiring to be repeated. On trying longer distances it was found that with a height of 80ft. on the ship and the same height as already stated on land, it was possible to communicate up to a distance of 25 miles, and it is worthy of note in this case that the curvature of the earth intervened very considerably at such a distance between the two positions. On one occasion, on a regatta day, I had the pleasure of the company of Prof. G. F. Fitzgerald, of Trinity College, Dublin, on the ship, who, as would be expected, took a very great interest in the proceedings.

Immediately after finishing at Kingstown I had the honour of being asked to instal wireless telegraph communication between the Royal yacht "Osborne" and Osborne House, Isle of Wight, in order that her Majesty might communicate with H.R.H. the Prince of Wales, from Osborne House to the Royal yacht in Cowes Bay, and during the trips his Royal Highness frequently took. The working of this installation was a very pleasant experience for me, and it afforded also an opportunity of more thoroughly studying the effect of intervening hills. In this installation induction coils capable of giving a 10in. spark were used at both stations. The height of the pole supporting the vertical conductor was 100ft. at Osborne House. On the Royal yacht "Osborne" the top of our conductor was suspended to the mainmast at a height of 83ft. from the deck, the conductor being very near one of the funnels, and in the proximity of a great number of wire stays. The vertical conductor consisted of a $^{7}/_{20}$ stranded wire at each station. The Royal yacht was moored in Cowes Bay at a distance of 1¾ miles from Osborne House, the two positions not being in sight of each other, the hills behind East Cowes intervening. This circumstance would have rendered direct signalling between the two positions impossible by means of any flag, semaphore, or heliograph system. Constant and uninterrupted communication was maintained between the Royal yacht and Osborne House during the 16 days the system was in use, no hitch whatever occurring. One hundred and fifty messages were sent, being chiefly private communications between the Queen and the Prince. Many of these messages contained over 150 words, and the average speed of transmission was about 15 words per minute.

By kind permission of the Prince of Wales I will now read to you some of the telegrams which passed between the Royal yacht and Osborne House: "Aug. 4, from Dr. Fripp to Sir James Reid. H.R.H. the Prince of Wales has passed another excellent night, and is in very good spirits and health. The knee is most satisfactory." "Aug. 5, from Dr. Fripp to Sir James Reid. H.R.H. the Prince of Wales has passed another excellent night, and the knee is in good condition." The following telegram was sent during a cruise, and while the Royal yacht was under way, as you will see from the context: "Aug. 10, from H.R.H. the Prince of Wales to Duke of Connaught. Will be very pleased to see you on board any time this afternoon when the 'Osborne' returns." This telegram was sent when the yacht was off Bembridge, at a distance of about seven or eight miles from Osborne. On Aug. 12 the "Osborne" steamed to the Needles, and communication was kept up with Osborne House until off Newton Bay, a distance of seven miles, the two positions being completely screened from each other (even to the tops of the masts) by the hills lying between. At the same position we found it quite possible to speak with our station at Alum Bay, although Headon Hill, Golden Hill, and over five miles of land lay directly between. The positions were 8½ miles apart. Headon Hill was 45ft. higher than the top of our conductor at Alum Bay station, and 314ft. higher than the vertical wire on the "Osborne." The yacht on the same trip proceeded till about three miles past the Needles,

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communication having been maintained during the whole trip. Another day, when I did not happen to be on board, the yacht went on a cruise round Bembridge and Sandown, communication being maintained with Osborne House, although more than eight miles of land lay between the two positions. The Prince of Wales and other members of the Royal family, especially the Duke of York, made much use of the system, and expressed themselves as highly satisfied with its practicability. I consider these results rather interesting, as doubts have been expressed by some as to whether it would be possible by this system to telegraph over long stretches of land. Results across hills were also obtained near Spezia by officers of the Italian Navy, using my system.

In December of last year my company thought it desirable to demonstrate that the system was quite practical and available for enabling telegraphic communication to be established and maintained between lightships and the shore. This, as you are probably aware, is a matter of much importance, as all other systems tried so far have failed, and the cables by which some three or four ships are sometimes connected are exceedingly expensive, and require special moorings and fittings, which are troublesome to maintain and liable to break in storms. The officials of Trinity House offered us the opportunity of demonstrating to them the utility of the system between the South Foreland Lighthouse, and one of the following light-vessels—viz, the "Gull," the "South Goodwin," and the "East Goodwin." We naturally chose the one farthest away—the "East Goodwin," which is just 12 miles from the South Foreland Lighthouse. The apparatus was taken on board in an open boat, and rigged up in one afternoon. The installation started working from the very first without the slightest difficulty. The system has continued to work admirably through all the storms, which during this year have been remarkable for their continuance and severity. On one occasion, during a big gale in January, a very heavy sea struck the ship, carrying part of her bulwarks away. The report of this mishap was promptly telegraphed to the Superintendent of Trinity House, with all details of the damage sustained. The height of the wire on board the ship is 80ft., the mast being for 60ft of its length of iron, and the remainder of wood. The aerial wire is let down among a great number of metal stays and chains, which do not appear to have any detrimental effect on the strength of the signals. The instruments are placed in the aft cabin, and the aerial wire comes through the framework of a skylight, from which it is insulated by means of a rubber pipe. As usual, a 10in. coil is used, worked by a battery of dry cells, the current taken being about six to eight amperes at 14 volts. Various members of the crew learned in two days how to send and receive, and in fact how to run the station, and owing to the assistant on board not being as good a sailor as the instruments have proved to be, nearly all the messages during very bad weather are sent and received by these men, who, previous to our visit to the ship, had probably scarcely heard of wireless telegraphy, and were certainly unacquainted with even the rudiments of electricity. It is remarkable that wireless telegraphy, which had been considered by some as rather uncertain, or that might work one day and not the next, has proved in this case to be more reliable, even under such unfavourable conditions, than the ordinary land wires, very many of which were broken down in the storms of last month. The instruments at the South Foreland Lighthouse are similar to those used on the ship, but as we contemplate making some long-distance tests from the South Foreland to the coast of France, the height of the pole is much greater than would be necessary for the lightship installation. We found that 80ft. of height is quite sufficient for speaking to the ship, but I am of opinion that the height available on the ship and on shore would be ample even if the distance to which messages had to be sent were more than double what it is at present. Service messages are constantly passing between the ship and the lighthouse, and the officials of Trinity House have been good enough to give expression of their entire satisfaction with the result of this installation. The men on board send numerous messages almost daily on their own private affairs; and this naturally tends to make their isolated life less irksome.

My company has been anxious for some time to establish wireless communication between England and France across the Channel, in order that our French neighbours might also have an opportunity of testing for themselves the practicability of the system, but the promised official consent of the French Government has only been received this evening. Otherwise this communication would have been established long ago. The positions for the stations chosen were situated at Folkestone and Boulogne, the distance between them being 32 miles. I prefer these positions to Calais and Dover, as the latter are only separated by a distance of about 20 miles, which is only slightly more than we are doing every day at Poole and Alum Bay, and as we find that distance so easy we would naturally prefer further tests to be made at much greater distances. We did ask for permission to erect a station at Cherbourg, the corresponding station to be at the Isle of Wight, but the French authorities stated that they would prefer us to have our station in that country in some other position on the north coast. My system has been in use in the Italian navy for more than a year, but I am not at liberty to give many details of what is done there. Various installations have been erected and are working along the coast, two of these being at Spezia. Distances of 19 miles have been bridged over in communicating with war vessels, although 10 miles have been found quite sufficient for the ordinary fleet requirements. Other installations are now contemplated in this country for commercial and military purposes, and I am confident that in a few months many more wireless telegraph stations will be established both here and abroad.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

151. Why do most dynamos spark less with carbon than with copper brushes, proper contact being given each?—A. D. A.

152. What are the advantages of high-speed engines as regards steam consumption and initial condensation of the steam?—W. D. W.

ANSWERS.

Question No. 145.—Describe, with a sketch of connections, a magnetic cut-in and cut-out for use with a dynamo charging accumulators.

Best Answer to No. 145 (*awarded* 10*s.*).—The illustration gives a diagrammatic representation of a very satisfactory form of cut-in and cut-out for the purpose specified. I am not at the moment sure of the name by which it is known, but I think it is the "Nevile." It consists of the following parts: A is an electromagnet of the shape shown, and wound with two windings, the meaning of which will be clear presently. B is a permanent magnet, pivoted at P, and furnished with a balance weight, W, whose position is adjustable between P and A. On the other end of B is hung C, a copper fork, with a pivoted joint at its point of suspension so that the arms may hang vertical. D are two mercury-cups of ordinary construction, blocks of copper with holes drilled in them, these holes being filled with mercury.) ‹ of the windings on the electromagnet, A,

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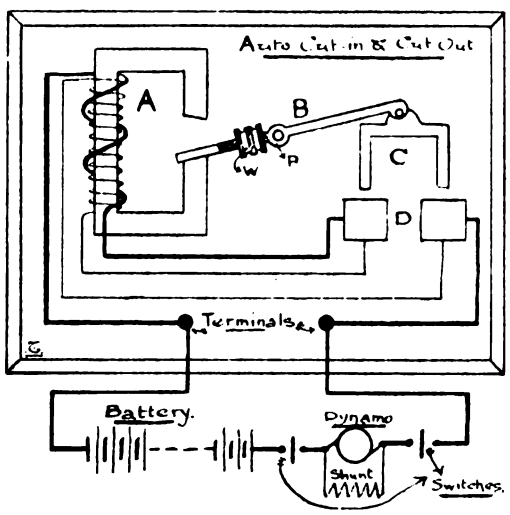
is of fine wire, and its ends are joined up, one to each of the two mercury-cups, as shown. The other winding is of thick wire, large enough to carry the full charging current. One end of this is joined to the mercury-cup, as shown; the other comes to a terminal block. From another terminal block a wire of similar dimensions is taken to the mercury-cup, which has not already a thick wire connected to it.



The counterbalance weight is adjusted so as to make the permanent magnet, B, take up the position of the diagram when there is no current in the windings of A—that is to say, when charging is not proceeding, the fork, C, is not dipping into the mercury-cups. Assuming now that the switch is connected up in circuit with the dynamo and accumulators, as shown in the diagram, the action is as follows: On closing the main dynamo switches, only a very small current will pass at first, because the fine wire winding is in series with the main circuit, as will be seen by an examination of the connections. This small current passing round the magnet a great many times will, however, give sufficient ampere-turns to set up a magnetic field in the gap of the electromagnet strong enough to repel the end of B to the other pole-piece. This will, of course, only happen (providing always that the switch is properly connected up) if the dynamo volts are greater than the back E.M.F. of the battery, for if the reverse be the case, the effect of the field of the electromagnet will simply be to hold B tighter in its present position. Hence B does not move until the dynamo volts are large enough to be safe for charging. The motion of B is sufficient to drop the ends of the fork, C, into the mercury-cups. This has the effect of putting the fork in parallel with the fine wire winding, and hence the latter is practically cut out of the circuit, which is now completed through the thick wire winding. The high resistance having thus been cut out of the charging circuit, the current rises to its proper value for charging. The end of B is now held to the upper pole-piece by the field set up by the main current in the thick winding. The function of the fine wire is therefore merely to start the action. And one of the good points about the switch is in this fact, that under normal conditions of charging the fine wire winding is cut out, and so energy is not wasted in it.

Assuming now that the current falls, it is evident that as soon as it reaches zero the magnetic field of the electromagnet will have disappeared, and in that case the balance weight of the permanent magnet will bring it down to its starting position, and will thus raise C out of the mercury-cups. This has the effect of again putting the fine wire into the circuit, so that, even should the dynamo volts fall much below the battery volts, only a small current can pass through the high resistance of the winding, and hence both dynamo and batteries are protected. As soon as the dynamo volts rise above the battery volts the fork will again dip into the cups, and the action will go on as already described.

In the instructions for working this switch it is specially mentioned that the main dynamo switches should preferably be closed before the dynamo is started up, unless particular precautions are taken to see that the dynamo volts are very little above the battery volts, because if there is a great difference the closing of the main switches would then send a large rush of current round the fine wire, which might demagnetise the permanent magnet. The fine winding is capable of standing the battery volts for a short period, as it will have to do so if the main switches are closed before the dynamo starts. These volts will not cause B to move, as they are in the wrong direction. If this course be adopted, then the switch will act practically as explained, and will go on when the dynamo volts rise sufficiently above the battery to make the electromagnet field strong enough to move the permanent magnet. This difference will be from two to five volts, according to the adjustment.

This switch may be taken as a typical example of a large class of magnetic cut-ins and cut-outs, the difference in the other types being merely matters of detail. For instance, the fine winding may be put directly across the dynamo poles. This has the disadvantage of wasting energy, for the closing of the switch does not short-circuit this winding. Or, again, B may be an electromagnet of varying shape, and may have the thick winding on it. This, however, is not so good, especially if the fine winding is always in circuit, because the magnetism of the fine winding will actually hold the other electromagnet on after the current has reversed, and will continue to do so until the magnetic field set up by the reverse current is sufficient to neutralise the other. Probably the switch described at length is one of the most certain and quick in action that can be employed Its working is eminently satisfactory.—T. C.

Answer to No. 145 (*awarded* 5*s.*).—A good form of automatic cut-out and cut-in is shown by the accompanying sketches. As will be seen from Fig. 1, it consists of two

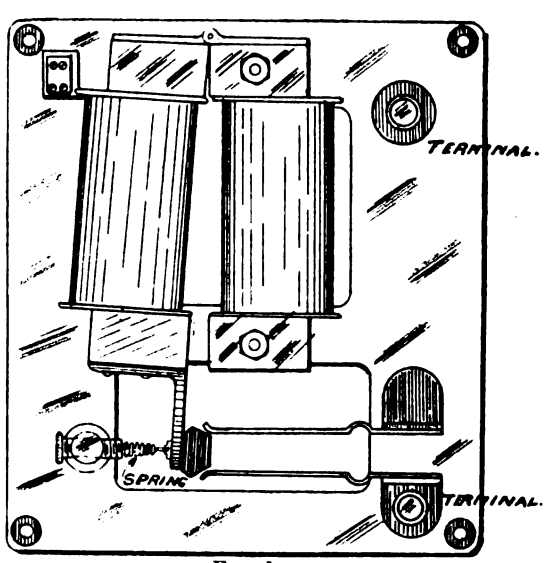


FIG. 1.

electromagnets hinged together and energised, the one by a series coil and the other by a shunt coil. The series

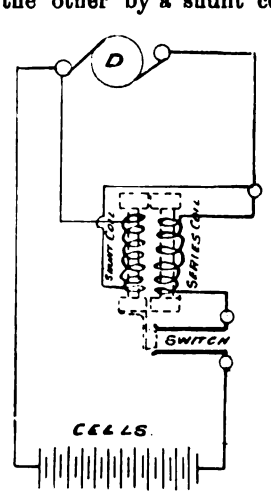


FIG. 2.

magnet is fixed to the baseplate while the shunt magnet is free to move. To the shunt-magnet armature a contact

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block is fastened by means of a bracket, this being held in the "off" position by a spiral spring, as shown.

Fig. 2 is a diagram of connections to the dynamo and cells. The cut-out must be fixed vertically. It can be either in the positive or negative circuits. The action of the cut-out is as follows: Upon the dynamo being started up, no current will flow until the dynamo E.M.F. has risen sufficiently high (just above that of the cells) to magnetise the armatures to the strength required to overcome the spiral spring, when the contact block will be pulled into the switch arms and the circuit thus completed. Should the E.M.F. of the cells become greater than that of the dynamo, the armature is released and the contact block pulled out by the spiral spring.—F. A.

Question No. 146.—Describe an electric brake as used on an electric tramcar.

Best Answer to No. 146 (*awarded* 10*s.*).—Many forms of so-called electric brakes have been devised in which the ordinary rigging and shoes are employed with some form of electromagnet to take the place of the usual handle in supplying power to the chain. Such brakes may be operated by current taken from the overhead line or from batteries on the car, but the first is unreliable, as the trolley might leave the wire at a critical moment, and the latter necessitates the addition to the car equipment of heavy and expensive apparatus.

The latest form of electric brake, and that which is extensively used in America and at home, consists of a split cast-iron disc keyed to each axle, and a circular electromagnet, also split, which faces the disc, and is supported and prevented from revolving by lugs projecting from the motor axle caps. The current from the motors is thrown by graduated steps through the movable magnetic discs, bringing them into close contact with the axle discs, the resulting friction retarding the latter and with them the car wheels, while the generator action going on in the motors at the same time tends to bring the armatures to rest, increasing the braking effect and relieving the gearing from strain.

Additional retarding action is also produced by the eddy currents set up in the axle disc as it revolves in the magnetic field surrounding the magnetic disc.

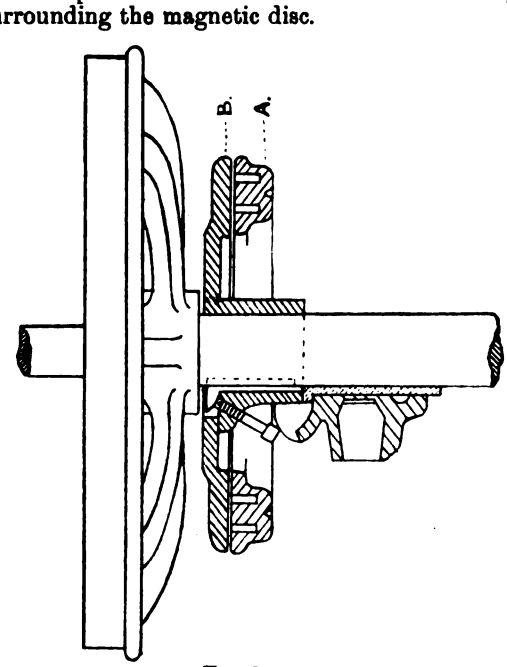

Fig. 1.

Fig. 1 shows the arrangement of the discs, A being the movable one and B the fixed one. This form of brake does not in any way interfere with the ordinary hand-brake, and the braking effect being independent of the car wheel, the wear and tear of service does not come upon the wheel treads. Any tendency to skid is prevented automatically, for the armature of the motor is connected through the gear and axle to the wheels, and the latter cannot stop turning without also stopping the armature, and with it the current from which the brake action is derived.

Fig. 2 is a diagram of connections. The limit switch is an arrangement provided in order to prevent a sudden flow of current from the motors in excess of that necessary to stop the wheels. This switch consists of a small coil of wire in series with the brake discs, which, when energised, lifts an armature, making connections, which cut out the

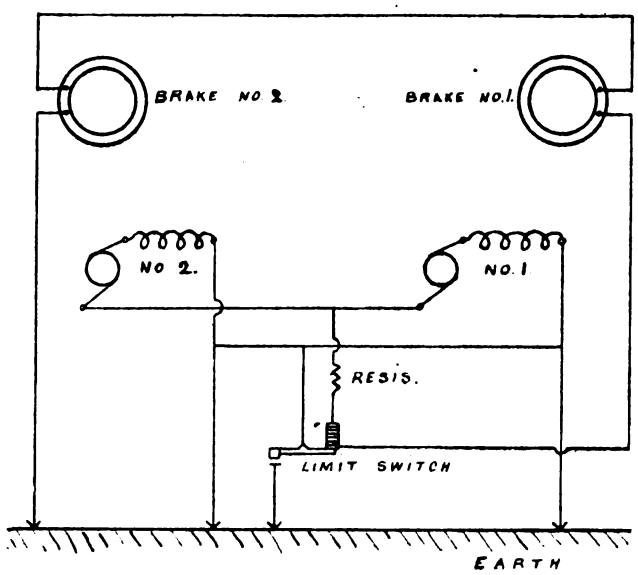

Fig. 2.

fields of both motors, thereby stopping the current.—C. J. S.

Answer to No. 146 (*awarded* 5*s.*).—The electric brake as applied to an electric tramcar is simply a development of the principle of conversion of the motors into generators, the armatures receiving their driving power from the axles of the car when moving by gravity or in virtue of its own momentum. Suppose, for example, the car is decending an incline, the current is shut off so soon as the desired speed is attained, and the journey is completed entirely or in part by gravity. It is obvious that the armatures of the motors are being driven by the car, thus forming generators whose revolutions and consequent output vary with the speed of the car. By supplying these interim generators with an external circuit in the form of a variable resistance, it is possible to so adjust the power absorbed by them as generators as to control the speed of the car to any desired degree. The resistance being once adjusted, the braking action is entirely automatic—that is to say, no further adjustment will be required till the foot of the incline is reached, when it will be necessary to once more apply power from the line, and the motors are again requisitioned to perform their proper function. The superiority of this form of brake over the ordinary hand-brake is obvious, because, firstly, no wear and tear (practically) takes place; and, secondly, flats on the wheels do not result. In the case of the hand-brake, not only are flats formed, but each subsequent application of the brake tends to aggravate any certain flat or flats already formed.

Regarding the electric brake from another aspect, we might consider its value in the case of an emergency. To avoid an accident it has been the practice to short-circuit the motors without resistance. This procedure naturally produces enormous mechanical strain on the armatures and gearing, the teeth of the gear wheels and pinions having been stripped by this means, while the commutators and insulation of the windings generally suffer. The insertion of resistance, on the other hand, renders the braking action insufficient to cope with an emergency. An improved form of brake has been introduced which not only relieves the motors to a great extent of this strain, due to magnetic drag, but is more powerful, and can be used to bring the car to a full stop. This, of course, is not possible with the form described above on account of the essentially intermittent action of the brake—that is to say, when the car has almost reached a standstill, it is evident that the retarding force, due to the generating action of the motors, will have reached a minimum, and the car is again accelerated by gravity. As soon, however, as the speed reaches a certain limit, the braking force becomes sufficient to overcome that of gravity, and the car is again slowed up.

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In the latest form of electric brake already mentioned, there is keyed on the axle of the car wheel, and revolving with it, a circular iron disc. Coincident with this disc is another of similar dimensions, but the latter is fixed, say, to motor frame, and is in the form of an electromagnet. The generating action of the motors comes into play as before, but the resulting current, in addition to passing through the variable resistance is also used to energise this electromagnetic disc. The electromagnetic disc exerts an attractive force on the rotating disc, bringing it into close contact with itself. The resulting friction (which may, of course, be controlled by the resistance) forms a powerful brake assisted by the magnetic drag due to generator action as before. In this case, however, the intermediate gearing is relieved of any dangerous strain by the simultaneous application of a retarding force at gear-wheel and pinion respectively. In addition to these forces, there is no doubt that Foucault currents play a very important part in the braking action between the discs. As stated above, this brake may be used to bring the car to a complete standstill, and for this reason: In order that the discs may withstand the unavoidable wear and tear, hard metals must be used for their manufacture, with the consequence that their retentivity is sufficiently high to cause the discs to remain in contact after the car has been brought to a standstill. This, of course, involves an excess of starting power. The difficulty is now surmounted in a very ingenious manner. In restarting the car the operation of switching on to the first contact of the controller simultaneously allows a small current to flow through the electromagnetic disc. The direction of this current is the *reverse* to that which previously energised the electromagnet, and its strength may be adjusted permanently by means of a resistance to just overcome the residual field in the discs. The controller is usually arranged so that one handle will suffice for power or brake, when turned in reverse directions. Such an arrangement besides being most convenient ensures the shutting off of power prior to the application of the brakes, and *vice versâ*, as in either case a waste of power ensues if both are in operation simultaneously. The additional power possessed by this brake would be sufficient, if suddenly applied, to cause skidding, which was referred to above as one of the inherent objections to the hand-brake. The skidding in this case, however, would only be momentary, because, the armature being brought to rest, the brake would be deprived of its source of power until the motion of the car overcame the adhesion between the discs and the inertia of the moving parts. This intermittent skidding often repeated would no doubt give rise to flats and wear and tear through time, a result which would deprive the electric brake of one of its most prominent features. To obviate this, an automatic device, sometimes called a "limit switch," is inserted in the circuit of the electromagnetic disc. An excessive current in this circuit immediately causes the switch to act, and it is so connected as to cut out part or all of the fields of the motors, and so weaken their generative action as to be equivalent to a more gradual application of the brakes. This device is, of course, electromagnetic, with tension spring adjustment, and should be adjusted so as to control the braking action just when it reaches the skidding limit, at which point the brake is most effective. Its use also prevents that damage to the motor windings which would certainly ensue in event of a rush of current due to sudden application of the brakes. The hand-brake may, of course, be used independently by applying blocks to the wheels in the usual way. It should be noted, however, that the application of this brake to such a degree as to cause skidding renders the electric brake completely useless, depending as it does upon the rotation of the wheels. This has been the cause of at least one serious accident. To prevent the possibility of such an occurrence, slipper brakes, acting by pressure on the rails, might be employed. It will be seen from these remarks that, contrary to a popular impression, the electric brake is entirely independent of the current in the trolley line.—A. M. O.

Answer to No. 146 (*awarded* 5*s.*).—To satisfactorily answer this question, it will be as well to divide under two headings: (*a*) braking dependent on its supply of power from the trolley wire, and produced without friction between two surfaces; and (*b*) that which is independent of the trolley being in position, and effected by friction.

Under (*a*) comes the ordinary arrangement as supplied to cars up to the present time, termed the "emergency brake," applied by so connecting up the motors that they can be short-circuited directly or through a resistance. It will be seen that this mode of effecting a braking action is entirely dependent on the supply of current, which, if stopped by the trolley being thrown off (as at Bradford), renders this brake inoperative.

(*b*) This system of braking has been designed and fitted by the British Thomson-Houston Company, and can certainly be classed a most efficient brake. It can be briefly described thus: By a movement of the controller handle, as usually fitted, it can be applied instantaneously. This is effected by having the motors so connected that each acts as a generator, the circuit being closed by a resistance which can be varied. The current generated energises a stationary disc magnet on the car axle, which attracts another disc keyed to and turning with the axle. The braking is thus produced by the friction between the discs.

The power is, therefore, dependent solely upon the motion of the car, and not, as in case (*a*), upon the supply of current from the trolley wire. Also, if it is decided to discard the ordinary hand-brake, the life of the wheels will be prolonged, due to the absence of the brake-blocks.—R. H. S.

WORCESTER ELECTRIC LIGHTING ACCOUNTS.

The accounts of the electricity department of the Worcester Corporation for the year ended Dec. 31, 1898, have just been published, from which we extract the revenue account, general balance-sheet, and statement of electricity generated, sold, etc. An abstract of report of Mr. C. J. Sutherland, city electrical engineer, to the Electricity Committee on the work of the department during the year is also appended:

REVENUE ACCOUNT.

Dr.	£	s.	d.
Generation of Electricity.			
Coal	1,211	10	2
Oil, waste, and engine-room stores	212	5	3
Wages at generating station	953	5	5
Repairs to building, plant, and machinery	196	15	1
Distribution of Electricity.			
Wages of linesmen, fitters, and labourers	39	12	8
Repairs and maintenance of transformers, meters, etc.	42	6	1
Repairs, maintenance of apparatus at distributing stations	0	2	3
Attending and maintenance of public lamps	406	12	5
Rents, Rates, and Taxes.			
Rents	30	12	0
Rates and taxes	48	19	3
Management Expenses.			
Salaries, engineer's department	476	11	8
Stationery and printing	43	3	8
General establishment charges	34	5	10
Law and parliamentary charges	35	12	9
Special Charges.			
Insurances	20	17	3
Free Wiring Company	13	8	2
Lamps	177	13	0
	£3,943	12	11
Balance carried to net revenue account	3,210	10	9
	£7,154	3	8

Cr.	£	s.	d.
Sale of current per meter at 1½d., 2d., 2½d., 3d., 3½d., 6d. and 7d. per Board of Trade unit	5,619	13	9
Public lighting	1,280	10	9
Rental of meters and other apparatus on consumers' premises	165	17	11
Carbons and lamps	3	19	7
Rent of water-mill at Powick	50	0	0
Rent of cottages	30	3	0
Repairs, testing fee, etc.	3	18	8
	£7,154	3	8

GENERAL BALANCE SHEET.

Liabilities.	£	s.	d.
Capital account—amount received	63,139	14	8
Sundry creditors	1,403	7	2
Sinking fund account	6,109	2	3
Treasurer	13,324	13	5
	£83,976	17	6

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Assets.	£	s.	d.
Capital account—amount expended for works	74,397	3	0
Stores on hand Dec. 31, 1898: coal, £42. 15s.; oils, waste, and engine-room stores, £201. 2s. 5d.; carbons, £3. 19s.; lamps, £57. 18s. 5d.....	305	14	10
Sundry debtors for current supplied to Dec. 31, 1898	2,302	1	10
Public lamps	323	10	9
Other debtors	79	3	9
Sinking fund account.....	6,109	2	3
Net revenue account—balance, being deficiency on revenue account	460	1	1
	£83,976	17	6

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in Board of Trade units.....		610,492
Quantity sold { Public lamps ..... 108,400 / Private consumers by meter .. 365,944 }		474,344
Quantity used in works		6,180
Total quantity accounted for.....		480,524
Quantity not accounted for		129,968
Number of public arc lamps		56
Number of public incandescent lamps		5
Total maximum supply demanded (kilowatts)		854

MR. C. J. SUTHERLAND'S REPORT.

I have the honour to submit to you the following report on the results of the fourth year's working of the electricity department. An analysis of accounts is appended, showing also the results obtained in the three previous years, and it will be at once seen that a very marked improvement has taken place in all the costs per unit, and that most of the cost items are actually less than the previous year, in spite of the fact that more units have been sold. I think there is every reason to be satisfied with the excellent results, and it should be noted that the loss on the year's working is only £460. 1s. 1d., the difference between last year's deficit and those of the previous years being very marked. The coal bill shows a reduction of £115. 6s. 10d., the cost per unit having been brought down from ·742d. to ·612d. per unit. This decrease has been effected in spite of the fact that 123 tons of coal were paid for at 24s., 25s., and 25s. 6d. per ton (instead of the contract price of 14s. 6d.) owing to the coal strike. Two of the other items under the heading of "Generation of Electricity" show a substantial decrease, salaries and wages having fallen from ·535d. per unit to ·482d., and repairs, etc., from ·315d. to ·099d., this latter figure being one of the lowest in the kingdom for a high-tension alternating station. The works costs are £2,655. 16s. 11d., against £3,053. 16s. 5d., making a decrease of ·365d. per unit, and the total costs show a decrease of ·283d. The actual financial result is a very considerable improvement on previous years, the net loss on the year's working having been reduced from £1,474. 10s. 9d. to £460. 1s. 1d., and I think the committee may look forward with perfect confidence to seeing a profit at the end of this year's working. I wish to point out that if the new engine had been completed in time for the load during the dark months at the end of last year, there is no doubt that the costs would have shown a further decrease, as it is a well-known fact that one large engine can work more economically at full load than several smaller ones working together on the same load, owing of course to the friction losses being smaller; and in the case of the plant at Powick there would also be considerable further saving in running the large plant owing to the dynamo being direct coupled, there being thus no loss in transmission of power by ropes. The load during the winter of 1898 could have been done as a rule by the Ferranti plant and the water power, the Brush engines being used as reserves, and this would have been a very economical method of running; in fact, I think it quite probable that if the new plant had been ready in time, if the Belliss engine had been in use all the year, instead of only from last October, and if the coal strike had not taken place, there would have been a profit made last year instead of a loss. The increase in the number of units sold is somewhat disappointing, the net increase being only 9·5 per cent. over that of the previous year. It will be found, however, that the increase in units sold for incandescent lamps is 22·67 per cent, but there is again a decrease in the units taken by the waterworks motors of 8·61 per cent., and a decrease in private day load of 54·99 per cent. This private day load item no longer exists, as under the new system of charging motors are included with incandescent lamps, the units appearing under the heading of "Private Day Load" for 1898 having been used on one motor only, which was not in use for more than a few months in the year. One cause which has prevented the load increasing as much as might have been expected, is that the connecting of new customers was not encouraged during the latter part of last year, owing to the overloaded state of the plant and the absence of reserve, caused by the non-completion of the new engine and alternator. The price obtained for public lighting has again decreased and is now only 1·93d. per unit, which is far below the average obtained in most towns, and ranks amongst the very lowest prices. The average price obtained for private lighting has fallen ·07d. per unit, showing that the proportion of customers who pay the higher rate is becoming smaller, and that the load is beginning to be spread over longer hours. We have, however, obtained an average price on all the units sold of 3·286d., against 3·135d. the previous year, this increase being due to the fact that a larger proportion of units were for private lighting. The number of hours when the generating was entirely by water power increased from 54·9 per cent. to 61·80 per cent. of the total running hours, which fact of course partly accounts for the reduction in the coal bill. There were 10 days in the year when water was completely unavailable owing to either flood or drought, against 25 days in 1896. It must be borne in mind, however, and will readily be seen from the percentages, that this by no means implies that water was available during the whole 24 hours of the remaining days, as during the latter end of the summer the turbines could only be run for a few hours each day, after which steam had to be used owing to the head having fallen beyond the working point. The cost of coal per steam-generated unit has been reduced from 1·32d. to 1·02d., and there is no doubt this figure would have been lower if the new small engine had been at work longer, and I anticipate that during the coming summer, when short of water, the benefit of this small engine will be very appreciable. It has also been of great use during the winter's load, when the plant has been running so much overloaded, and the extra power thus given to No. 5 plant was of considerable benefit. The Free Wiring Company have secured 18 customers during the past year, and I hope to see this number very considerably increased during the present year, as it is certainly disappointing that so few people should have availed themselves of the opportunity of having their premises wired free of charge. The total number of new customers connected during the year is 80, an increase of 30 on the number connected during 1897; the number of additional 8-c.p. lamps being 3,637, or nearly 1,000 more than during the previous year. This increase shows that the new system of charging is gradually being appreciated, and there is no doubt that as the system becomes more universally understood, the number of new customers will increase rapidly. The price charged is among the lowest in the kingdom, and the price obtained is absolutely the lowest, and I hope, therefore, to see a considerable increase in custom from private houses, who are of course long-hour customers, and considerable gainers under the new charges. Taken as a whole, the mains at present laid may be said to chiefly tap the business portion of the city, and I hope before long to see more mains laid in the residential streets, even though the number of customers is small to begin with, for it must be remembered that if the interest on the money spent is at first small, it gradually grows as new customers come on, and it is frequently found that the best method of canvassing is to lay a main past the doors of prospective customers, such main, of course, being on its way to a customer who has already applied for the light. The new Ferranti plant is now very near completion, and I am expecting the first steam run very shortly; but I do not, however, anticipate that it will be available for the public supply for another six or eight weeks. The new switchboard is now practically complete, and I hope to commence the work of changing over on to this very shortly.

UNITS GENERATED BY STEAM AND WATER POWER, WITH PERCENTAGES FOR 1898.

Month.	Total units.	Steam.	Water.	Steam, per cent.	Water, per cent.
January ...	63,051	26,380	36,671	41·8	58·2
February ...	51,337	14,633	36,704	28·5	71·5
March	50,445	12,668	37,777	25·1	74·9
April.....	41,402	9,382	32,020	22·7	77·3
May	38,551	8,130	30,421	21·9	78·1
June	31,538	5,209	26,329	16·5	83·5
July	33,926	19,989	13,937	58·9	41·1
August.....	36,243	28,136	8,107	77·6	22·4
September..	47,044	43,500	3,544	84·0	16·0
October.....	64,841	50,724	14,117	78·2	21·8
November..	72,177	34,825	37,352	48·2	51·8
December..	79,937	29,496	50,441	36·9	63·1

INSTITUTION OF ELECTRICAL ENGINEERS, Mar. 23.

At last night's meeting of the Institution the following were the candidates balloted for:

Associate Members.—J. A. Bell, 12, Beechgrove-terrace, Aberdeen; Major P. R. Burn-Murdoch, R.E., 23, Cadogan-gardens, S.W.

Foreign Member.—P. Fournier, Rue Christophe Colomb, Calais.

Associates.—H. T. Hazzledine, 15, College-street, Nottingham; H. Henderson, 14, St. John-street, York; A. G. Jackson, Adelaide-street, Brisbane, Queensland; J. D. Murphy, Telegraph Department, Brisbane, Queensland; E. H. Rainbow, 47, Argyle-road, Ealing, W.; C. W. Torrens, Baston Manor, Hayes, Kent; A. Wright, 119, Buckingham Palace-road, S.W.

Students.—J. F. Avila, 11, Colville-road, Sparkbrook, Birmingham; K. C. H. Newman, The Towers, Trinity-square, Llandudno; J. A. Ross and T. G. Smith, Faraday House, Charing Cross-road, W.C.

The Universal Electrical Directory.—The eighteenth edition of the Universal Electrical Directory (J. A. Berly's) is now before us, and we have again to call attention to the propensities this publication has for increasing in size. Thus, in this year's there are 64 more pages than in the 1898 edition, and over 1,600 more names of electrical engineers and electrical firms. The whole of the names and addresses have been carefully revised and added to since last year, as we can testify from personal experience. The totals for the various sections now stand as follows: British section, 9,845 names; Continental, 8 195 names; American, 5,304 names; and the Colonial section, 2,120 names. This brings up the grand total to 25,464 names of persons and firms, and is an eloquent testimony to the progress of electrical engineering. The English section is well sub-divided into trades, and, again, the local distribution of the engineers is given. The directory is most handy for reference, and is a credit to its publishers, Messrs. Alabaster, Gatehouse, and Co. The price is 6s.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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ELECTRIC TRACTION.

Mr. Philip Dawson discoursed at considerable length on this question at the Society of Arts on Wednesday last. The English people interested in this question are greatly indebted to Mr. Dawson for keeping them so fully acquainted with the developments of electric traction, and especially in the experience gained by our cousins across the Atlantic. Of course, American experience is very far from being a safe guide when transplanted to this side, because the ruling conditions are quite different. Still, accepting the truth of Mr. Dawson's remark that "there is no country in which electric traction is advancing more rapidly, and in which finer plants are being installed, than in Great Britain," we are bound to acknowledge that the education on this side has been almost entirely derived from the experience of America. Quite recently the plant supplied by firms on this side has taken an equally high if not a superior position to that obtained from America. The fact is that the American systems are mostly railways, and not tramways, whereas the British systems are mostly pure tramways. Our excuse for touching once again upon this topic is to emphasise some remarks of a correspondent who, calling attention to the question, expresses surprise at the supineness of the great railway authorities to the fact that many of the tramway schemes are interfering to a very large extent with their traffic, and wondering why the railway authorities have not themselves developed suburban electric traffic. There is no secret in the matter, it being well known that in the one or two cases where electric trams have come into direct competition with suburban railway traffic the latter has been almost entirely destroyed. With the rapid growth of tramway systems this factor will have to be considered, and municipalities and companies will find themselves face to face with the antagonism of railways. Another sentence of Mr. Dawson may be quoted as bearing on this phase of the question. He says: "The problem of greatest importance, however, in which electric traction will be a principal factor, is the rapid transportation of large crowds from and to their business in our cities." Contrary to the general run of opinion, we contend that the crowds which go to and fro have almost reached the limit of their numbers, and thus the transport of these crowds by newer systems of transportation will largely divert the traffic of the old ways. If this is so—and the instances that exist seem to prove it—then the railways which have hitherto catered for suburban traffic will have a large part of this traffic diverted into cheaper and more convenient channels. It is all very well for outsiders to grumble at the facilities given by the railways, and to howl at the crushing that goes on at the railway stations between certain hours, but the railway authorities and the shareholders look at the question from the point of view of loss of revenue. The long-distance traffic on railways is of great importance, but not more so than the local traffic. It is the latter which will be imperilled, and, as our correspondent says, "it is

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a wonder the railway authorities are not actively moving in the matter and promoting schemes which will ensure this traffic being retained in their own hands." It is needless to point out that no railway service is or can be as convenient as a tramway service, and if railways do compete in this direction they must construct something, and work it, of the nature of a tramway.

FORTHCOMING EVENTS.

FRIDAY, MARCH 24.

Royal Institution.—At 9 p.m., "Transparency and Opacity," by Lord Rayleigh.

Physical Society.—At 5 p.m., "On the Criterion for the Oscillatory Discharge of a Condenser," by Dr. Barton and Prof. Morten; "The Minor Variations of the Clark Cell," by Mr. A. P. Trotter.

Electro-Harmonic Society.—At 8 p.m., smoking concert, St. James's Hall Restaurant (Banquet room).

SATURDAY, MARCH 25.

Institution of Junior Engineers.—At 3 p.m., visit to the testing station of the British Fire Protection Committee, Hanover-gate, Regent's Park.

Royal Institution.—At 3 p.m., "The Mechanical Properties of Bodies," by Lord Rayleigh, M.A., D.C.L., LL.D., F.R.S. Last lecture of the series.

North-East Coast Institution of Engineers and Shipbuilders (Graduate Section).—At 7 p.m. in the Institution Lecture Hall, Newcastle-on-Tyne, "The Application of Electricity to Coal-Mining," by Mr. Talbot Duckitt.

TUESDAY, MARCH 28.

Institution of Civil Engineers.—At 8 p.m., "Alloys of Iron and Nickel," by Mr. Robert Abbott Hadfield, M.I.C.E.

THE EDISWAN ENCLOSED MOTOR.

The Edison and Swan Electric Light Company, Limited, have recently introduced a new type of enclosed motor which is likely to find favour with the general public. The body of the motor consists of two steel castings, which form the enclosing framework and the magnetic circuit. They are accurately fitted together at a broad joint, which in no way interferes with the perfectness of the magnetic circuit. The material is a specially soft quality of cast steel having a magnetic permeability superior to wrought iron, thus enabling the weight of the motor to be reduced to the smallest amount possible Most effective lubrication is brought about by capacious oil-chambers cast in the lower parts of the brackets capable of holding a supply of oil for a considerable time without refilling. The oil is drawn up by the action of two chains to each bearing and most effectually distributed over the rubbing surfaces by means of oil channels, and carried back into the reservoir. These chains are easily accessible without undoing any part of the machine. The parts are so arranged that it is impossible to overfill the reservoirs and cause the oil to enter the main body of the motor. The shaft is provided at each end on the inside of the bearings with oil throwers, which cast off any oil which may travel along the shaft into a guard, which itself is enclosed in a second guard, thus preventing all possibility of oil creeping into the main body of the motor. The brushes are of electro-graphitic carbon, having a very high conductivity and readily making a thoroughly good contact with the copper of the commutator. They are held in brush-holders of a special design, and can be readily replaced in a few seconds by spare brushes where necessary. The smallest motors have two brushes each side, the larger ones two or more according to the output. Any one brush is capable of being removed while the machine is running in a few seconds for adjustment or any other reason, and all brushes can be adjusted individually for pressure on the commutator. There is no sparking at all loads, and the brushes are fixed in position, not requiring movement from no load to 20 per cent. over full load or more. All the brush gear terminals and internal connections are at once accessible by lifting the lid provided over the commutator box. In this way the machine may be rapidly disconnected in such a way that the upper half of the body may be easily removed with its own magnet coil attached, the connections being so arranged to the terminal board that a mistake can hardly be made in replacing them in their proper positions. Terminals are provided, so that by following the instructions sent out with every motor the direction of rotation can be at once changed, if desired, by rearranging the connections on the above-mentioned terminal board; such change in direction and rotation does not necessitate a readjustment of the brushes. The wires for connecting the motor to the source of supply are passed in through ebonite glands in the commutator box, which are placed opposite to the terminals into which those wires have to go. The armature is of the slotted drum type, the plates being securely attached to the shaft by means of gunmetal end plates and gunmetal spider, thus securing great freedom from eddy currents, and consequent cool running. The magnet windings, which are thoroughly insulated, are on two separate bobbins, easily detachable from the body of the motor, and fitted with their own pair of terminals. The whole of the motor is of substantial design, capable of running continuously without overheating at the full load marked. It is designed also to stand 20 per cent. overload for an hour or more without any injury whatever. The parts are so proportioned that the energy waste in the motor is the least possible under the circumstances, and thus the motor is of very high efficiency. It is completely enclosed, dustproof, the commutator cover having a glass window in it, enabling the commutator to be inspected without opening the case.

ELECTRIC LIGHTING BILLS FOR LONDON.

A committee of the House of Commons, consisting of Sir W. Coddington (chairman), Mr. Price, Mr. Cubitt, and Mr. Clough, commenced on Thursday last week the consideration of a group of Bills, including some important proposals connected with the electrical supply of London. The Bills on the first day's list included one to empower the St. James's and Pall Mall Electric Lighting Company, Limited, to acquire lands and erect generating stations and for other purposes, and a second to confer upon the Central Electric Supply Company, Limited, powers to construct works and supply electrical energy.

In opening the promoters' case for the former of these two measures, Mr. BALFOUR BROWNE said the Bill was almost exactly similar to one which passed through both Houses of Parliament last year at the instance of the Chelsea Electric Lighting Company. The promoting company came into existence in 1888. When it was registered it proposed to raise a capital to the extent of £100,000. For the first seven years the company worked under a license—rather an obsolete form of provision. But in 1890 they obtained an order by which they secured a length of life of 42 years—from August, 1889. When the company began its business of public lighting it was very difficult indeed to find the capital, and there was only a subscription of 5,000 £5 shares. The business had to be carried on by means of a loan of £35,000, afterwards increased to £50,000 in terms which gave the debenture-holders option of changing their debentures for ordinary shares. The present capital of the company amounted to £160,000 ordinary shares and £100,000 preference shares. The business was so great that more land was required for the extension of the company's undertaking. They could not acquire the land by agreement, therefore they were obliged to come to Parliament for compulsory powers. This procedure was adopted in accordance with the report of a committee which sat last year, presided over by Lord Cross, and considered the provisions of four Bills dealing with electrical supply. Last year the Chelsea Company and the Metropolitan Supply Company obtained powers similar to those which were now sought. He submitted that there was an absolute necessity for the passing of the Bill. In 1890, when they began their business, they had 177 consumers, and the number had grown to 1,394 in 1897 and 1,400 in 1898. There were now on their system 142,853 lamps, and whereas in 1891 they supplied 1,000,000 units of electricity, in 1898 they supplied 3,448,000 units. The company had only surplus supply capacity in plant of 13 per cent., so that should there be a fog or breakdown they might easily exhaust the surplus. According to experts, prudent working for safety should give them 25 per cent. surplus. The average price obtained was 4·35d. per unit, the authorised charge being 8d. For public lighting they charged 2½d. per unit, which was a less amount than adjoining

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local authorities who made their own electricity could manufacture it for. The horse-power of the company's engines now was 4,500. It was not proposed to double this, but only to add 2,500 h.p. And beyond this it was proposed to put up transformers which would be constructed in connection with the generating station they were seeking to put up in conjunction with the Westminster Company on the banks of the Regent's Canal. He pointed out that on the previous day, when the fog was very bad, the company used as much as 60 tons of coal, and were brought to the end of their tether so far as manufacture was concerned. Turning to the petitions, he said that that of the St. James's Vestry, Westminster, complained of the inconvenience of putting up such large works as those proposed in the West-end within 150 yards of Regent-street. In reply to that, he pointed out that the promoters were anxious to avoid the construction of too large a generating station, and, therefore, they proposed entering into partnership with the Westminster Company and constructing works on the Regent's Canal. Then it was complained that no provision was made for compensating the petitioners for damage which would be done to their roads and other property. This he did not understand, for the reason that all the mains in the streets were to be made, not under the proposed Bill, but under a provisional order already in existence. In answer to Mr. Freeman, Q.C., for the St. James's Vestry, Westminster, Mr. Balfour Browne said that if sewers were interfered with compensation would be paid. In conclusion, he dealt with the other petitions, which he held were matters of compensation.

Mr. Eustace Balfour, chairman of the promoting company, was then called and examined by Lord R. Cecil. He stated that the company could not carry out their statutory duty unless they had power to enlarge their works. In cross-examination by Mr. C. A. Russell, Q.C., on behalf of the Craven Trustees, witness said that the works which were being proposed at Carnaby-street would only enable them to meet their requirements down to 1901. He did not know that the number of persons who would be displaced under the Bill would be 500. He had not gone into that question.

By the Chairman: The price for ordinary lighting was 4·35d. and for public lamp lighting 2½d., but the charge for energy used for power purposes was only 3d. The energy was made at a time when the engines was not at work for lighting purposes. The company hoped to be able to decrease that price to 2d. If they could get the price down to 2d. they would be able to complete directly with gas-engines.

Mr. Sydney Dobson, engineer to the promoting company, said that at present they had 6,000 h.p. at work. In 10 years' time they expected to supply 500,000 lamps with electricity, and then they would require 15,000 h.p. This extension was necessary in order to prevent a breakdown.

Sir Frederick Bramwell said he had given considerable attention to electric lighting undertakings in London, and was a director of one of them. He had known the works of the promoting company for some time. They were admirably conducted, but of insufficient capacity, and the powers now sought were quite necessary. He pointed out that in cases where there had been private installations they had been given up for the electrical supply of the promoting company. The case of the Athenæum Club was one in point.

Mr. Robert Viger, surveyor, spoke of the difficulty of purchasing land by agreement. This case was just one of those which should be dealt with by arbitration. It should be regarded as purely a question of compensation.

This was the case for the promoters.

Mr. Freeman, Q.C., then opened the case for the St. James's Vestry. He declared that the Vestry and owners of property would tell the committee that there was at the present time inconvenience and nuisance both from smoke and from vibration, and the fear was entertained that if Parliament allowed the Carnaby-street generating station to be enlarged as proposed the nuisance must inevitably be increased. He held that this was the last parish in which generating works should be concentrated in one place, and that the company could make arrangements under their other Bill for generating all the electricity elsewhere. In any circumstances they might spread their works instead of concentrating them. If the Bill passed, the promoters might undertake to bear the expense of widening the streets in their neighbourhood and compensate the petitioners for the loss of rates on the property to be acquired.

Mr. Munsey, vestry clerk of St. James's, Westminster, gave evidence in support of the opening statement of counsel, and the committee then adjourned.

Friday's Proceedings.

Mr. Henry Monson, surveyor to the St. James's Vestry, was the first witness called. He said he was thoroughly acquainted with the property proposed to be taken under the Bill, and the streets round it. At the present time when coals were being unloaded in Carnaby-street the thoroughfare was completely blocked to other traffic, as there was not sufficient room for two vehicles to pass each other. As a result, a vehicle which required to pass from end of the street to the other was obliged, when coals were being unloaded, to make a considerable detour. A still greater detour would have to be made if the present Bill passed and the properties pointed out in the plans were acquired. A clause in the Bill said that not more than 20 houses should be acquired, but over 40 separate tenements were included in the schedule. It was absurd to suppose that the present works of the electric light company had improved the neighbourhood. The Bill could not improve the neighbourhood, for the reason that a large generating station like that proposed in the middle of a mass of property caused noise and vibration, and emitted dirt and smoke from the chimney. At times noxious smells and heat were caused.

Dr. James Evans, medical officer of health to the district of St. James's, said that complaints had been made as to the smoke and cinders which were discharged from the chimney of the works in Mason's-yard. He had visited the works, and had made a report on them. The discharge of cinders, which had since been moderated, was due to the chimney being overworked, the draught through it being too rapid. He understood that cinders were being discharged from the Carnaby-street works. This, of course, was detrimental to the health and comfort of the neighbourhood.

Mr. Edwin Crook, of 5, Carnaby-street, and owner of house property in the neighbourhood, complained of the noise and vibration caused by the existing works.

Edward Raynor Crook, son of the last witness, said that in 1896 and 1897 he had a serious illness through the noise and vibration from the Carnaby-street works. He had had congestion of the brain owing to want of sleep. He had called in a physician, who had ordered him to change his residence. He had put indiarubber pads under his bed in Carnaby-street to lessen the vibration, but to no purpose.

Mr. Russell, Q.C., then addressed the committee in support of the petition of the Craven Trustees. He maintained that it was impossible for the committee to deal properly with this Bill, as they did not know what powers the promoters would acquire under the Central Electric Supply Bill, which stood next on the list, and under which new works were to be constructed on the Regent's Canal. The promoters were here now, not in the public interest, but for their own benefit as a commercial undertaking, to prevent their trading rivals from obtaining an advantage over them between now and the time that the works under the next Bill would be constructed. The number of people who would be displaced under the Bill was 500, but a larger number would be disturbed.

Mr. Goodwin, surveyor to the Craven Trustees, examined by Mr. James, said that the proposed works would do a great deal of injury to the property of the petitioners. It would displace a great many workmen, especially tailors, to whom it was of importance that they should be near their headquarters—the master tailors in Conduit-street and other streets in the neighbourhood of Regent-street.

Mr. George Angold, a member of the St. James's Vestry, Mr. J. Wallis, Mr. W. Watson, Mr. Rolfe, and Mr. Griffiths gave evidence to show that the district was almost exclusively occupied by working tailors, whose business was very seriously injured by the smoke and dirt and noise occasioned by the promoters' works.

Sir John Whittaker Ellis, giving expert evidence as a surveyor and valuer against the Bill, expressed the opinion that the effect of the construction of the proposed works would be to drive out of the district a large number of the inhabitants, and considerably reduce the customers of the tradespeople who remained.

Mr. Boyle, Q.C., then addressed the committee for the remaining petitioners—John Halsey and B. T. Davison, cardboard manufacturers. He submitted that it was uncertain as to whether the promoters would take the property of the petitioners, and this uncertainty was damaging to their interests.

Evidence having been given in support of the opening statement of counsel,

Mr. Balfour Browne summed up the case for the promoters. He submitted that, being at Carnaby-street with the authority of Parliament, and having a large amount of plant there, and, further, being in want of an increased supply of electricity, it was only right that they should be allowed to so extend their works as to give them all the energy they required pending the construction of the proposed new works on the Regent's Canal. They were only proposing at Carnaby-street an extension sufficient to last them up to 1901. They only desired to have 2,500 h.p. in addition to the 4,500 h.p. they possessed at present. He submitted that the Bill was really in the interest of the public, who had a right to be supplied with what electricity they required. If a nuisance were created and properties were injured thereby, the question would be how much compensation should be paid.

The room was then cleared while the committee remained for a short time in private deliberation. On the readmission of the public, the Chairman said they had decided to pass the preamble subject to the condition that Ganton-street should be widened. This would apply to that part of the street on which

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the new works would abut. As to the existing works, the question would remain open, and in the meantime the committee would visit the station. The committee also expressed a desire that as much notice as possible should be given to Messrs. Halsey and Davison.

The Central Electric Supply Bill.

On Monday last the same Select Committee commenced the consideration of the above-named Bill.

Mr. Balfour Browne, in opening the case for the promoters, said the object of the Bill was to confer on the Central Electric Supply Company, Limited, power to construct works and supply electrical energy, and for other purposes. The promoters were proposing to make a new generating station in the parish of Marylebone close to the Regent's Canal and the Central Railway. They were proposing to go outside their own district. The promoters were the St. James's and Pall Mall Electric Light Company, whom the committee had had before them, and the Westminster Company. The St. James's and Pall Mall Company had two generating stations, one at Carnaby-street and one at Mason's-yard, and the time would rapidly come when the capacity of these stations would be exhausted even with the new powers the company were obtaining. The two companies were combining to go outside their districts to make the proposed works on the Regent's Canal, in a most suitable position. This was in accordance with the report of the joint committee of last year. To connect the companies' work with the proposed station they would have to lay trunk lines through the streets, and the breaking up of streets was also in conformity with the report of the committee. These were the two principles which he propounded, and which were reported on in his favour in the report of the joint committee. The promoters were giving the Marylebone Vestry power to dictate the route which should be followed by the companies' wires. The Vestry asked for power to purchase the works, but they would not supply the Marylebone district, and such a proposal had never been contemplated in the Act of Parliament. If the petitioners were to receive power to buy the works it might enable them to supply not only their own district but half London. The promoters were ready to supply electricity in bulk to a large number of authorities far beyond Marylebone. They wished to be near the Regent's Canal with their new works, to be near the railway, and to have access to the canal to obtain water for condensing. As to the Westminster Company, it supplied St. George's (Hanover-square) and Westminster, including Mayfair, Hyde Park, and the Houses of Parliament. The two companies guaranteed the necessary capital. Each was to be entitled to a new supply from the proposed new works near the Regent's Canal between North-bank, Lodge-place, Grove-road, and near the proposed sidings of the Great Central Railway Company abutting on the Regent's Canal. The supply would be at cost price so long as they took equal amounts, but when one company wanted more than the other it was to pay, in addition, an amount sufficient to cover cost and capital.

Mr. Boulnois, M.P. for Marylebone, and member of the London County Council for East Marylebone, gave evidence in support of the Bill. He stated that he was a director of the Westminster Company, that the company required a new generating station, and that it was impossible to get it in their existing district. He did not believe the proposed works would be disadvantageous to Marylebone.

Prof. Kennedy, electrical engineer, also gave evidence in support of the Bill.

Tuesday's Proceedings.

Mr. S. T. Dobson, engineer to the St. James's and Pall Mall Electric Light Company, was called, and was examined by Lord Robert Cecil. He stated that the generating accommodation of his company was nearly exhausted, and as business increased it would be necessary to have new works. The Regent's Canal site was chosen last year, and would be a very convenient one. Instead of damaging the parish of Marylebone it would be a great gain, as it would give large rates and bring a large number of wage-earners into the district.

In cross-examination, the Witness said the electricity which it was proposed to generate would not necessarily be a continuous current. The promoters had not yet settled as to whether it would be a continuous or alternating current. If the current were continuous it would be at a high voltage. There were other companies, he believed, in this country supplying continuous-current electricity. It was done, to the best of his recollection, at Wolverhampton and Oxford. The combined requirements of the two companies would amount to 18,000 h.p., but authority was sought in the Bill to obtain between 40,000 h.p. and 45,000 h.p. The wires of the promoters would cross the chief transmission main of the Metropolitan Electric Supply Company.

So far as the County Council were concerned, the cross-examination went to show that the tendency, when the new works were constructed, would be to make the companies which took their electrical supply from the new works more and more dependent on those works for their supply.

Sir Frederick Bramwell said he had inspected the proposed site and considered it extremely suitable for a generating station. He could not imagine anything better. The proposed works would be far more advantageous than the existing generating stations, as the company would have admirable access by water and rail to their coal supply.

Mr. R. Vigers, surveyor, who was the next witness, said it was necessary that compulsory powers should be conferred on the promoters if they were to get the land they required at anything like a reasonable price.

This was the case for the promoters.

Mr. Worsley Taylor, Q.C., in opening the case for the London County Council, said his clients felt that questions of the very greatest public importance were raised by the Bill. They did not want for a moment to prevent this or any other company from extending the facilities they possessed for giving electric light to the public, but they did want to see that the powers given should be consistent with public policy as that public policy had been laid down in statutes. Did they know in the whole course of their experience a case in which Parliament had departed from that which had been the practice—namely, that, where there were compulsory powers granted to the company, as a *quid pro quo* for that grant there was something put on those who got them in the shape of obligation or regulation or both? The company for their own profit were asking for compulsory powers without incurring a single obligation to the public. There was nothing in the measure to prevent the promoters from becoming electric light undertakers, and, if they did, away would go the whole of the conditions laid down by Parliament in connection with electric lighting Bills.

Mr. Wallace, Q.C.: We only take power to supply eight people, who are named in the Bill.

Mr. Worsley Taylor said he did not want to make too much of that point, especially as there were larger questions behind. He objected to the promoters having their Bill without being under the ordinary obligations as to price, inspection, public safety, regulation of works, and so on. Under the general law it was not competent for the promoters to give preferential terms, and they would be bound to give a supply equally to everyone in the district. The go-by was given to all these provisions, and two companies, subject to all the conditions of the Acts of 1882 and 1888, would be able to get, to a great extent, out of them by this joint measure. He would ask the committee to hesitate before passing the Bill, but if they decided that the preamble was proved, he would urge them to insert clauses in the Bill for the protection of the public.

Mr. Benn, a member of the London County Council, formerly chairman of the Highways Committee of that body, said that he had been deputed to give evidence before the committee. He thought that in any Bill dealing with the supply of electricity in London, especially any measure proposing to supply electricity in bulk, adequate provisions should be inserted to enable some local authority to purchase the works at the expiration of a specified time. There should also be provisions in the Bill incorporating the regulations as to price and regulation inserted in ordinary electric lighting Bills under the Acts of 1882 and 1888.

Mr. E. R. Moore addressed the committee for the Metropolitan Electric Supply Company. He pointed out that his company generated electricity at Willesden, and carried their transmission main through Marylebone and Paddington for the supply of those districts. It was of importance that there should be no interference with that transmission main. He asked the committee to give his company protection against interference with their mains for the purpose of supplying Marylebone with electricity.

Mr. Talbot, Q.C., for the Marylebone Vestry, contended that adequate provision should be made for the protection of the rates of the petitioners. He also protested against the proposal to generate electricity for the six other companies (besides the two promoting companies) mentioned in the schedule.

Mr. Balfour Browne having replied for the promoters, the preamble of the Bill was declared proved.

For the above report we are indebted to the *Times*.

GLASGOW ELECTRIC TRAMWAYS.

REPORT BY MR. HORACE F. PARSHALL.

The following is the text of a report by Mr. H. F. Parshall to the sub-committee of Tramways Committee of Glasgow upon the system of generating and distributing the electric energy for the overhead system of electric traction. The report is dated London, Feb. 28, and reads as follows:

Complying with your request of Feb. 6, I have studied the

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conditions under which the Glasgow tramways have to be worked, and beg to submit the following report as to the most efficient and economical method of generating and distributing electricity for the overhead trolley system of electric traction :

Increase of Traffic with Electric Traction.—You are at present working in Glasgow 380 cars by horse traction and 27 by electric traction, and, having reference to your proposed extensions and the usual growth accompanying the conversion of horse traction systems into electric traction systems, 600 cars may be taken as a reasonable number to provide for in your generating and distributing arrangements. In fixing upon 600 cars as a basis, it might be well that I should emphasise the fact that such an increase in the number of cars is not unusual, and that the above contemplated service is not excessive. In the city of Boston, U.S.A., which is of somewhat less population and of not greater area than the city of Glasgow, double this number of cars are being operated at a profit. It would be a short-sighted policy to instal a system of generation and distribution which did not provide for such a growth as has been found usual, since, when the traffic has grown beyond the capacity of the plant originally installed, it is commonly found that provisions for an increased supply of power cannot be made except by an expenditure greatly beyond that which would have been originally required had the first arrangements been adequate.

Capacity of Generating Plant.—The consumption of power per car mile varies in different cities with the conditions as to permanent way, frequency of stops, gradients, etc. In your city the track construction adopted is admirably suited for electric traction, since the rails are of the best possible cross-section, and of ample weight. The policy of charging low fares which you have adopted increases the number of passengers carried per car mile, as well as the number of stops, the result being that the amount of power which would be consumed in Glasgow is greater than is consumed in many other cities. From actual measurements taken on your present electric traction works, I find your average consumption of power at the car is 7·2 kw., or 9·65 h.p. I have gone over the other lines in the city, and, having considered your traffic arrangements, have concluded that the above figure is a fair one to take for the whole system in general. Taking, therefore, 600 cars as the number to be reckoned upon, the amount of power to be delivered to the car for average working conditions is, approximately, 5,800 h.p. In traction systems the ratio of the average to the maximum load varies greatly at different hours of the day, on account of the stops for passengers and the number of passengers carried, also on different days according to the weather and other conditions. I have before me the load curve of a number of cities, and from these, as well as from your own experience, conclude that 60 per cent. should be added to the average working load to provide for the maximum load that would occur under normal working conditions in Glasgow. This means that the capacity of your machinery must be such as to deliver 9,250 h.p. to the cars, or, allowing for loss in transmission and distribution, approximately, 11,500 e.h.p. must be generated as a maximum working load at the power station. Taking 85 per cent. as the ratio of electrical horse-power at the 'bus bars to the indicated horse-power of the engine, the engine capacity for the maximum working load would amount to, approximately, 13,500 h.p. Allowing a safe margin for spare plant, an aggregate of 17,000 i.h.p. will be required in the generating station.

Conditions of Electrical Distribution.—Having determined the amount of power required for working the tramway system, it remains to be determined, having regard to the distribution of cars and frequency of service, whether the supply of energy for the cars can be more efficiently controlled and economically supplied from one central point or from several points. I have come to the conclusion that, in order to meet the conditions obtaining in Glasgow, you require several centres of distribution, for the following reasons : (1) the distances to which energy has to be conveyed are so great and varied as to preclude an economical supply at 500 volts ; (2) the maintenance of your own property in gas and water mains, and the conditions to be complied with in regard to difference of potential on the rails specified by the Board of Trade, would entail in the case of a single centre of distribution an elaborate and complicated return system, involving great outlay in cables and machinery, which would necessarily require sub-division into several comparatively small units to meet the varied conditions and the distances to which the cables would need to be carried. The importance of this point—that is, as to the working of the earth circuits under safe conditions—will be apparent when it is considered that in many American cities incalculable damage has been done to the gas and water pipes owing to electrolysis, which is brought about by the current straying from the rails. The amount of current that would be returned through your rails in Glasgow to a central point would be sufficient to eat away 50 tons of iron per annum from the pipes, which is a sufficient demonstration that the earth return is a point of primary consideration, if not the primary factor, in determining the nature of your distributing system. This becomes more evident when we consider that the maximum voltage drop allowed by the Board of Trade is seven volts, and that in some of the central streets in Glasgow, with the increased traffic contemplated, the drop would amount to 15 volts per mile, or double that which is allowed by the Board of Trade Practice has demonstrated that, under such conditions as those existing in Glasgow, a maximum voltage drop of not more than one-half of that permitted by the Board of Trade—namely, 3½ volts—is all that should be entertained. In other words, having reference to the safe conditions to be maintained in the track and return, in many cases in Glasgow the current should not be taken for more than half a mile from any point of distribution. Being satisfied that more than one centre of distribution is an economical necessity, I find, upon further investigation into the distribution of cars throughout the system, that your present requirements can be fulfilled from five centres of distribution.

High-Tension Generating Station, with Sub-Stations, v. Several Generating Stations.—Having determined the probable increase in traffic, the amount of power necessary to meet the demand, and that at least five centres of distribution are necessary, it remains to determine whether the energy can be the more economically supplied from a single station generating polyphase currents at high voltage, to be transformed into continuous currents at 500 volts in a number of sub-stations, or from the same number of generating stations, suitably located, and generating continuous currents at 500 volts. I have no hesitation in advising that, under the circumstances, the first—viz., the three-phase high-tension generating station, with sub-stations—is the more advantageous from every point of view. The following is a summary of the advantages of the one system over the other : (*a*) Less capital expenditure in buildings, generating plant, and in real estate investments. On the one hand, you have to provide a site for a generating station, and have a considerable latitude in the choice, inasmuch as there are several sites available at such a distance from the centre of Glasgow that the power can be economically transmitted at moderate cost in transmitting mains, and where you will be able to obtain the advantages of good coal delivery by more than one railway system, and where you will be able to provide for extensions. Another consideration of importance is that the sites now used as car sheds and stables are suitably located for sub-stations. No alterations would be required in the existing buildings, and the transforming apparatus would only occupy a small portion of the present floor space. On the other hand, the separate generating stations' scheme would involve the purchase of four or five sites, the choice of which would be limited, if fixed with due regard to the proper working of the tramway system and suitable railway sidings for coal supply. (*b*) The three-phase system has the advantage of less working cost and repairs. On the one hand, there is a skilled staff at the generating station, together with the unskilled labour at the several sub-stations. On the other hand, there is a skilled staff at each of the generating stations, which are equal in number to the sub-stations. It has been conclusively shown at Niagara, Dublin, Middlesbrough, and other places which have now been working a sufficient length of time so that reliable conclusions can be drawn, that rotary converters require less attention than ordinary 500-volt railway generators, and that no skilled labour is required. There is a saving in supplies and repairs, owing to the use of a few large steam generating units against numerous smaller ones. The concentration in load also effects a saving in fuel and water. Also better facilities as to coal-handling arrangements can be afforded in a single large station than in several smaller ones. I have made a careful comparison between the two systems, both as regards fixed charges and working costs, and append the statement to this report. (*c*) The three-phase system has greater flexibility and is better adapted to the requirements of future extensions. Should your lines extend further in any direction into the country, sub-stations can be installed at any convenient point or points. These sub-stations do not require special buildings, and to show the small space occupied, I may say that the 2,500-h.p. stations of the Central London Railway are contained in two vertical cylinders 22ft. in diameter and 100ft. below the surface of the ground. (*d*) In considering the transition from horse traction to electric traction, the question of time is of great importance. The single generating station which I have recommended can be installed and put in working order more quickly than several stations. The loss through delay can be estimated upon the basis of your present working. The cost for horse traction is 3½d. per mile, on a mileage of 9,000,000 per annum ; taking the working cost for electric traction on the same basis as to maintenance, etc., the saving, assuming no increase in traffic, amounts to £112,000 per annum. In addition to the above, in installing a multiphase station you would be following the very latest and most approved practice, and would be installing a type of plant that would be less likely to be superseded than a 500-volt type of apparatus, and which would have to be installed in several minor steam-generating stations. This is clearly shown by the experience gained in New York, Chicago, and Brooklyn, where, under the original arrangements, the area was served by several small stations. It has been found that these small stations can be worked with greater economy by multiphase currents transmitted from a single generating station. I have before me the works cost of some of these installations, and there is no doubt of the economy gained.

Nature and Arrangement of Plant in Generating Station.—In the event of my recommendations as to a single generating station being adopted, the following further recommendations as to the arrangement of the plant may be of use: For your traction purposes there would be consumed in Glasgow, approximately, 26 millions of Board of Trade units per year, or, approximately, four times as much as that generated by the largest lighting company in London. Owing to the small ratio between the average and maximum load—that is, to the load factor common to traction systems—this amount of electricity would be generated in a plant of nominal capacity of not more than one-third at which it could be generated in a lighting station, owing to the machinery working at its full capacity for many hours in a day. In Glasgow you would be working the cars, approximately, 16 hours per day at full service, and four or five hours per day additional at one-third service. This distribution of load for so many hours per day would be very satisfactory, in that your generating station

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could be designed with but few units working at the best economy during all hours in the day. I find that four generating sets would give the best result—three of these to be worked during normal conditions of loads, and the fourth unit to provide for abnormal conditions and emergencies. With regard to the engines, I would recommend the use of three-crank tandem compound engines, provided with massive flywheels so as to give a uniform turning moment, and to provide the maximum effort for uctuations of load. These engines should not, for best results, work beyond 75 revolutions per minute, and should be especially constructed having in view the nature of the load and the conditions peculiar to an electric traction system. The engines should be direct connected to tri-phase generators of the flywheel type, with rotating magnets and stationary armatures. Machines of this type have been constructed, with entirely satisfactory results, for as high a working pressure as 13,000 volts. Having reference, however, to the comparatively short distance of transmission, and the small investment in copper required, 6,500 volts is a satisfactory working pressure, all conditions considered, and the calculations as to cost of three-phase machines and transformers is made up on this supposition. The station should be provided with automatic coal-handling plant, so that the coal would be handled automatically from the place where it would be dumped from the railway sidings. The station should be designed with electrically-driven auxiliaries throughout, thereby securing the greatest possible economy. The switching arrangements in the generating station would be comparatively simple, owing, first, to the small number of generating units; and, secondly, to the number of outgoing cables being few as compared with that required in a lighting system of the same capacity, or, in fact, a 500-volt tramway system with its numerous feeders running to various points of supply. The method of distributing the energy from a single station need not occupy much space in this report. The method you have already adopted in Glasgow—namely, of drawing your cables into ducts and manholes, approximately 100 yards apart—represents the best practice in electric traction. You will find that at from 400 to 600 amperes per square inch, according to the distance, high-tension cables can be run through the same set of ducts, but where they enter the same manhole, the manhole should be of ample size, so that the high-tension cables could be carried on one side, and clear the low-tension cables.

Comparison of Lighting and Tramway Plants.—In reporting upon the generation of power for the tramway department, it is scarcely possible to avoid reference to the question of joint supply of electricity for the two purposes of traction and lighting. I find that on a large scale the two systems can be kept separate with advantage, owing to a difference in the nature of the plant and in the supply of power. The following are points which militate against a joint supply from lighting stations: (*a*) On many days in the year the maximum load in lighting and that in traction occur at the same time so that the same maximum total capacity in plant has to be provided whether or not the supply is from a common station. (*b*) Owing to the different nature of the loads, the capital cost for a given watt-hour production is three or four times as great for lighting as it is for traction; in other words, in traction apparatus it is worked at its greatest capacity three or four times as many hours in the year as is lighting apparatus, consequently it can be of a more substantial type with advantage. (*c*) That machinery of a different type is commonly used for lighting, and the switching appliances are absolutely different. In the Glasgow lighting stations numerous small high-speed engines are in use; such engines are unsuited for the generation of current for your electric traction purposes. I have yet to find the engineer of extended experience in dealing with traction matters who would propose the use of high-speed engines for such loads as you have to consider in Glasgow for electric traction. (*d*) The electrical arrangements for electric lighting are necessarily much more complicated and elaborate than is the case for electric traction. Electric lighting has to be carried on with reference to the delicacy of the human retina—in other words, the voltage at the point of consumption has to be regulated to a nicety. In electric traction the same conditions do not obtain, since uniform acceleration and speed of the car can be obtained to the satisfaction of the passenger within a much greater range of voltage. (*e*) From a business point of view, the different conditions in electric supply are sufficiently shown by the difference in cost of energy between electric traction and electric lighting. The cost of energy for electric traction, owing to the better load factor, would not be more than 25 per cent. of that for lighting. The present cost of electric lighting in Glasgow is 1·26d. per Board of Trade unit, which does not compare unfavourably with that of lighting for other cities. This figure is 4·8 times as high as would be expected in the traction service outlined. When you consider that in Edinburgh, according to published accounts, current is generated cheaper than in any other city in the United Kingdom, and this cost is 2·95 times that which I predict for your traction system, the difference in the nature of the load is apparent. (*f*) It has been suggested that economy in staff will be gained in a joint station. This does not apply provided the tramway business is attended to as a business by itself. In the station which I have outlined this staff will, as I have said, be regularly employed during the 16 hours of the day at practically full load, and during five more hours at one-third load, so that the staff would be fully occupied during the hours of working. Owing to the difference in the nature of load, a different class of attendants would be required for the two classes of work.

Combined Stations in other Towns.—A combined station for lighting and traction was the subject of consideration by the Bristol Tramways and Carriage Company, Limited, also by the Corporation of Sheffield. I was asked to report on the former installation, and found that there would be direct disadvantages in such a joint supply. This report subsequently received the endorsement of Lord Kelvin and the late Dr. John Hopkinson. The general absence of such combined stations indicates sufficiently that they are not in demand, as is also the fact that plant of a type now commonly used for lighting, which were originally installed for traction purposes, have been superseded by slow speed machinery. There are are two prominent examples of such plant which have been from time to time discussed—viz., the one at Toledo, Ohio, U.S.A., and the other at Hamburg. The former makes use of slow-speed engines of a type suitable for electric traction. To the main shaft of these engines are direct-connected railway generators. The flywheel of this machine is connected by a rope-drive to countershafts, from which are driven several different types of machines, principally alternators and arc-lighting machines. The station is exceptional in character, is wasteful in floor space, and employs a method of driving lighting machines which has been generally superseded in England, and could not be followed out except by mechanical arrangements, which are necessarily wasteful and objectionable. The station at Hamburg is designed with slow-speed type of plant suitable for your electric traction work. It makes use of storage batteries to equalise between the traction and lighting loads. There was a complaint at the beginning that the station arrangements did not keep pace with the traction requirements, and the subsequent arrangements have been in the direction of increasing the capacity of the station from a traction point of view, and in purchasing machinery especially suited for traction purposes. These two stations, however, cannot be taken as examples to be followed by Glasgow. With the exception of the stations referred to, the general practice, on a large scale, is to have the plant for the two systems separate.

General Conclusion.—The conclusion arrived at in this report may be summarised as follows: Having regard to the nature of your tramway system as a whole, a single generating station, with high-tension multiphase transmission to sub-stations located in some of your existing car sheds and stables, will be found the most economical to work, involves less capital outlay, takes less time to instal, lends itself to complying with the Board of Trade requirements, and the safety of your property in gas and water mains, and is of a type least likely to be superseded when further demands are made, either as an increase in the area to be served, or increase of traffic over the existing system. In following my recommendations, you will be setting out with an installation of the highest class, and will be unhampered by trying to make use of plant or arrangements that are either obsolete or unsuited for the economical working of your system of electric tramways.

COMPANIES' MEETINGS AND REPORTS.

BRITISH ELECTRIC TRACTION COMPANY, LIMITED.

On Saturday the third ordinary general meeting of this Company was held at Donington House, Norfolk-street, Strand, under the presidency of Sir Charles Rivers Wilson, G.C.M.G., C.B. The report and abstract of accounts appeared in our last issue.

The **Chairman** said when he last had the honour of meeting them he ventured the prediction that the balance-sheet which would be presented on the present occasion would show the Company to be in a very strong position. He was happy to think that his prediction had been realised, and he thought that this was a view which would be shared by all present. The year had been one of very great labour, accompanied by certain anxieties, and they had had to encounter very great obstacles. A great deal, however, had been accomplished, and he thought they might consider that they had prepared the ground for a series of large and, he trusted, very successful operations in the future. Having referred to several items mentioned in the report, and which have already been published, he alluded to the goodwill account. Last year this stood at £15,000, and they proposed this year to write off £5,000, thus leaving it in the books at £10,000. The directors proposed gradually to extinguish this account. An enormous amount of work had been done which was not represented in the accounts at all. The Company had not only made a satisfactory profit, but it had built up a great organisation, which would serve the purpose of creating and carrying on a great business in the future. After paying or providing for the dividend on the preference shares up to the end of last year, a balance of £53,451 was left to be dealt with. As the proposed dividend of 6 per cent. on the ordinary shares for the year would only absorb £18,000, leaving £35,000 to be carried forward to the next account, some shareholders might think the directors had erred on the side of extreme prudence, and that they ought to distribute a larger dividend. But this matter had given the Board much anxious consideration, and while they were quite satisfied that the profits had been fully earned, and that if they could be quite sure of the future there would not be any objection to a larger dividend, yet in view of the fact that they were developing a large business, and one not altogether free from uncertainties, they thought it would be better to put the Company in a thoroughly sound and impregnable financial position, because by so doing they would obtain the best possible security of a continuance of profitable business and increased dividends. They were working largely for the future, and he thought they would share the opinion of the Board that it would be suicidal for the shareholders to take the

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whole of their profits now, and thereby sacrifice the benefits to come. Moreover, as he had said on a previous occasion, the full development of this business required large increases of capital. There was another consideration also. If they would turn to the accounts, they would see that the charge for dividends during the past year amounted to only £21,448, whereas the charge for dividends in the coming year upon the capital actually issued, and without taking into consideration a charge that might accrue in respect of future issues, would be £46,000. There was also one other consideration. They thought it was very desirable that they should at least equalise their dividends in the future, quite irrespective of any increase, and he felt sure he should have the concurrence of those present in the very conservative policy pursued in this particular. Turning to the capital account, he referred to other items already published, and went on to remark that at the present moment they had a reserve fund of something like £75,000 which it was intended to invest in Consols and first-class securities. Now that the whole of their share capital had been subscribed, they considered it advisable that the shareholders should give the directors the necessary power to make further issues as and when they might deem advisable. They would not needlessly increase the capital, but it would be a regrettable thing if they were not in a position to take up any good business that might be offered to them. The proposal which they would submit at the extraordinary meeting which was to be held at the close of the present meeting was to double the share capital. This would give the directors power also to double also the present issue of debenture stock, which would certainly be sufficient to carry them on for the present. He would now like to say a few words on the subject of contracts and undertakings. The list, as they would see from the report, embraced undertakings from Devonport, Poole, and Brighton in the South, to Greenock in the North, and there was scarcely a division in the British Isles in which the Company was not carrying on its operations. Taking the Potteries Electric Traction Company as a sample, that company, which had a subscribed capital of £400,000, were carrying out electrical tramways and light railways extending over a distance of 34 miles. Having mentioned the Swansea Improvements and Tramways Company and other undertakings in which their Company were interested, he remarked that on referring to the appendix of the report they would see there were a large number of other undertakings which were in course of development, and an important point in connection with all these separate undertakings was that although for various legal and other reasons it was necessary to carry out these works by means of separate companies, yet most or all of those companies were under the control and management of the British Electric Traction Company. Each company only bore its fair proportion of the total expenses. The result was that they obtained the best and most efficient expert administration at a very much smaller cost than otherwise would be the case. As their first efforts were to make these companies successful, the shareholders belonging to them not only had a very good security, but this Company would permanently have many sources of income. Turning to the question of the Company's investments, he remarked that, as by far the largest part of their capital was invested in debentures and shares in associated and other companies, it was important that they should be able to feel satisfied that these investments were sound and remunerative, and when he told them that they covered a list of no less than 40 companies they would have no cause to fear that all their eggs had been put into one basket. He believed he was not mistaken in asserting that every one of their investments was a satisfactory source of profit, and care was taken in making them to obtain an immediate minimum return. It was not so much at present for the sake of investment, however, that they put their money into these companies, but rather with a view of developing electric traction and the business of their company. They had first of all to teach the existing tramway companies that it was to their own interest to adopt electric traction, and when they had succeeded in doing this they had to approach the local authorities and persuade them to allow electric traction to be used. In each case they were met with some misgiving and suspicion, and in the case of local authorities they were brought face to face with the difficulty caused by the present tendency of municipalities to undertake trading operations. Municipalities had not the enterprise or the initiative to propose electric tramways, but directly the Company approached them with proposals to improve the service of the tramways in their towns or to provide additional tramway facilities, it at once occurred to them that the Company, being a commercial body, would not make such proposals if they were not likely to be profitable. And then the authorities wanted to know why, if a profit was to be made, they should not make it themselves. But though they did not know really how to go about the business, they did not hesitate to negotiate with the Company—to pick their brains, in fact—and when the Company had given information, they frequently decided in favour of a policy of what was called municipalisation, on the ground that this was in the interests of the ratepayers. But the curious thing about this cry of municipalisation for the benefit of the ratepayers was that in most cases where corporations had thus municipalised commercial undertakings the rates did not go down, but, on the contrary, steadily increased. On a former occasion when he addressed them on this subject, he referred to the difficulties which corporations had in municipalising tramways and light railways when worked by electricity, because these undertakings sometimes required to be carried beyond municipal boundaries. The directors' further experience of these difficulties had convinced them that if the development of this enterprise in this country was to be in the hands of local authorities, we should never have the tramways and light railway facilities which other countries possessed. He might say much more on this subject, but it would suffice on that occasion to tell them that the Government had realised some of the difficulties he had referred to, and had decided to appoint a joint committee of both Houses of Parliament to consider what should be the proper sphere and scope of municipal enterprise. He might just add *apropos* of this question that the Company did not propose to confine their operations entirely to England, Scotland, and Ireland, but were looking outside these islands, and hoped to obtain a share in profitable undertakings in foreign countries, or, still more probably, in some of our colonies. He insisted that in the opposition they encountered from local authorities there was a sort of object lesson, showing how that opposition had a tendency to drive away British enterprise and British capital out of this country. The Board proposed in future to keep up the accounts of the Company to the end of March each year. This would enable them to include in their profit and loss account the results of the year's working by the various companies in which they were interested.

Mr. Emile Garcke seconded the motion.

Mr. Makins said he wished to suggest whether they could not have half-yearly dividends, or at any rate, an interim report.

The **Chairman** remarked that he was the very first to desire in all cases to be in close touch with the shareholders. At the same time, there were reasons which, he thought, would commend themselves to the shareholders generally which would rather conflict with the too frequent publication of their operations. If, however, there were any of the shareholders who might require information, the office was open to them, and the best attention would be given by their officers. But he thought they would agree with him that it was not desirable to make too frequent public reports.

In reply to a question as to the manner in which control was exercised over the various companies,

The **Chairman** explained that this was done by obtaining a preponderating majority of the Board in each case—sometimes the whole of the Board, represented by the Company's own directors, or their own officers—therefore they had the complete control, if not the entire management, of these undertakings, and in so appointing their officers and directors as administrators of these companies they did not allow them to receive any fees whatever. The fees were received and paid into the treasury of their own Company.

The motion having been carried,

An extraordinary general meeting was then held, when

The **Chairman** proposed the following resolution: "That the capital of the Company be increased from £600,000, divided into 60,000 shares of £10 each, to £1,200 000, divided into 120,000 shares of £10 each, by the creation of 60 000 new shares of £10 each, and that the following provisions shall apply to such new capital—namely: (*a*) that 30,000 of the new shares be called preference shares and 30,000 ordinary shares; (*b*) that the new preference shares be entitled to a cumulative preferential dividend at such rate not exceeding 6 per cent. per annum, as the board of directors may before issue thereof determine; (*c*) that save as aforesaid the 60,000 new shares be treated as part of the original capital of the Company."

Mr. Makins moved as an amendment, "That all new shares shall be offered to members in proportion (as nearly as conveniently can be) to the existing shares held by them, and such offer shall be made by notice specifying the number of shares to which the member is entitled, and limiting the time within which the offer, if not accepted, will be deemed to be declined; and after the expiration of such time, or on receipt of an intimation from the member to whom such notice is given that he declines to accept the shares offered, the board of directors may dispose of the same in such manner as they think most beneficial to the Company."

The **Chairman** wished the meeting to understand at once that it would be quite impossible for the Board to accept this amendment as a binding instruction. In the matter of convenience especially it was most essential that discretion should be left to the directors to be justified in its application afterwards when they met the shareholders. There was a great deal to be said for the occasional adoption, it might be, of the practice indicated by the amendment, but to impose on the directors a standing application under all circumstances without reservation to offer the shares to shareholders, it was a matter that they did not think would be advisable in the best interests of the Company. They had not obtained that assistance from their shareholders in the past which would have enabled them to do without the help of the outside financial world, and he proceeded to furnish illustrations in support of this. The shareholders had not yet perhaps acquired that complete confidence in the undertakings as would justify the directors in looking to them always to find the capital required. There was a good deal to commend itself to him in the proposal of Mr. Makins, but what he deprecated was that it would be imposed upon them as a definite practice. It was premature, however, to press it upon their notice at the present time, and he therefore urged that the shareholders would not bind or fetter them by adopting it.

Mr. Makins gave his reasons for submitting his motion, and said that, in addition, there were one or two questions which he would like to ask, but not out of any ill-feeling to the directors. The first question was as to whether there was any necessity to pay for the services of another company to undertake the issue of any new capital, which would have been readily taken up by the shareholders of the British Electric Traction Company, and why? It was also asked whether any director of that Company was also a director of the company employed in the late issue, and if so whether this was not injudicious? Also, how many shares

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were issued to the shareholders of the British Electric Traction Company?

A **Shareholder** said, in regard to debentures, he made an application for £100 first issue and his money was returned, although the form came from the secretary of that Company, and it was well known that he was a shareholder.

The amendment having found a seconder,

The **Chairman** said that Mr. Makins had failed to convince him of the necessity for fettering them with such instruction, and he could only repeat that the time might come when they could repose much more upon their shareholders than they had done in the earlier career of the Company. But he could not expect, and had no reason to expect, that their comparatively small body of shareholders would be able to guarantee the very large undertakings and very large amount of capital which they would have to issue. There was a very great element of danger involved in the application of this principle proposed to them. What was to happen if, under certain circumstances, they had to put down a large amount of securities and the shareholders did not adequately respond to the application? They would have lost the assistance and incurred the hostility of their financial friends; the public would not come in, and it would be a most serious matter. If the amendment was passed, the board of directors would have most seriously to consider their position and what line they would adopt. It would place them in the most serious of difficulties, and he deprecated in the strongest manner their having their hands tied in this way. Having said so much he could only appeal to the good sense of the meeting and ask them to give judgment as to whether it would be wise to impose this upon them. There was only one observation he need refer to, and he referred to it with regret and mortification. An enquiry was made as to whether it was the case that one of the Board was connected with the Electric and General Investment Company. He (the chairman) was understood to suggest that it was perfectly true that Mr. Garcke, to whom they owed almost exclusively the successful result of their Company, was so connected. He, however, protested in the strongest possible manner against such an observation.

Mr. Makins said he did not cast that imputation on Mr. Garcke at all.

The **Chairman** said he certainly understood and took the observation as implying a reflection, and he therefore protested in the strongest manner.

Mr. Makins remarked that he did not mean it at any rate. He then asked to be allowed to withdraw the amendment, and to say that when this new capital was issued that they were perfectly prepared to take it up.

The **Chairman** thought Mr. Makins had acted with great wisdom, and thanked him on behalf of the Board.

The amendment having been withdrawn, the original motion was carried.

DOVER ELECTRICITY SUPPLY COMPANY.

The annual meeting of the Dover Electricity Supply Company was held last week at the Board-room, Park-street Station.

The **Chairman** (Sir W. H. Crundall, J.P.), in presenting the report, which appeared in our last issue, and which was adopted, said the result of last year's trading showed steady progress as compared with former years. In 1895, their first year, the loss had been £955; this was reduced to £455 in 1896, and in 1897 there was a profit of £1,127; and last year a profit was made of over £2,000, which was equal to 2½ per cent. on their ordinary capital. They had placed everyone of their ordinary shares, had extinguished their loan, and hoped to make some arrangement during the current year to extinguish the debit of the profit and loss account. He hoped that they would earn a 5 per cent. dividend on this year's work, and so progress at the same ratio. They had now connections with 12,500 8-c.p. lights in addition to their traction plant. Power for about 26,000 8-c.p. lamps remained still, which was equivalent to double the power over what they now utilised. Therefore, with a very small extra expenditure, they could practically double their income, and in addition to that, with a small extra expenditure in the works, treble it. During the last four weeks the directors had been able to complete arrangements for a contract for lighting and the supply of a certain amount of power with Messrs. Pearson and Son, the National Harbour contractors, and they looked forward to a large increase of income from that source. In addition to that, they had received 50 per cent. more applications from private consumers up to the present time this year as compared with the same period last year.

The re-election of the retiring directors, Sir W. Crundall and Mr. Van Tromp, and of the auditor, Mr. R. H. March, was carried, and a vote of thanks to the chairman concluded the proceedings.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING COMPANY, LIMITED.

Directors: The Right Hon. Lord Rathmore (chairman); J. B. Braithwaite, jun. (deputy-chairman); Emile Garcke; Frederick W. Reynolds; Aymor H. Sanderson; Francis E. Savory; Joseph Shaw; R. Percy Sellon; B. H. Van Tromp. Engineer and manager: A. J. Lawson, M.I.E.E. Secretary: H. B. Renwick.

Report of the directors (with abstract of accounts) to be presented to the shareholders at the fifth ordinary general meeting of the Company to be held at Winchester House, Old Broad-street, E.C., on Monday, March 27, 1899, at 12.30 p.m.:

The capital expenditure during the year in respect of the Company's London districts amounted to £148,797. 16s. 2d., making the total expenditure on account of those districts up to Dec. 31 last £562,587. 6s. 2d. This expenditure was met mainly by the balance of instalments falling due on the 10,000 ordinary shares issued at par, and allotted *pro rata* to the ordinary shareholders on Dec. 6, 1897. The net revenue for the year, including the balance from last account, and after payment of proportion of rents, rates, taxes, interest, and general establishment charges, is £17,375. 18s. 6d. Out of this sum an interim dividend on the preference shares for the half-year ended June 30 last, at the rate of 6 per cent. per annum, has been paid, and the directors now recommend that a further dividend on the preference capital for the half-year just ended be declared at the same rate. This will leave a balance of £5,775. 18s. 6d., which it is proposed to carry forward. In the above amount nothing is included for the considerable increase in value that has taken place in the Company's investments, which stand in the balance-sheet at cost. The Company is promoting a Bill in the present session of Parliament, the main objects of which are to enable the Company to obtain compulsory powers for acquiring lands and securing rights of way for the purpose of connecting its various London districts. A special resolution approving this Bill was passed at an extraordinary general meeting of the shareholders held on Jan. 16, 1899, and confirmed at a subsequent extraordinary general meeting held on Feb. 13 last. The directors have appointed Mr. Joseph Shaw to a seat on the Board to fill the vacancy created by the retirement, in 1896, of Mr. W. C. Braithwaite. The retiring directors are the Right Hon. Lord Rathmore and Mr. F. W. Reynolds, who are eligible for re-election. The auditor, Mr. R. H. Marsh, also retires, and is eligible for re-election.

London Stations.

St. Luke and Clerkenwell and Eastern Holborn.—The net revenue for the 12 months ended Dec. 31, 1898, amounted to £2,158. 13s. 2d. In these districts the total applications to Dec. 31 last, including power, represented the equivalent of 43 599 8-c.p. lamps, of which 36 303 were then connected to the mains. The applications for the year represented an increase of 18,769, and the connections 12,456. At the same date 35 users of motors, aggregating 128 h.p., were supplied from the Company's mains, and further applications have since been received, raising the total to 60, representing 273 h.p. To meet the growing demand for power, special plant for the generation of continuous current capable of supplying 1,500 h.p., is in course of erection, which will make, with the power plant already at work, an available total of 2,000 h.p.

Western Holborn and St. Giles.—The provisional order for the parts of these districts lying to the north of High Holborn and New Oxford-street, and having Tottenham Court-road as the western boundary, granted by the Board of Trade in 1897 was confirmed in the last session of Parliament. The laying of mains in the district has been commenced, and a supply of energy, both for lighting and power purposes, will be available at an early date. The Company also holds orders confirmed by Parliament for Mile End Old Town, St. George's-in-the-East, and the district of the Limehouse District Board of Works, all of which it is intended to supply from the City-road station.

Wandsworth District (including the parishes of Putney, Wandsworth, Clapham, Streatham, and Tooting).—The net revenue for the 12 months ended Dec. 31 last amounted to £4,958. 18s. 11d. Applications for the equivalent of 32,636 8-c.p. lamps had been received at Dec. 31 last, of which number 28,914 were then connected to the Company's mains. The increase in lamps applied for during the year was 15,802, and in lamps connected 15,007.

Camberwell.—The street work in this district has been unavoidably delayed through various causes beyond the directors' control, but it is expected that a supply will be available by June next, a right of way through Lambeth having been obtained. The equivalent of 3,041 8-c.p. lamps were applied for at Dec. 31 last.

St. George-the-Martyr.—The work of laying mains in the compulsory streets in this district is in progress, and the supply of current will be commenced at the same time as in Camberwell.

St. Olave.—The works in this district will be commenced forthwith.

Investments in Provincial Electricity Supply Companies.

Bournemouth and Poole Electricity Supply Company, Limited.—This Company has declared a dividend on the ordinary share capital at the rate of 4 per cent. for the year ended Dec. 31 last.

Dover Electricity Supply Company, Limited.—In the third completed year of the working of this station the gross profits amounted to £2,133. 7s. 11d., as against £1,127. 17s. 5d. in 1897, and the Company is rapidly improving its position. The equivalent of 11,490 8-c.p. lamps were connected to the mains at Dec. 31 last, showing an increase of 1,353 for the year, and applications representing a further 208 were then awaiting connection. The supply of power by this Company to the Corporation for its municipal electric tramways amounted in 1898 to 179,844 units, and is rapidly increasing. A contract for the supply of current for a term of years for both lighting and power to the contractors for the National Harbour works has been entered into.

Richmond (Surrey) Electric Light and Power Company, Limited. The balance to credit of net revenue account, including the amount brought forward, and after payment of interest charges, depreciation and reduction of suspense account, is £1,340. 12s. 4d., which allows the payment of a dividend on the ordinary shares of the Company at the rate of 4 per cent. for the year, less income tax, as against 3 per cent. for the previous year. The equivalent of 12,352 8-c.p. lamps were connected to the Company's mains at Dec. 31 last, showing an increase of 2,840 8-c.p. lamps connected for the year.

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Dr. Revenue Account.	£	s.	d.
Proportion of directors' remuneration, salaries and wages, rents, rates, taxes, and insurance	3,342	0	6
Printing and stationery, and postage	372	12	7
Sundry charges, including legal and travelling expenses	615	18	5
Auditors' fees	105	0	0
Depreciation of office furniture	135	8	0
Interest paid on temporary loans	1,915	11	2
Balance carried to net revenue account	7,285	4	4
	£13 771	15	0
Cr.			
Gross profits derived from interest on investments, rents, discounts, and administration of associated companies	3 996	11	9
Transfer fees	95	10	0
Dividends receivable	2 562	1	2
Balance from revenue accounts	7,117	12	1
	£13,771	15	0

County of London (North) Electric Lighting Order, 1892.

Revenue Account.

Dr. Generation of Electricity.				£	s.	d.
Engineers' salaries and wages	£1,523	1	9			
Coal and other fuel	2,466	13	2			
Oil, waste, water, etc.	520	12	2			
Station lighting, etc.	358	2	11			
General charges	99	16	11			
Repairs: buildings, £8. 1s. 11d.; engines and condensers, £385. 19s. 11d.; steam-pipes, £101. 2s. 1d.; boilers, etc., £385. 15s. 8d.; dynamos, £27. 1s. 3d.; accumulators, £26. 8s.; other machinery, tools, etc., £75. 7s. 9d.	1,009	16	7			
				5,978	3	6
Distribution of Electricity.						
Engineers' salaries and wages	360	16	0			
Repairs	28	14	4			
General charges	49	18	6			
				439	8	10
Rents payable	644	10	4			
Rates and taxes	995	11	1			
Insurance	55	19	2			
Depreciation of meters	174	16	4			
Stationery and printing	60	8	5			
Audit fee—Board of Trade	49	0	0			
				1,980	5	4
Balance profit carried to revenue account				2,045	13	1
				£10,443	10	9
Cr.						
Gross receipts from sale of current, £12,337. 14s. 9d.; less abatements under the Company's sliding scale, £2,555. 8s. 3d.				9,782	6	6
Rental of meters				349	12	9
Rents receivable				311	11	6
				£10,443	10	9

County of London (Northern Extensions) Electric Lighting Order, 1897.

Revenue Account.

Dr. Generation of Electricity.				£	s.	d.
Engineers' salaries and wages	£114	10	5			
Coal and other fuel	185	12	9			
Oil, waste, water, etc.	38	5	9			
Station lighting, etc.	26	19	0			
General charges	7	8	1			
Repairs: buildings, 11s. 2d.; engines and condensers, £29. 1s.; steam-pipes, £7. 11s. 2d.; boilers, etc., £28. 19s. 7d.; dynamos, etc., £2. 0s. 7d.; accumulators, £1. 19s. 2d.; other machinery, tools, etc., £5. 13s. 4d.	75	16	0			
				448	12	0
Distribution of Electricity.						
Engineers' salaries and wages	71	10	5			
Repairs	2	2	0			
General charges	3	14	1			
				77	6	6
Rents payable	38	15	0			
Rates and taxes	74	18	0			
Insurance	4	4	1			
Depreciation of meters	14	4	2			
Stationery and printing	4	11	0			
				136	12	3
Balance profit carried to revenue account				113	0	1
				£775	10	10
Cr.						
Gross receipts from sale of current, £937. 8s. 1d.; less abatements under the Company's sliding scale, £190. 5s. 7d.				747	2	6
Rental of meters				28	8	4
				£775	10	10

Wandsworth Electric Lighting Order 1892.

Revenue Account.

Dr. Generation of Electricity.				£	s.	d.
Engineers' salaries and wages	£1,177	7	2			
Coal and other fuel	1,999	0	3			
Oil, waste, water, etc.	508	1	10			
Station lighting, etc.	192	8	11			
General charges	125	1	10			
Repairs: buildings, £32. 1s. 11d.; engines and condensers, £235. 9s. 6d.; steam pipes, £26. 18s. 5d.; boilers, etc., £337. 14s. 8d.; dynamos, £16. 15s. 1d.; other machinery, tools, etc., £31. 5s. 7d.	680	5	2			
				4,682	5	2
Distribution of Electricity.						
Engineers' salaries and wages	405	6	8			
Repairs	34	5	1			
General charges	62	14	5			
				502	6	2
Rents payable	75	7	6			
Rates and taxes	481	6	10			
Insurance	42	9	5			
Depreciation of meters	186	15	11			
Stationery and printing	67	13	9			
Audit fee—Board of Trade	45	0	0			
				898	13	5
Balance profit carried to revenue account				4,958	18	11
				£11,042	3	8
Cr.						
Gross receipts from sale of current, £11,927. 12s. 11d.; less abatements under the Company's sliding scale, £1,334. 9s. 1d.				10,593	3	10
Rental of meters				373	16	10
Rents receivable				72	1	0
Testing fees				3	2	0
				£11,042	3	8

Statement of Electricity Generated, Sold, etc.

County of London (Northern Districts).	
Quantity generated in B.O.T. units	604,092
Quantity sold to private consumers by meter	447,078
Quantity used on works	31,279
Total quantity accounted for	478,357
Quantity not accounted for	125,735
Total maximum supply demanded (kilowatts)	484
County of London (Southern Districts).	
Quantity generated in B.O.T. units	581,270
Quantity sold to private consumers by meter	471,397
Quantity used on works	19,560
Total quantity accounted for	490,957
Quantity not accounted for	90,313
Total maximum supply demanded (kilowatts)	659

SOUTH LONDON ELECTRIC SUPPLY CORPORATION, LIMITED.

Directors: George Ellis, Esq., J.P. (chairman); Captain E. Ironside Bax (managing director); Bennett Fitch, Esq., M.I.C.E.; W. W. Phipps, Esq.; Algernon Turnor, Esq., C.B. Secretary: Sidney H. Webster, Esq. Engineers: Messrs. Kincaid, Waller, and Manville.

Report of the directors presented to the ordinary general meeting of shareholders held at Winchester House, E.C., on March 21, 1899:

In making their second annual report to the shareholders, the directors are pleased to be able to state that good progress has been made in developing the Corporation's undertaking. The buildings comprising the dust destructor, engine-house, coal store, and workshops are nearly completed. The boilers are already in position, whilst the necessary steam-pipes, electrical plant, storage batteries, engines, and steam alternators are in course of construction, and should be delivered in a few weeks. Permanent offices have been erected at the works, in which the staff of the commercial and technical departments will be concentrated. The present temporary offices in Victoria-street, Westminster, will be vacated on the 25th inst. After thoroughly investigating the probabilities of finding water, your directors decided upon sinking an artesian well at the Corporation's site. The result has been most satisfactory, the engineers reporting a test showing that at least 5,000 gallons of excellent water per hour can be depended upon. The total cost of boring and equipping the well will amount to less than £1,000. This will save a considerable annual expenditure for water. The work of laying the mains has proceeded with great rapidity. The length of roadway in which mains have been laid now reaches 22 miles, making about 68 miles of ways, into which upwards of 37 miles of cable have been drawn. In pursuance of the policy alluded to in their last report, the directors have been able to supply electricity to a large number of lamps, pending the construction of the generating station, by connecting the Corporation's mains to those of the County of London and Brush Provincial Electric Lighting Company, Limited, whose supply has at all times been most efficient. It must be borne in mind that this policy has been adopted with the view of forming the nucleus of a business, and not in the expectation of

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earning immediate profit. When the works are opened the lamps of the numerous consumers already connected will at once provide a load for the machines, there being at this date on circuit the equivalent of upwards of 15,000 8-c.p. lamps, with applications in hand for a further 2,500. As the undertaking is still in its constructional stage, the accounts cannot yet be drawn up in the Board of Trade form. A revenue account is appended, the balance of which has been carried into the general balance-sheet. In accordance with the articles of association, two of the directors W. W. Phipps, Esq., and Algernon Turnor, Esq., C.B., retire, but, being eligible, offer themselves for re-election. The auditors, Messrs. Price, Waterhouse, and Co., also retire, and, being eligible, offer themselves for re-election.

Dr.	Revenue Account.	£	s.	d.
Purchases of electric current		1,905	2	6
Proportion of salaries and meter readers' wages		40	0	9
Repairs and maintenance of mains		31	10	10
		1,976	14	1
Rent of offices and of the transformer premises		136	18	5
Proportion of directors' fees		600	0	0
Salaries of secretary, clerks, and canvasser		576	8	7
Advertising expenses, and canvasser's commission		103	19	9
Stationery and printing		64	7	8
Office expenses, postages, travelling, and incidentals		116	16	10
Special charges		70	10	11
Law charges		30	0	11
		3,675	17	2
Profit carried to balance-sheet		61	14	7
		£3,737	11	9

Cr.	£	s.	d.
Sales of electric current	2,255	18	4
Meter rentals	66	14	5
Interest	1,288	7	1
Discount on purchases	6	13	2
Mains leased at a rental	40	0	0
Transfer fees	70	5	0
Shareholders' lists sold, sundry fees, and other petty receipts	9	13	9
	£3,737	11	9

The Secretary (Mr. S. H. Webster) having read the notice convening the meeting,

Mr. George Ellis, J.P., who presided, said: In greeting you at this second annual meeting I do so with the utmost confidence, as I feel that our financial policy has proved to have been based on thoroughly sound and business principles, and has consequently been of immense advantage to the Company. In fact, had we not seized the opportunity which presented itself of placing the balance of the share capital when we did, we could not have carried out the contracts in their entirety, or have built a station and erected plant of sufficient capacity to enable us to satisfactorily supply the extended area over which we have powers. It is very satisfactory to feel that after meeting all the charges incumbent on us we shall have ample trading capital and be able to start business on a thoroughly sound financial basis. I will now briefly explain the progress we have made and the condition as it stands to-day of each department of our work—that is to say: (1) the negotiations in connection with the acquisition of the site; (2) the mains, transformers, and house connections; and (3) the plant and machinery. First as to the buildings and the work upon the site. You will recollect that owing to difficulties and negotiations in connection with the acquisition of the site, it was not until the Michaelmas of 1897 that we were able to obtain possession of the land, so that, what with the time taken up in getting building materials on it and organising the labour, it was not until the month of November in 1897 that the contractors were able to commence the actual construction of the buildings. During the spring and summer months of 1898 the weather was most favourable for building operations; but this was succeeded by several months of broken and wet weather, during which the builders were much impeded. Lately, again, we have had very favourable weather, and the work has been carried on with great speed. The position to-day is that the chimney shaft, 180ft. in height, is quite complete and ready for use. The main building, consisting of the destructor-house, boiler-house, engine and dynamo house, is finished and roofed in, and the various rooms adjoining the main building are also finished. The offices are ready for occupation, being quite complete with interior fittings and furniture, so that in a few days—in fact, on the 25th inst.—we are removing our clerical and engineering staff into them, and by thus having all the officers under one roof much labour and inconvenience, and, consequently, expenditure, will be saved. The whole of the boilers have been delivered and erected, and four of the boilers and eight of the destructor cells are finished and ready for use, whilst the progress being made on the remainder makes it certain that the whole of the work within the destructor and boiler house will be finished by the early summer. The artesian well alluded to in the report is finished, and is 390ft. in depth, and the Board are extremely gratified, as I feel sure you are, at the success which has attended this venture, for I must call it so. We took a considerable time in deciding as to whether we should spend the necessary amount—roughly, £1,000—for the experts whom we consulted on this point were not unanimous in their opinion as to whether we should obtain an abundant and, what is more important, a permanent supply. However, the water we have struck has proved to be flowing from a true fissure vein in the chalk, and will be ample for all our needs. Secondly, as to the mains, transformers, and house connections. The map before you will enable you to judge of and to realise the amount of work done, and you will, I feel sure, admit that good use has been made in this branch of the time we have had at our disposal. The progress made by the British Insulated Wire Company in the laying of mains during the past year has been most satisfactory. Mains have now been laid in a total of over 22 miles of streets. Earthenware conduits to carry high-tension cables have been laid for sufficient length to carry over 44 miles of high-tension cable. Twenty-four miles of low-tension distribution cable have been laid on the solid filling-in system and brought into use, and over 13 miles of high-tension feeders have also been drawn in the before-mentioned ducts and brought into use. The above work has involved the excavation and making good of 25 miles of streets. From these mains 220 connections to consumers' houses have already been run, and, of course, meters erected and connected up in each case. Thirdly, as regards the plant and machinery. I am sorry I cannot report to you quite so favourably with reference to these items, but, as many of you are doubtless aware, the late strike in the engineering trade has caused quite a congestion in this field of work. English manufacturing firms are so far quite unable to make up the time lost owing to that unfortunate strike. As you are aware, we have been taking on consumers and supplying them with energy by means of connecting our mains to those of a company who have a generating station in a district adjoining ours. Of course, this has not been done without incurring some additional expense, but we consider that we are amply compensated for the cost involved, for we have by this means been enabled to take on consumers with a total number of about 16,000 8-c.p. lamps already, which will enable us to employ our machines directly they are ready, and thus avoid the great loss which generally occurs after the opening of an electric light station while waiting for customers to get their premises wired. This should be most satisfactory to our shareholders, as if such a large number of consumers can be obtained before the station is opened there must be every prospect of a large and lucrative business in store for us. We have not made any great effort in procuring customers so far, for there have been difficulties and troubles in supplying under these conditions, which have caused us a good deal of anxiety, and which we trust will not occur when we are in a position to supply direct from our own station, and, moreover, we have not been able to deliver current, except to a limited area of our district.

Mr. W. W. Phipps seconded the motion.

The Chairman, in reply to questions, said the directors expected the Company's station to be ready to supply at the end of May or the beginning of June. As to prophesying that there would be 50,000 lamps on in the autumn, he could not go so far as that; he could only judge by his experience in another place, where he had found that in the second year the number of lamps was double that of the first year, and that there was an annual increase at the rate of 25 per cent. in the next three years. With reference to the next call, they had sufficient money in hand to carry them up to the middle or end of May, so that it might be the middle of May or the beginning of June before another call would be made. The number of shops and private houses taking the light was at present about equal. The Company had an absolute monopoly in the district. The Vestry could purchase the undertaking at the end of 21 years, but they would have to pay the Company 25 per cent. over the capital expended; they could obtain it, however, at par in 31 years under the Act. At the present time they had 220 customers, and 26 more orders had just come in.

The motion was unanimously carried.

The retiring directors, Messrs. W. W. Phipps and Algernon Turnor, C.B., were re-elected; and Messrs. Price, Waterhouse, and Co were reappointed auditors. The proceedings closed with votes of thanks to the chairman, directors, and secretary.

RICHMOND (SURREY) ELECTRIC LIGHT AND POWER COMPANY, LIMITED.

Directors: Frederick W. Reynolds (chairman); Francis E. Savory; the Chevalier Soares. Engineer and manager: A. J. Lawson, M.I.E.E. Secretary: H. B. Renwick.

Report of the directors (with abstract of accounts) presented to the shareholders at the fifth ordinary general meeting of the Company, held at the registered offices of the Company, Moorgate-court, London, E.C., on March 23, 1899:

The capital account shows an expenditure during the year of £6,452. 12s. 3d.. chiefly upon machinery and mains, making a total sum of £51,246. 4s. 10d., expended to Dec. 31 last. The balance to credit of net revenue account, including the amount brought forward, and after payment of interest charges and reduction of suspense account, is £1,340. 12s. 4d. Out of this sum the directors recommend the payment of a dividend on the ordinary shares of the Company at the rate of 4 per cent. for the year, less income tax, which will absorb £1,211. 8s. 6d., thus leaving £129. 3s. 10d. to be carried forward to next account. The equivalent of 12,352 8-c.p. lamps were connected to the Company's mains at Dec. 31 last, showing an increase equivalent to 2,840 8-c.p. lamps connected for the year. In order to meet the rapidly increasing demand for current, additional plant has been installed, and further additions will be made during the present year. Considerable extensions have been made to the Company's mains, and further extensions are in contemplation. The retiring director is Mr. F. E. Savory, who, being eligible, offers himself for

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re-election. The auditor, Mr. R. H. Marsh, also retires, and offers himself for re-election.

REVENUE ACCOUNT.

Dr. Generation of Electricity.	£	s.	d.	£	s.	d.
Coal and other fuel	£692	12	2			
Oil, waste, water, etc.	61	18	5			
Engineers' salaries	58	9	10			
Wages	306	14	1			
Repairs: buildings, £24. 14s. 11d.; engines and boilers, £120. 17s. 5d.; other machinery, instruments, and tools, £10. 18s. 5d.; accumulators and accessories, £9. 9s. 5d.	166	0	2			
				1,285	14	8
Distribution of Electricity.						
Engineers' salaries	40	15	3			
Wages	23	13	1			
Repairs: mains, £26. 19s. 10d.; apparatus on consumer's premises, £3. 10s. 6d.	30	10	4			
				94	18	8
Rents payable	59	0	0			
Rates and taxes	327	11	5			
				386	11	5
Directors' remuneration	133	6	8			
Salaries, head office	100	0	0			
Stationery and printing	40	11	8			
General establishment charges	56	18	0			
Auditor of Company	15	15	0			
Auditor appointed under the provisions of the order	10	10	0			
				357	1	4
Law expenses				4	18	6
Insurance				98	8	10
Bad debts written off				18	8	10
Balance carried to net revenue account				2,873	8	9
				£5,119	11	0

Cr.	£	s.	d.
Sale of current	4,693	1	3
Rental of meters	224	6	6
Rents receivable	177	15	0
Discounts	24	8	3
	£5,119	11	0

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	50,580	0	0
Sundry creditors on open accounts	2 610	14	11
Depreciation fund account	900	0	0
Balance from net revenue account	1,340	12	4
	£55,431	7	3

Dr. Assets.	£	s.	d.
Capital account—amount expended	51,246	4	0
Stores on hand at Dec. 31, 1898: coal, £15. 7s. 6d.; oil, waste, etc., £6. 3s. 3d.; general, £87. 11s. 4d.	109	2	1
Deposit with Richmond Corporation	100	0	0
Sundry debtors	2,168	12	7
Suspense account, £1,250; less amount written off, £400	850	0	0
Cash at bankers and in hand	957	8	7
	£55,431	7	3

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.O.T. units	185,461
Quantity sold to private consumers by meter	166,087
Quantity used on works	1,862
Total quantity accounted for	167,949
Quantity not accounted for	17,512
Total maximum supply demanded (kilowatts)	213

WILLANS AND ROBINSON, LIMITED.

Directors: Mark Robinson, Esq., M.I.C.E. (chairman); Sir Gilbert A. Clayton-East, Bart. (deputy-chairman); Captain H. Riall Sankey, R.E. (Ret.), M.I.C.E.; Lieut.-General Sir Richard H. Sankey, K.C.B., R.E.; Thomas O. Lazenby, Esq., J.P.

Tenth half-yearly report of the directors, to be submitted at the ordinary general meeting of the Company to be held at the City Terminus Hotel, Cannon-street, E.C., on Wednesday, March 29, at 2.45 p.m.:

After writing off as depreciation from plant, patents, etc., the sum of £5,013. 3s. 4d., and paying interest upon debenture stock, the balance to the credit of profit and loss account for the half-year (including £2,441. 6s. 11d. brought forward) is £25,069. 14s. 3d. Out of this the directors propose that dividends be paid at the rate of 6 per cent. per annum upon the preference shares, and at 10 per cent. per annum upon the ordinary shares, together amounting to £12,000. The amount payable to the original directors, in accordance with the articles of association, is £3,863 10s. 2d. leaving a balance of £9,206. 4s. 1d. From this the directors propose to carry £2,000 to the debenture redemption sinking fund and £3,500 to the reserve fund, leaving a balance of £3,706. 4s. 1d. to be carried forward. The balance of £11,124. 14s. 6d., which stood in the last accounts to the credit of the share premium suspense account, has been disposed of as follows: £163. 12s. 7d. has been written off removal expenses; £3,368. 6s. 8d. has been written off the value of the freehold works at Thames Ditton, and £1,606. 7s. 10d. off sundry items of plant at Thames Ditton; £986. 7s. 5d. is kept in hand in a removal suspense account, and £5,000 has been carried to the reserve fund. As the period of the accounts now presented corresponds with the conclusion of the fifth year of the Company's working, it may be pointed out that the sums reserved out of profits in the five years—viz., £25,146. 9s. 11d. in the reserve fund, £10,000 in the debenture redemption fund, and the balance of £3,706. 4s. 1d. now carried forward—amount together to £38,852. 14s., and that this sum exceeds the amount paid for the goodwill of the business. The last year, and more particularly the last half-year, have been marked by a great increase in the demand for the special class of machinery which the Company manufactures. As has been pointed out before, there has also been a rapid increase in the size of the engines the Company is called upon to supply. Twelve months ago it was announced that an engine was on order to develop as much as 1,500 h.p.—a notable advance upon the sizes previously made by the Company. Six months ago the directors were able to state that the number of such engines on order had increased to four. The number on order now is 16, and there is reason to expect that much larger sizes will be called for. The directors believe that the increased demand for engines, and especially for large engines, is due to permanent causes, and that it will continue to increase to an extent far exceeding the present producing powers of the Company's plant. They also believe that if the Company becomes unable to accept the orders offered to it, they will pass into the hands of foreign competitors, with permanent injury to the reputation of the Company and to the interests of the shareholders. The directors are therefore of opinion that the plant should be increased, and that larger and more powerful tools should be provided. The directors also consider that the manufacture of the Niclausse boiler should be taken up upon a larger scale than has hitherto been contemplated, or than is possible at Rugby. Under these circumstances the directors propose to take the existing boiler shop at Rugby as an additional machine shop, and to make some other additions, adding in all about 60 per cent. to the space now available for machine tools; they also propose to double the size of the foundry. They propose to erect separate boiler works upon a site which has been secured near Chester, upon the River Dee, with the advantages of cheap sea carriage for materials, and easy railway communication with Rugby and other important centres. The foregoing scheme has had the very careful consideration of the directors, who are satisfied as to its advantages and its necessity. It will render necessary an increase of capital, and resolutions will be submitted to the meeting authorising the creation of 40,000 new shares of £5 each, for one-half of which the directors propose to invite subscriptions in the course of the ensuing month, to provide for the necessary new buildings and plant, and to supply additional working capital. Subject to the concurrence of the existing preference shareholders, it is proposed to follow the system which is believed to have worked hitherto to the satisfaction of both classes of shareholders, and to take power to issue half the new shares as preference and half as ordinary shares. Sir Gilbert Augustus Clayton-East, Bart., and Mr. Thomas Orger Lazenby retire from the Board, in accordance with the provisions of the articles of association, but are eligible, and offer themselves for re-election. The auditors, Messrs. Cooper Bros. and Co., also retire, but are eligible for re-election.

OXFORD ELECTRIC COMPANY, LIMITED.

Sir Henry C. Mance, C.I.E. (chairman), presided at the eighth ordinary general meeting of the shareholders of this Company recently held at Oxford.

The following is the report of the directors: The revenue account shows a profit (including £18. 17s. 5d. brought forward from last year) of £4,692. 9s. 1d. After providing £1,613. 13s. 8d. for debenture and other interest, and writing off the balance of the capital issue suspense account, £218. 3s. 10d. and £25. 8s. 2d. on account of hire-purchase installations, the available balance is £2,835. 3s. 5d., which your directors propose to appropriate as follows: £2,500 in payment of a dividend at the rate of 5 per cent. per annum on the share capital, and £250 to be added to the reserve and renewal of plant account (which will then amount to £750), leaving £85 3s. 5d. to be carried forward to next year's accounts. The capital expenditure during the year has been provided for by the issue of debenture stock as required. Since the last report 4,564 8-c.p. lamps (or their equivalent) have been connected to the mains. This increase compares favourably with the progress in 1897, and is partly due to the introduction of the hire-purchase system of installing the light. An additional boiler of 200 h.p. capacity has been installed at the works, and the distributing mains of the Company extended in the Woodstock, Banbury, Fyfield, Museum, Bradmore, New, and Crick roads, also in Little Clarendon-street. The capacity of the high-tension mains connecting the generating and sub-stations has been practically doubled during this year, and the efficiency of the system thereby considerably increased. The control of the distribution of current has been transferred from Broad-street to the generating station at Osney with very satisfactory results. The whole of the plant has been maintained in efficient order. The committee of the London Stock Exchange has granted a quotation for the Company's shares.

The report was adopted. Sir Henry C. Mance, C.I.E., and Mr. L. A. Selby Bigge were re-elected directors; and the auditor, Mr.

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W. S. Carver, was also re-elected. A vote to the chairman concluded the meeting.

BUENOS AYRES AND BELGRANO ELECTRIC TRAMWAYS COMPANY, LIMITED.

The report and accounts for 1898 comprise the receipts and expenses of the old horse lines from March 1, 1898, to Dec. 31, 1898, and the receipts and payments on about 2¼ miles of new electric line taken over by this Company on June 22, 1898. The total receipts amounted to £57,337 and the expenses to £41,392, showing a profit for 10 months of £15,945. The debenture interest has absorbed £9,920, and the directors recommend a dividend at the rate of 6 per cent. per annum on the amounts paid on the "A" preference shares. This will absorb £3,083, leaving a balance of £2,844 to be carried forward. The increase in sterling receipts is partly attributed to the increase in the traffics and partly to the fall in the gold premium, the average premium in 1898 being 157, as compared with 193 in 1897.

DIRECT SPANISH TELEGRAPH COMPANY, LIMITED.

The report for the year 1898 shows, after providing for interest on and redemption of debentures, a balance to the credit of revenue of £11,843. After adding the usual sum of £5,000 to reserve, the directors recommend dividends for the year of 10 per cent. on the preference shares, and 4 per cent., tax free, on the ordinary shares, absorbing £5,486. Half of this amount was distributed in October as an interim dividend. A balance of £1,357 will remain, and the directors, in view of fluctuations of traffic, etc., consider it advisable to transfer this amount to the contingencies account. The traffic receipts show an increase of £3,812, and the ordinary working expenses were £349 in excess of those for the year 1897.—*The Times.*

PONTYPOOL ELECTRIC LIGHT AND POWER COMPANY.

The seventh annual report of the directors states that they have expended a further sum of £518. 6s. 10d. in free wiring, which has yielded a most satisfactory return. The running of the station for the year ended Dec. 31, after carrying a sum of £100 to renewal account, has resulted in a net profit, which, with the balance carried forward from last year, amounts to £475. 5s. 2d.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Edinburgh.—The Corporation invite tenders for water-tube boilers by April 3.

Salford.—The Electric Light Committee are prepared to receive tenders for the various stores.

Wimbledon.—The Urban District Council are about to call for tenders for wiring the electric lighting station.

Tynemouth.—The Corporation are prepared to receive tenders for the various electrical plant. Tenders by noon on April 15.

Edinburgh.—The Corporation invite tenders for installing the electric light at the City Chambers (extension buildings). Tenders by April 10.

West Ham.—The Tramways and Electric Lighting Committee of the Town Council will shortly advertise for tenders for engines and alternators.

Aberdeen.—The Corporation are prepared to receive tenders for 400 tons steel girder rails and 20 tons fishplates. Tenders by 10 a.m. on 29th inst.

Barking.—The Urban District Council are prepared to receive tenders for the supply and erection of various plant. Tenders by 12 o'clock noon on March 27.

Peterborough.—The Corporation are prepared to receive tenders for the supply and erection of the plant for the municipal electricity works. Tenders by April 20.

Madrid.—The Public Works Department are inviting tenders for the building of an electric tramway in the city. Applications must be sent in by p.m. on April 14.

Southend-on-Sea.—The Corporation are prepared to receive tenders for the temporary transfer of their powers under the Southend Electric Lighting Order, 1891. Tenders by April 6.

Aberdeen.—The Corporation are prepared to receive tenders for the supply and erection of materials for the equipment of their George-street and Woodside tramway route. Tenders by March 29.

Derby.—The Electric Lighting Committee are prepared to receive tenders for the supply and erection of an overhead hand crane at their electric station, Sowter-road, Derby. Tenders by 30th inst.

Dublin.—The Directors of the Great Northern Railway Company (Ireland) invite tenders for the various works in connection with their line between Sutton and Howth, near Dublin. Tenders by April 20.

Rothesay.—The Electric Lighting Committee of the Town Council are prepared to receive tenders for the supply and erection of various plant for the electric lighting of the burgh and harbour. Tenders by noon on March 27.

Poplar.—The Board of Works invite tenders for engine and pump room equipment and all electrical plant in the works except the battery, boiler-house equipment, battery and battery stands, and public street lighting. Tenders by 10 a.m. on April 25.

Belfast.—The Belfast Harbour Commissioners require tenders for the construction and erection of two overhead tramways on the Queen's Quay, Belfast. Specification, etc., may be obtained from the harbour engineer, Mr. G. F. L. Giles. Tenders by 27th inst.

Manchester.—The Lancashire and Yorkshire Railway Company invite tenders for the supply of the following articles during 12 months ending April 30, 1900: (No. 25) signal and telegraph fittings; (26) signal, telegraph and electric light wires. Tenders by April 3.

Sunderland.—The Corporation are prepared to receive tenders for the annual contracts for (*a*) indiarubber-covered cables; (*b*) cast and wrought iron pipes and street service boxes; (*c*) stoneware casings and bearers; (*d*) house fuse boxes. Tenders by noon on March 30.

Port Louis.—The Municipal Corporation invite tenders for the exclusive privilege of private and public electric lighting. Conditions, etc., may be obtained from the Agent-General, 9, Idol-lane, E.C., on payment of a deposit of £1. 1s. each copy, such sum to be returned to persons sending in bona fide tenders. Tenders by April 23.

Dublin.—The Great Northern Railway Company (Ireland) invite tenders for the construction of about 2¾ miles of tramways through fields, etc., from the Bailey Post Office to Howth Station. Specifications (£2. 2s.) may be obtained at the office of the Company's Engineer-in-Chief, Amiens-street Terminus, Dublin. Tenders by 27th inst.

Aberdeen.—The Corporation are prepared to receive tenders for the following: (1) two Babcock and Wilcox boilers; (2) one 180-kw. steam dynamo, engine to be of Messrs. Belliss's or Messrs Willans and Robinson's make, with steam and exhaust pipes; one 75-kw. balancing set. Tenders to Town Clerk, marked "Tender for Electric Plant," by April 5.

Perth.—Applications will be received at the City Council Office from persons desirous of applying for a concession for the installation and working of a system of electric lighting for the municipal buildings and streets of the city of Perth, as well as house-to-house lighting. Conditions of contract and full particulars may be obtained on application to the Agent-Generals for Western Australia, 15, Victoria-street, Westminster, London, or Gordon and Gotch, St. Bride-street, Ludgate-circus, E.C. Tenders by May 2.

Cape of Good Hope.—The Controller and Auditor-General of the Colony is prepared to receive at his office at Cape Town alternative tenders for the construction of a light or ordinary railway, with or without permanent-way materials and bridge-work, from Sir Lowry Pass Station to Caledon, about 53 miles in length. Further particulars, as soon as they shall have been received from the Colony, will be obtainable by intending contractors upon application at the office of the Agent-General for the Cape of Good Hope, 112, Victoria-street, Westminster, S.W. Tenders by noon on April 17.

Beckenham.—The Urban District Council invite tenders for the construction of a dust destructor to be worked in conjunction with the electric lighting station proposed to be erected by the District Council in Arthur-road, Beckenham. Contractors tendering are to fully describe and specify in detail their proposed installations, which are not to include chimney shaft, inclined roadway, boilers, or roofing, but must be complete in all other respects. Preliminary plans and particulars, together with forms of tender, may be obtained at the office of Mr. John Angell, engineer to the Beckenham Urban District Council, on deposit of £1, which will be returned on receipt of a bona fide tender. Tenders, endorsed "Tender for Dust Destructor," to Mr. F. Stevens, clerk, by 4 p.m. on 27th inst.

Doncaster.—The Corporation invite tenders for the supply and delivery of the following articles, together with the fixing thereof at the electrical generating station in Bath-fields, Doncaster, or elsewhere within the borough, as may be indicated, according to conditions, plans, and specifications to be seen or obtained as follows—namely (*b*) three mild-steel Lancashire double-flued boilers; (*c*) three sets of steam dynamos, likewise two sets of larger steam dynamos, condensing plant, and other necessary adjuncts, likewise a six-ton overhead traveller; (*d*) electric storage battery of 136 cells, with a capacity of 750 ampere-hours, with stands and other adjuncts; (*e*) electrical instruments and other apparatus; (*f*) underground armoured cables, street boxes, and other appliances, laid and fixed, in the streets as required. Specifications, etc., may be seen and copies had at the office of Mr. James N. Shoolbred, C.E., 47, Victoria-street, London, S.W., or at the office of the Borough Surveyor, Doncaster, on payment of £2. 2s. for each of the various sections, or £5 for the entire set, which amounts will be returned on receipt of a bona fide tender. Tenders by 28th inst.

RESULTS OF TENDERS.

Putney.—The contract for the electric lighting for the Public Library has been let to Messrs. W. J. Fryer and Co.

Lynn.—The contract for guard-posts to be fixed round the arc lamps has been obtained by Messrs. J. and A. Law at 52s. 3d. each.

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Ashton.—The Town Council have sealed an agreement with Mr. John Fletcher for the laying of electric mains in the Market-avenue.

Wimbledon.—The Electric Lighting Committee have accepted the tender of Messrs. Gimson and Co., at £109. 10s., for a cast-iron tank.

Ipswich.—The Guardians have accepted the tender of Messrs. Martin and Newby, at £30. 1s. 6d., for electric bells at the new workhouse.

Ventnor.—The Committee of the Royal National Hospital have accepted the tender of Messrs. W. J. Fryer and Co. for an electric light installation, at £1,297.

Wolverhampton.—The Lighting Committee have accepted the tender of Mr. H. Gough, Dudley-road, for the works required in erection of an extension of the electric lighting station, Commercial-road.

London and South-Western Bank.—The directors have accepted the tender of Messrs. W. J. Fryer and Co., Sloane-square, for the installation of the electric light in their buildings in London and Ealing.

West Hartlepool.—The Town Council have accepted the tender of Mr. Geo. Marshall, of Darlington, at £11,473, for the erection of the electric lighting station; also the tender of the Callender Cable Construction Company, at £8,770, for the supply of feeders and mains.

Aberdeen.—The Town Council have accepted the tender of the Electric Railway and Tramway Carriage Works, Limited, to supply four open cars, with an overhead canopy, to hold 50 passengers, at the price of £120 each; and that of Messrs. Thos. Bolton and Sons, Limited, amounting to £638. 8s., for the supply of copper strip.

Hereford.—The Council have accepted the following tenders for erection of new buildings in connection with the proposed electricity station in Widemarsh-street: Buildings, W. P. Lewis and Co., Hereford, £2,241; chimney, W. P. Lewis and Co., £461; ironwork, Alexander and Duncan, Leominster, £394; lightning conductor, W. P. Lewis and Co., £50.

Greenock.—The Board of Police have accepted the following tenders for supply and erection of the following plant (low-tension system) for their electricity works: Messrs. Babcock and Wilcox, boiler-house plant (water-tube boilers, economiser, mechanical stokers), £1,956; Messrs. Carrick and Ritchie, overhead travelling crane, £450; Silvertown Company, engine-house (steam dynamos, boosters, switchboard, accumulators, complete piping arrangements, feed heater, and feed pumps), £11,517. 10s.; Callender Company, mains (low-tension system), including erecting arc lamps, poles, etc., £12,603. 3s. 2d.; J. M'Ewan, buildings. Total, £30,000.

BUSINESS NOTES.

Leeds.—The town hall clock is to be lighted by electricity.

Newcastle Tramways.—A poll of the ratepayers on the Corporation's new Bill will be taken on April 11.

Lincoln.—The Local Government Board have sanctioned a loan of £19,000 for additional electric light plant, etc.

Aberdeen.—The Town Council have revised and adjusted the wages of the staff in connection with the electricity works.

Dorking.—Mr. Trentham's report on the electric lighting of Dorking is before the General Purposes Committee of the Urban District Council.

Farnborough.—The Council have agreed to transfer their powers under the electric lighting order to Power and Traction, Limited, for the next 35 years.

Wilts County Council.—The electrical lighting and heating of the asylum will cost £3,000, which amount is included in the loan now applied for by the County Council.

Charing Cross Euston, and Hampstead Railway Bill.—This Bill has passed Mr. Jeffrey's Select Committee of the House of Commons, the preamble having been declared proved.

Rochdale.—Mr. W. C. C. Hawtayne's appointment of consulting electrical engineer to report upon the proposal to light the district by electricity has been confirmed by the Council.

National Telephone Company.—We hear that in all 96 additional petitions have now been deposited praying to be heard by counsel against the National Telephone Company's Bills.

British Continental Electricity Company.—The directors have delared an interim dividend on the preference shares at the rate of 5½ per cent. per annum for the half-year ended Oct. 31, 1898.

Londonderry.—At last week's meeting of the Corporation notice was given to put on the agenda paper for next meeting the desirability of introducing private electric lighting in the city.

Birkenhead Electric Tramways.—The Bill has now passed Lord Poltimore's Committee, an agreement having been arrived at between the Corporation and the Wirral Tramway Company.

Colne.—The Town Council have appointed a special committee whose duty will be to enquire into the whole subject of electric supply of light, traction, etc, and to report at their earliest convenience.

Aron Electricity Meter Company, Limited.—An interim dividend at the rate of 6 per cent. per annum on the preference shares will be paid on April 1. The transfer books will remain closed until that date.

Houghton-le-Spring.—The Urban District Council have decided to give their support to the proposed system of overhead wire electric tramways from Fence Houses to Penshaw, Newbottle, and on to Hetton and Sunderland.

Broadstairs and St. Peter's.—The Council have resolved to take into consideration the better lighting of the front. During the discussion the hope was expressed that the time would soon come when they would have the electric light.

Camborne.—The Board of Trade have granted the electric lighting order. The Council have replied with the request that a proviso be inserted stipulating that whatever sum they paid a lighting inspector the company should repay.

Wolverhampton.—The charge for a supply to all churches and chapels will be 4½d. per unit from April 1, and consumers of electrical energy to the extent of 35,000 units and upwards annually will be charged at a uniform rate of 4d. per unit.

Leatherhead.—Messrs. Handcock and Dykes have submitted a supplementary report on the electric lighting to the Urban Council, in which they state the total running cost at £860, and the revenue at £1,310, leaving a surplus of £450.

Camberwell.—The Libraries Committee have obtained information as to the electric lighting of the art gallery, central, and Livesey libraries, from which it appears that the work can be carried out at a cost of £900 for the three buildings.

Leamington.—Major Cardew held a Board of Trade enquiry at Leamington on the 21st and 22nd inst. into applications of the Corporation and the Midland Electric Lighting Company for provisional orders to supply electricity to the borough.

London Gazette.—The first meeting in the case of the Central Electrical Engineering Company is set down for the 28th inst. at 2 30 p m., at Bankruptcy Buildings, Carey-street, W.C. The date of public examination is fixed for April 26, at 11.30.

City Lighting.—At yesterday's meeting of the Court of Common Council, Mr. Brooke Hitching's motion *re* the purchase of the undertaking of the City of London Electric Lighting Company (referred to in our issue of the 10th inst.) was negatived.

Bath.—A great many new lamps were resolved upon in various parts of the town on the recommendation of the Lighting Committee last week. The lighting of Peter-street, Avon-street, Corn-street, and St. James's-parade is to be reconsidered.

Taunton.—At the last meeting of the Town Council the Electric Lighting Committee reported that they were advertising the old arc plant for sale by tender. The contractors had delivered the second 150-kw. alternator, and it had been running for the last fortnight.

Manchester.—The Corporation have received the sanction of the Board of Trade to supply electrical energy to the districts of Levenshulme, Moss Side, and Withington on the extra high-pressure principle. This system allows a maximum pressure of 5,000 volts.

Glasgow.—Mr. Parshall's scheme for the proposed electric tramways has been adopted. Part of the route to Springburn is already lighted, the rest will be completed soon. The Partick electric lighting order is still the bone of contention between the two Councils.

Llandudno.—The electric light cables are being extended in various directions. A cable which will supply Bryn-y-bia, estimated at £96, and a cable in Market-street will be constructed. Another at a cost of £106 and the supply to the market hall are being considered.

Plant for Sale.—The Conway and Colwyn Bay Joint Water Supply Board have for sale a 180 h.p. turbine, together with compressed air engine, steel pipes, and other appliances.—A complete plant is for sale at 122, Charing Cross-road, London, W.C. Particulars appear in another column.

Freshwater and Totland (Isle of Wight) Electricity Supply Company, Limited.—This Company has been registered, with a capital of £15,000, with the object to form centres at Freshwater and Totland, in the Isle of Wight, and elsewhere, for the generation of electric light and power, etc.

Litherland.—The Electric Power and Lighting Committee of the Liverpool Corporation have passed a resolution approving of the proposal of the Bootle Corporation to obtain power to supply electrical energy for working tramways in Litherland, by agreement with the Liverpool Corporation.

Weston-super-Mare.—A sub-committee has been appointed to consider the details of the proposed Weston-super-Mare and tramways provisional orders, and to report to the Council as to the alterations and clauses necessary or expedient to be made in such order for the protection of the Council.

Anglo-American Telegraph Company, Limited.—The directors have resolved, after placing £6,000 to the credit of the renewal fund, to declare an interim dividend for the quarter ending March 31 of 15s. per cent. on the ordinary stock, and £1. 10s. per cent. on the preferred stock, less tax, payable on May 1.

Eastern Telegraph Company.—The directors announce the payment on April 14 next of dividends at the rate of 3½ per cent. per annum, less income tax, on the preference stock for the quarter ending 31st inst., and an interim dividend of 1¼ per cent. on the ordinary stock, free of income tax, in respect of profits for the quarter ended Dec. 31, 1898.

Direct Spanish Telegraph Company.—At the ordinary general meeting of the Direct Spanish Telegraph Company, Limited, on

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the 17th inst., the Marquis of Tweeddale presiding, the report was adopted, as was also the directors' recommendation to pay, after placing £5,000 to the reserve fund, 10 per cent. on the preference shares and 4 per cent. on the ordinary shares.

Heckmondwike.—Referring to the delays which have occurred in the Council's electric lighting and public baths schemes owing to the intention of utilising the boilers of one plant for both purposes, it is now stated that the preliminaries in connection with the electric lighting scheme will be soon completed, and that both schemes will be pushed forward as rapidly as possible.

Liverpool.—The rate of charge for electric energy decided upon by the Electric Light Committee is as follows: 4d. per unit for lighting, 2d. per unit for power up to 3,000 units per quarter, and 1d. per unit for all over this; for street-lighting by the Corporation, 2d. per unit; and for office, etc., lighting by the Corporation, 3d. per unit. These rates come into force on April 1.

Manchester.—The Light Railways Commissioners have held an enquiry into the application of the British Electric Traction Company for an extension order authorising them to construct a line between Cheetham Hill and Rhodes. The Earl of Jersey said that the Commissioners would hesitate very much before they sanctioned a scheme which was opposed by all the local authorities.

Radcliffe.—The Electric Lighting Committee of the District Council have resolved that a conference of representatives of the Radcliffe, Little Lever, Prestwich, and Whitefield District Councils be called with a view to considering the question of joint action for the provision of electricity for the lighting of the district, and the adoption of the Light Railways and Tramways Act in these districts.

Ingleton. — Mr. Hopkinson, managing director to Messrs. Mather and Platt, Manchester, has visited Ingleton and surveyed the proposed route to the summit of Ingleboro'. With regard to the Ingleton Electric Light and Power Company, we learn that out of a nominal capital of £4,000 more than 50 per cent. has been subscribed locally, and this is considered sufficient for present purposes.

Lytham.—A meeting of the ratepayers was held on Tuesday, when it was resolved to oppose the Bill in Parliament for the construction of a tramway and bridge between Southport and Lytham. Mr. E. R. Lightwood, in explanation of this action, said that Lytham was quite in favour of a connecting link between the two places, but it was a question as to the way in which it was to be carried out.

British Thomson-Houston Company, Limited.—Amongst the orders recently received by this Company we note extensions to overhead line construction for the tramways in Leeds; tramway plant for Sheffield, Dudley, and Stourbridge, Manchester, and Colombo, and generators ranging from 75 kw. to 500 kw.; and plant for the electric lighting works in Glasgow, Govan, Croydon, Sheffield, Lowestoft, and Wolstanton.

Westminster Electric Supply Corporation, Limited.—The directors have decided to issue the balance of their £50,000 3½ per cent. first mortgage debentures of £100 each to the shareholders at par, as far as possible *pro rata* to their holdings of ordinary shares of Feb. 1 last, when the transfer books were closed. We hear that it is not probable that any allotment can be made to holders of less than 100 shares.

Walsall.—With regard to the proposal to construct a light railway between Birmingham and Walsall, we learn that the form of traction will be the overhead wire system, the wires being carried along the side of Walsall-road. The cars will probably be adapted to the carriage of parcels as well as passengers, and the generating station will be fixed somewhere near Hamstead, in order to be as near as possible to the supply of coal.

Appointments Vacant.—The Corporation of Edinburgh invite applications for the post of assistant to the superintendent of mains.—The Corporation of Middleton are prepared to receive applications for the appointment of an electrical engineer.—The Corporation of Wolverhampton invite applications for the appointment of mains superintendent. Particulars of these and other vacancies will be found in another column.

Bath.—The adoption of the Electric Lighting Committee's report evoked considerable discussion at Tuesday's meeting of the Town Council, comment being made upon the losses shown in the year's working. The Chairman said that during the year they had reduced the charge to consumers from 6d. to 4½d., which made a difference of £279. 18s. 3d., and they had had many expenses which would not be incurred another year.

Denbighshire.—At the annual meeting of the County Council a report was submitted by the Committee of Visitors to the Denbigh Asylum dealing with the proposed scheme for lighting the institution with electricity. The estimated cost was £4,442, exclusive of engineers' charges of £200 agreed upon. It was resolved that the recommendation of the Asylum Committee be approved, and that the Council should agree to pay its quota of such expense.

Wimbledon.—The Electric Lighting Committee have fixed the charge for the lighting of places of public worship at 4d. per unit, and that for public lighting at £3 per lamp per annum. It is stated that the committee expect a revenue of about £5 000 from the electric light works for a start. The private lighting will be commenced first, there being already nearly 5,000 private lights ordered. Before the end of the year additional capital will be required.

Clontarf.—At Tuesday's meeting of the Urban District Council a letter was read from the solicitors to the Board, intimating the provisional order for the electric lighting of Clontarf had been practically approved by the Board of Trade, but there was a serious question as to the retention of a clause dealing with the right of the Council to transfer the order. Messrs. Sutton were of opinion that every effort should be made to retain such a clause. The letter was approved of.

Willing's Press Guide, 1899.—This guide, published by James Willing, jun., London (price 1s.), which on account of its simple arrangement is of the greatest usefulness for quick reference, has grown to such dimensions that it is almost a gift at the price. Its pages are not restricted to the Press of the United Kingdom, but it contains also the more important Colonial, American, and Continental newspapers and magazines, and the London addresses of Colonial and foreign newspapers.

Dublin.—The town clerk has been instructed to obtain a return showing the extent of tramway lines owned by railway or shipping companies both on the north and south sides of the River Liffey, and the terms under which such lines are held. At the meeting of the Borough Council on the 20th inst, the town clerk read a letter from the Municipal Industries Syndicate, Limited, submitting a proposal for the taking over of the electric lighting of the city. The letter was marked "read," an amendment to refer it to a committee having been defeated.

Stirling.—At the monthly meeting of the Police Commission last week, the clerk read a letter from the Secretary for Scotland approving of the borrowing of £25,000 for electric lighting. Lord Balfour wrote that he should be prepared to consider the question of increasing the amount to £30,000 at a later date on further application being made to him by the Burgh Commissioners. The clerk submitted an estimate showing how the money was to be spent, and it was approved. It was agreed to meet on May 8 to dispose of the proposal to borrow.

New Agencies.—We are informed that Messrs. Williamson and Joseph, Limited, Northampton Works, Northampton-grove, Canonbury, have appointed Mr. John G. Dixon, of 55, Norfolk-chambers, Norfolk-street, Sheffield, as their agent at Derby to represent the company in the North of England. They have also appointed Messrs. Ross and Co., of 95, Bath-street, Glasgow, as their agents for Scotland; and Mr. A. F. Sargeant, of 51, Lincoln's-inn, Corporation-street, Birmingham, to represent the company in Birmingham and the surrounding districts.

Hammersmith.—The salary of the resident engineer, Mr. G G. Bell, has been increased by £100 per annum, and Mr. J. Hill, the assistant engineer, has been placed on the official staff at a salary increased by £50 per annum. The last report of the Electricity and Lighting Committee again shows an increase. The number of applications received for private lighting is now 312 for a total of 21,871 lamps of 8 c.p.; the number of consumers already connected is 262, with 17,957 lamps, and the maximum number of lamps alight at one time is 16,713 (including street lighting).

Stock Exchange. — The Stock Exchange Committee has appointed March 28 as a special settling day for W. T. Henley's Telegraph Works Company, Limited (further issue of 2,500 ordinary shares of £10 each fully paid, Nos. 12 501 to 15,000). The undermentioned securities were ordered to be quoted in the official list: Chelsea Electricity Supply Company, Limited (further issue of £40.000 4½ per cent. debenture stock); W. T. Henley's Telegraph Works Company, Limited (further issue of 2,500 ordinary shares of £10 each fully paid, Nos. 12,501 to 15,000).

Huddersfield.—The Town Council have adopted the report of the borough engineer on electric tramways, and the work is to be carried out in sections. The town clerk has been authorised to make application for the necessary borrowing powers, etc. The Board of Trade's certificate for running the trams on the Outlane section has been received. During February the number of electric light consumers increased from 824 to 842, and the lamps from 54,778 to 55,757. The units were 89,416 as against 59,182 during the same period last year. The month's accounts amounted to £3,053. 7s. 1d.

Carlisle.—The General Purposes Committee have instructed the surveyor to send the drawings of standards, etc., for the tramways which they have approved to Prof. Kennedy for his opinion. The General Purposes Committee have agreed to reconsider the question of extending the electric light to St. James's-road and Murrell-hill district, and they will extend the electric cable from Long-lane to Fisher-street Church. In reply to a question whether there would be sufficient power and accommodation to supply the whole city with the electric light, the Mayor said at the last meeting they had power to supply all that was likely to be required.

Joseph Brooke and Sons.—We have received from this firm, which is a branch of the Leeds Fireclay Company, a useful little memorandum book for the waistcoat pocket. Perhaps one of the greatest advantages of this little book is that the firm in question have not taken up a large amount of space in advertising their own wares. In fact, the cover alone is used to draw attention to the well-known types of glazed and salt-glazed bricks, wall tiles, and to the various sanitary appliances manufactured by the firm. All the rest of the note-book, which is conveniently arranged for refilling, is available for memoranda. The book is well bound in morocco.

Ilfracombe.—A special meeting was held last week to consider the question of lighting the town by the electric light. The report of Mr. W. H. Trentham, C.E., strongly advised the Council to carry out the work for themselves. The estimated cost of the work is given at £14,000, and the old Town Mills, it was pointed out, would make a capital generating station, without in the least causing any nuisance. The question whether the town should do the work themselves was deferred until after the election, as the constitution of the Council might be altered, and the new members

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would probably like to have a voice in the matter. It is understood that the business will be taken at the earliest possible date.

Personal.—Mr. Herbert A. Jones is resigning his position with the Electrical Power Storage Company, Limited, having been appointed manager of the Phœnix Dynamo Manufacturing Company, of Bradford. Mr. Jones has been many years with the Electrical Power Storage Company, latterly as their representative in the North, and previously in their laboratory at Millwall.—Captain E. I. Bax, director of the South London Electric Supply Corporation, and Mr. Henry St. John Winkworth, have joined the Board of the Blackheath and Greenwich District Electric Light Company, Limited.

Harwich.—The Town Council have decided to sell for £300 to the English Industrials, Limited, of Manchester, the rights, powers, and obligations of the Corporation under the Harwich (Corporation) Electric Lighting Order, 1892. A condition of the contract is that the company immediately (or within one year from the date of the contract) instal the electric light in Harwich and Dovercourt throughout the compulsory area of supply, and also that the Corporation shall be permitted to purchase as a going concern the electric lighting works and all other works connected therewith at any time within 20 years upon paying to the company such a sum as may then be mutually agreed upon, or, failing agreement, shall be settled by arbitration in the usual way.

Messrs. Richard Melhuish, Sons, and Co.—We have received a comprehensive and neatly-bound work forming a part of the extensive catalogue issued by the well-known firm of hardware merchants, Messrs. Richard Melhuish, Sons, and Co., of 84, 85, and 87, Fetter-lane. Its contents, which are well illustrated and give every detail as to the character and diversity of the stock, extend to over 300 pages, and the publication forms the latest edition of the "engineer's section" of the firm's list. This will be found to be quite up-to-date and to contain descriptions of a very large selection of the latest patterns in stocks and dies, cutters, general machine shop and special precision tools, lathes, drilling and milling machines, and a variety of other apparatus and supplies capable of meeting the requirements of contractors and of engineering in all its grades. For electrical purposes we also find included in the list drills, lathes, telegraph tools, and electro-plating outfits.

Norwich.—The contractors who have the work of laying the track for the new electric tramways in Norwich are making good progress, as already some 11 miles of this has been completed. We understand also that the car-sheds are in a fair way towards completion, and that a large number of the cars have arrived. The electrical equipment is not so far ahead, as the foundations for the power station are not completed. In the same way, although a large number of poles for the overhead work have been delivered, they have not yet been erected on many parts of the route. It will be remembered that in Norwich the rail joints are of the cast-welded type. The contractors for this work are Messrs. R. W. Blackwell and Co., of Victoria-street, who have now got their building plant in good working order. At first some difficulty was experienced with the joints at the points and crossings, but certain modifications introduced by this firm have now completely removed all these difficulties.

Langdon Davies Electric Motor Company, Limited.—This Company have issued lists referring to the system of hire and hire-purchase which they have just adopted for their alternate-current motors. In the former case the charges vary from £1. 2s. 6d. for the first month and 15s. for each of the following months (for ½ b.h.p.) to £7. 10s. for the first and £5 for subsequent months (for 12 b.h.p.). In this case half amount of rent due and paid is allowed as rebate in the event of purchase. When motors are supplied on the hire-purchase system the term of the hire is one year. The instalments are payable monthly. The hirer may terminate the agreement on giving one month's notice and paying all rents due to the date of termination, and the motor becomes the property of the hirer on his paying the full rent for the year. Both systems are advantageous to those who either have no faith or experience in alternate-current motors, or who are not sure of the size best suited to their requirements. The hire of a motor for a month or two is insignificant as compared with the cost of purchasing one right out, and the experiment might be repeated until the customer is suited—or the Company's patience is exhausted.

Coventry.—The Town Council adopted last week a report of the Electric Light Committee stating that the scale adopted by the Council at present was 6d. per unit for all current consumed in a half-year, up to a total equivalent to two hours' use per day of the maximum demand, and 3½d. per unit for all current beyond that total. After watching the working of this system since its introduction, the committee have arrived at the conclusion that, while the principle is sound and equitable, the details of the scale of charges press unduly upon certain consumers, and thus restrict the growth of the consumption of current. The committee have enquired as to the practice in other towns, and after giving the subject careful consideration are of opinion that the full price of 6d. per unit should be charged only on a consumption equivalent to one hour's use per day of the maximum instead of two, and that all further consumption should be charged at the rate of 3d. per unit. The committee are of opinion that the slight loss which will be occasioned at the inception of this system will be quickly rectified by the growth of the consumption, and recommend that the above scale of charges be adopted by the Council as from the close of the current quarter on March 31 next.

Brighton.—A meeting of the Town Council was held on Thursday evening last week, when the accounts of last year's working of the electricity undertaking were presented. These show a gross balance of £19,347, nearly all of which goes in payment of interest on redeemable stock, loans, etc, and to sinking fund. The actual balance left is £6,802, and it is divided as follows: relief of general district rate, £2,135; depreciation of batteries, £2,000; depreciation of meters, £1,000; and engineer's commission account, £1,496. The total income was £42,194. The quantity of electricity generated was 3,242 017 units—2,648,701 units were sold, 549,905 of which were consumed in the public lamps. Other sources of income were attention to public lamps, £3,437; installing works on public lamps, £366; rental of meters, £947; and work executed for customers, £700. The expenditure amounted to £22,846. The capital expenditure up to the present time is £237,987. The only important proposal in the proceedings was that the charge should in future be 1d. instead of 1½d. per unit after the first hour. This was agreed to, as was also a proposal of the Tramways Committee that the whole of their members should visit Rouen, Paris, and Brussels for the purpose of inspecting the tramway systems in operation in those cities.

Hetton-le-Hole.—At last week's meeting of the Urban District Council, Mr. D. Balfour, C.E., Mr. Trewhitt, solicitor, Sunderland, and Mr. Hancock, electrical engineer, attended to lay before the Council a scheme for establishing electrical trams worked on the overhead wire system, and asking for permission so far as the Hetton Council's district was concerned. Mr. Balfour said the District Tramways Company proposed to take Houghton-le-Spring as a central point, and tramways worked on the system mentioned would proceed from the Houghton parish church along the road to Fence Houses Station, Newbottle, Philadelphia, on to Penshaw Station. From Herrington Mill they would branch off up to Herrington Colliery. From that point it was advisable, although not just immediately intended, to proceed to Ryhope and Grangetown, in this way meeting the proposed tramway from Sunderland, which was going up to that district. In the other direction from Houghton parish church the tramways would run along the road to Hetton, coming up to the centre of Hetton and proceeding on to Easington-lane, reaching ultimately South Hetton. Altogether it was proposed that about 16 miles of tramways line would be laid. Under the Tramways Act the company would lay the line and keep the permanent way and 8in. outside the rails in repair. They would not be able to pay any consideration or rent for the use of the road, and what they would submit would be that at the end of 21 years the Council would have the right of purchasing and obtaining under the Act at what might be called scrap value, without consideration or compensation. Mr. Trewhitt presented a report which he had made on an inspection of tramway systems on the Continent on behalf of the Corporation, and said they had interviewed the Houghton Urban and Houghton Rural District Councils, both of which had given their consent, it appearing that the proposed tramways would be of great public benefit. The reports are to be further considered by the Council.

Southampton.—On Thursday week the Mayor (Councillor G. A. E. Hussey) switched on the light for the public electric lighting of a portion of the borough, in the presence of members of the Electric Lighting and Works Committees of the Council. The deputy-chairman of the Electric Lighting Committee (Alderman W. Bone) delivered a short address, in which he referred to the history of the works up to the present time. He said the old company was formed in 1888, but they did not begin to supply current until 1891. The undertaking was purchased by the Corporation in 1891 at £21,000. The works had then to be extended, which was done by Messrs. Kincaid, Waller, and Manville, and the greatest credit was due to the firm for the admirable way in which the work was carried out. The Corporation had been in possession about three years, and during that period they had not been standing still. In 1897, the first year they had possession of the works, they had 8,948 lamps connected, and at the present time they had no less than 23 000. The units supplied in 1897 were 131,000, and in 1898 they numbered 265,000. There had been some delay in getting the street lighting ready owing to the difficulties the contractors had had to contend with. Messrs. Playfair and Toole also had had their difficulties, since they had to erect buildings over works already in existence. He acknowledged the valuable assistance of Mr. Lee and his successor, Mr. Chaplin. Having now completed the first section of the work, they looked forward to the Works Committee and the Tramways Committee becoming good customers of the works. They did not want to make a large profit, but each committee must pay for what it had from another committee at a fair and reasonable price. They had made provision for supplying the current to the tramways, and had ample plant for carrying out their present tramway system, and for a small extension as well, and when their battery-room was built they would be in a position to supply more. Provision had been made for 100 street lamps, and it would not be long before the other sections were ready. Mr. Manville and Mr. Waller also spoke. A vote of thanks to the mayor concluded the interesting ceremony.

Fulham.—A special meeting of the Fulham Vestry was held on Monday to consider a report of the Electric Lighting and Dust Destructor Committee, stating that the solicitor submitted the following report: "Fulham Generating Station.—I beg to report that I have been in further communication with Messrs. Wilkinson Bros., and they are not disposed to proceed upon their tender which was accepted by the Vestry, unless the Vestry are willing to vary it by extending the time for the execution of the works to 12 months, and the rate of payment to 90 per cent. and not 80 per cent. as mentioned in the conditions upon which the tender was based. This being so, I communicated with Mr. Minter, and submitted to him draft contract for perusal, and he is prepared to enter into the contract if the Vestry will accede him 10 months'

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time for the execution of the works instead of six as mentioned in the conditions of contract. Should the Vestry consider it desirable to proceed with Mr. Minter's tender, I submit herewith engrossment of contract, specifications, and plans for recommendation to the Vestry for sealing." The committee recommended that the tender of Mr. F. G. Minter be accepted at the sum of £22,970, and that the contract as prepared by the solicitor be approved and sealed; the time allowed for the completion of the works being increased to 10 months. The consulting engineer submitted the following report: "I have to inform you that Messrs. the Horsfall Furnace Syndicate, Limited, have asked me to obtain for them the committee's approval of Mr. Cammack Dennis, of Bury, as subcontractor for the chimney shaft. As the firm is one of good standing, I have taken upon myself the responsibility of telling the Horsfall Syndicate that they may let the sub-contract to him, and that the Electric Lighting Committee will ratify my action. I need scarcely point out that the course I took is to be accounted for by what I know to be the committee's desire—that an actual start should be made with the work as soon as possible on account of the application being made by the County of London and Brush Provincial Electric Light Company for a provisional order for the Fulham district, and also that it is their wish to have the work begun and finished as soon as possible, so as to give a supply of electricity in the parish with the least delay." The committee recommended that the report of the engineer be approved and adopted, subject to the conditions of the Horsfall Company's contract being strictly adhered to. Both clauses of the report were adopted. With respect to the estimates, Mr. R. H. Meyer, the accountant, reported as follows: "I would suggest an addition for £100 under the heading 'contingent expenses' during the above period I have consulted with the electrical engineer as to the provision for capital outlay during the coming six months, and he is of opinion the following will be ample: Horsfall contract, £10,000; building, £15,000; electrical, etc., equipment, £18,000; artesian wells, engineer's commission, clerk of works, and contingencies, £3,500—total, £46,500. These amounts will have to be provided out of loans, but I would not advise the committee to ask the sanction of the Council to borrow the £46,500 now, but would suggest that as soon as the various contracts tendered for have been received and full estimates for other necessary works made out, that application be made to the Council to borrow the whole cost at a lesser rate than 3 per cent. for, say, 42 years, the loan to be taken up at various periods during the current year. By this means I am of opinion the parish will eventually save a considerable sum by way of interest." The estimates were referred to the Finance Committee.

PROVISIONAL PATENTS, 1899.

MARCH 13.

5416. Improvements in spring break switches for electric currents. Joseph John Walklate, 116, Moseley-road, Birmingham.

5464. Means for rendering electrically conductive incandescence bodies which conduct only when their temperature is raised, and apparatus therefor. Paul Scharf, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

5468. Improvements in the electro-deposition of metals. August Zimmerman, 24, Southampton-buildings, Chancery-lane, London. (Dr. Courant, Germany.)

MARCH 14.

5486. Improvements in electric incandescence lamps. Gerald Carlyle Allingham and William Fennell, Harrow Green, Leytonstone-road, London.

5514. Improved electric light apparatus for taking photographic portraits. George Wilson Morgan, 393, Union-street, Aberdeen.

5518. Improvements in electric spark-gap apparatus. Thomas Burton Kinraide, 56, Chancery-lane, London. (Complete specification.)

5519. Improvements in electric break apparatus. Thomas Burton Kinraide, 55, Chancery-lane, London. (Complete specification.)

5543. A multiplex selective system of "wireless telegraphy." Bertram S. Cohen and Philip Henry Cole, 20, Lessing-street, Honor Oak Park, London.

5572. Improvements in insulators for carrying electric line wires. Gustav Hüllstrung, 1, Broad-street-buildings, Liverpool-street, London. (Complete specification.)

5545. Improvements in induction motors for alternating electric current circuits. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edwin W. Rice, jun., and Charles P. Steinmetz., United States.) (Complete specification.)

5546. Improvements in induction motors for alternating electric current circuits. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. Edwin W. Rice, jun., and Charles P. Steinmetz., United States.) (Complete specification.)

5547. Improvements in devices for changing the frequency of alternating currents in systems of electrical distribution. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.) (Complete specification.)

5548. Improvements in devices for changing the frequency of alternating currents in systems of electrical distribution. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.) (Complete specification.)

5549. Improvements in systems of electrical distribution. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States). (Complete specification.)

5550 Improvements in self-starting alternating electric current motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz and Ernst J. Berg, United States.) (Complete specification.)

5551. Improvements in devices for starting alternating electric current motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz and Ernst J. Berg, United States.) (Complete specification.)

5570 Improvements in closed conduits for electric railways and trolleys therefor. Alexander Melville Clark, 53, Chancery-lane, London. (The Campbell Electric Traction Company, United States.) (Complete specification.)

5576. Improvement in automatic systems of preventing collisions on electric railways. Charles Foster Bancroft and Patrick Francis Sullivan, 18, Buckingham-street, Strand, London. (Complete specification.)

MARCH 15.

5601. Improvements in travelling cranes driven by electric power. Joseph Adamson and Daniel Adamson, 17, St. Ann's-square, Manchester.

5619. Improvements in or applicable to galvanic batteries. Franz Emil Singer, 70, Deansgate, Manchester. (Complete specification.)

5634. An improved lampholder and shade-attaching device for incandescent electric lamps. Robert Rough, 52, Chancery-lane, London. (Robert Charles Graham Clark, South African Republic.)

5647. Improvements in secondary batteries. Harold Steuart Gladstone and Ewart John Beckett 53, Chancery-lane, London.

5657. Improvements in apparatus employed in wireless telegraphy. Guglielmo Marconi and the Wireless Telegraph and Signal Company, Limited, 24, Southampton-buildings, Chancery-lane, London.

5665. Improvements in apparatus for electrically transmitting orders, signals, or indications from one place to another. Alfred Upton Alcock, 46, Lincoln's-inn-fields, London.

5672. Improvements in electric switches. Reginald Bycroft Roberts, Norfolk House, Norfolk-street, Strand, London.

MARCH 16.

5680. Improvements in and connected with incandescent electric lamps. John Francis Stanley, Earl Russell, 82, Victoria-street, London.

5685. An improvement in arc lamps especially for cinematograph and other projection applications. Henry Irvine Whitty, The Lower Close, Norwich.

5699. Improvements in storage batteries. Alexander Pallavicini, 160, Friedrichstrasse, Berlin.

5707. Improvements in electric fuses for firing blasting and other explosives. George Smith and David Corrie, 121, West George-street, Glasgow.

5717. Improved dynamo machine. William Turvey, 4, Aubrey-walk, Campden-hill, London.

5726. Improvements in electrical incandescent or glow lamp holders. Ralph Scrivener Keep, 7, Staple-inn, London.

5734. Improvements having reference to hydrocarbon engines for driving dynamo-electric machines and to dynamo-electric machines driven thereby. Comte Georges Vitali, 55, Chancery-lane, London.

5740. An improved arc electric lamp. David Loch, 73, St. Stephen's-road, Upton Park, London.

5761. An improved electric accumulator. George Cecil Dymond, 6, Lord-street, Liverpool. (George Daseking and August Brandes, Germany.) (Complete specification.)

5781. Improvements in electrolysis and electrolytical apparatus. Urbain Louis Paul Le Verrier, 46, Lincoln's-inn-fields, London.

MARCH 17.

5795. Improvements in and connected with electric light by incandescence. James Swinburne, 82, Victoria-street, Westminster, London.

5797. Improvements in alternating-current induction motors. William Gould Rhodes, The Royal Technical Institute, Salford.

5849. Improvements in brushes for dynamos. Carl Endruweit, 18, Buckingham-street, Strand, London. (Complete specification.)

5838. Elevator and transfer crane for storage batteries. George Herbert Condict, 60, Queen Victoria-street, London. (Date applied for under Patents, etc., Act, 1883, Section 103, Sept. 3, 1898, being date of application in United States.) (Complete specification.)

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5839. Battery box and tray for motor vehicles. George Herbert Condict, 60, Queen Victoria-street, London. (Date applied for under Patents, etc., Act, 1883, Section 103, Sept. 3, 1898, being date of application in United States.) (Complete specification.)

5840. System and apparatus for loading and unloading storage batteries. George Herbert Condict, 60, Queen Victoria-street, London. Date applied for under Patents, etc., Act, 1883, Section 103, Oct. 19, 1898, being date of application in United States.) (Complete specification.)

5847. Improvements in switching apparatus for controlling electric or gas lights for advertising and display purposes. Guy Carey Fricker, 46, Lincoln's-inn-fields London.

5857. Improved apparatus for use in connection with electrical advertising signs and display boards. Frederick Brown, 11, Burlington-chambers, New-street, Birmingham.

5874. An improvement in telephones. Siemens Bros. and Co., Limited, and Alexander Selgius Schloemer, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

5879. Improvements in incandescence electric lamps. Ewald Rasch, 46, Lincoln's-inn-fields, London.

MARCH 18.

5897. Improvements in telephone holders. Ernst Pack, 42, Neuenweg, Barmen, Germany.

5932. Improved method and apparatus for rapidly transmitting and recording telegrams. Anton Pollak, Joseph Virag, Julius Egger, and Friedrich Silberstein, 6, Lord-street, Liverpool. (Complete specification.)

5934. Improvements in wave motors or devices for utilising the power of sea waves more particularly for the generation of electricity. Max Gehre, 6, Lord-street, Liverpool.

5941. Improvements in incandescent electric lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edwin W. Rice, jun., United States.) (Complete specification.)

SPECIFICATIONS PUBLISHED.

1898.

1803. Electric arc lamps. Codd and Codd.

4455. Electric railways of the sectional conductor type. Esmond.

4549. Apparatus for electrically controlling the hoisting mechanism of elevators or any other type of machinery. Leigh. (Sprague.)

4746. Method of and means for measuring the work performed in a rotary phase current system. Siemens Bros and Co., Limited. (Siemens und Halske, Aktien-Gesellschaft.)

7283. Miners' lamps, and apparatus for electrically lighting the same. Harrison.

8584. Automatic switch for electric cooking utensils. Down and Eck.

9218. Secondary batteries. Pritchett, Pritchett, and Gold.

9789. Electroliers and incandescence electric lamp pendants. Hirst and Collings.

9895. Apparatus for raising and lowering arc lamps. Davy and Thomas Davies.

14548. Electrical contact makers. Bowles.

15802. Electric accumulators. Leimer.

17191. Overhead conductors for electric railways and the like. Schäfer and Lörintz.

18051. Electric fuse. Childs.

18552. Motor trucks for electric and other railways or tramways, and driving gear therefor. Capewell.

21005. End connections for electric cables. W. T. Henley's Telegraph Works Company, Limited, and Wright.

23706. Manufacture of dynamo brushes. Johann Chrisostimus Leissing and Charles Louis Hiebl.

24051. Electric switch mechanism for surface-contact electric railways. Murphy.

24053. Crossings for electric railways. Murphy.

24377. Electrical stop-motion for warps. Thompson. (Kip.)

24703. Instrument for interlocking railway point and signal levers with electric block or train-signalling switch on double lines of railway. Burns.

25058. Electrical cut-outs. Solomon.

26136. Electrical measuring instruments. Lehner.

1899.

96. Supports or cross-overs for ove-head electric conductors. Andersen and Anderson.

1103. Telautographs. Newton. (The Gray National Telautograph Company.)

1324. Manufacture of electrode plates for electric accumulators. Thompson. (Accumulatoren und Elektricitäts-Werk A.-G. vorm. W. A. Boese and Co.)

1334. Electrically-illuminated signs or advertisements. Campbell.

1481. Supports for the active material of accumulator electrodes. Wüste, von Rupprecht and von Rupprecht.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1899.	Corresponding week 1898.	Increase or decrease.	Total receipts for half-year. 1899.	1898.
		£	£	£	£	£
Birmingham Tramway	Mar. 18	3 850	3,478	+ 372	31,395	38 110
Blackpool and Fleetwood Tramroad	,, 18	236	—	—	1,912	—
Bradford City Trams	Feb. 5	145	—	—	6,733‡	—
Bristol Tramways and Carriage Co.	Mar. 17	2,709	2,503	+ 206	—	—
City and South London Railway	,, 19	1,099	1,030	+ 69	13 278	12,826
Dover Tramways	,, 18	142	117	+ 24	1,571	1,166
Dublin U.T., elec. cars	,, 17	1 039	717†	+ 322	9,478	7,603†
Dublin S.D. Electric Tramways	,, 17	733	402	+ 330	6,804	4,333
Halifax Corporation Tramways	,, 8	301	—	—	9,729*	—
Liverpool Overhead Railway	,, 19	1,369	1,316	+ 53	15,142	16 140
South Staffordshire Tramways	,, 17	615	552	+ 63	6,550	6,341

* Since June 30, 1898. † Including horse cars. ‡ Since July, 1898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	24½-25½
Bournemouth and Poole Electric Supply, Limited, Ord.	10	13½-14
—— 4½ per cent. Cum. Pref	10	10½-11½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	19½ 20
—— 6 p. c. Cm. Pf., 30,001-40,000 (all paid)	10	13½-14½
—— 5 per cent. Perpetual Debenture Stock	100	126-129
Brush Electrical Engineering, Limited, Ordinary	2	1⅞-2⅛
—— Non. Cum., 6 per cent. Pref.	2	2⅛ 2⅜
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	102-105
Callender's Cable Company, Debentures	100	114-117
—— Ordinary	5	12½-13½
Central London Railway, Ordinary	10	9½-10½
——	3	7⅜ 8⅛
—— Pref. Half-Shares	3	3½ 4
—— ,, ,,	5	4½-4⅝
Charing Cross and Strand	5	11½-12½ xd
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	8-9
—— 4½ per cent. Debentures	100	114-116
City of London, Ordinary	10	18-19 xd
—— ,, 90,001-100,000	10	18-19 xd
—— 6 per cent. Cumulative Pref.	10	15-16
—— 5 per cent. Debenture Stock	100	124- 29
City and South London Railway, Consolidated Ordinary	100	68-70
—— Ordinary	3	4⅜-5½
—— 4 per cent. Debenture Stock	100	135-136
—— 5 per cent. Pref. Shares	10	14½ 15½
—— ,, ,, '96	10	14-15
County of London and Brush Prov. Elec. Light Co., Ord.	10	11-12
—— ,, ,, No. 30,001-40,000	10	11-12
—— 6 per cent. Cum. Pref.	10	14-15
Crompton and Co.	3	3⅛ 3⅜
—— 5 per cent. Debentures		98-101
Crystal Palace District, Ordinary 5 per cent. Stock	100	130 135
—— Preference 5 per cent. Stock	100	140-145
Ellison and Swan United Ordinary	3	2⅛-2⅜
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	97-99
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5½-5⅝
Electric Construction, Limited	3	2⅛-2⅜
—— 7 per cent. Cumulative Pref.	7	3-3½
—— 4 per cent. Perp. 1st Mort. Deb.	100	103-106
W. T. Henley's Telegraph Works, Ordinary	10	26-27
—— 7 per cent. Preference	10	18½-19½ xd
—— 4½ per cent. Debentures	100	112-115 xd
House-to-House Company, Ordinary	5	8½-9½ xd
—— 7 per cent. Preference	5	9-10 xd
Imperial Tramways, Limited	6	24½-25½ xd
India Rubber, Gutta Percha, and Telegraph Works	10	21½-22½
—— 4 per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	13-14
London Electric Supply, Ordinary	3	3½-4
—— 6 per cent. Pref.	5	6½-7 xd
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	105-107
Metropolitan Electric Supply, Limited, Ord., No. 1-62,500	10	16-17
—— ,, ,, No. 62,501-85,000	4	12-13
—— 4½ per cent. First Mortgage Debenture Stock	100	117-120
National Telephone, Ordinary	5	4½-5
—— 6 per cent. Cum. First Pref.	10	13-14
—— 6 per cent. Cum. Second Pref.	10	13-14
—— 5 per cent. Non. Cum. Third Pref.	5	4⅞-5½
—— 3½ per cent. Deb. Stock, Red.	100	99-101
Notting Hill Electric Lighting Company, Limited	10	16½-17⅛ xd
Oriental, Limited, 1879	1	1⅛-1⅜
—— £5 Shares	5	7⅛-7⅜
—— £4½ Shares, New	4½	6½-6⅞
Oriental Telephone and Electric Company	1	¾-1
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6⅞-7⅛
Royal Electrical Company of Montreal	1⅛	17⅝-19⅜
—— 4½ per cent. First Shares Mortgage Debentures	100	107-109
South London Electric Supply, Ordinary	3	3⅛ 3⅜
St. James's and Pall Mall, Limited, Ordinary	5	17-17⅜
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	38-42 xd
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	100	109-112
Westminster Electric Supply, Ordinary	5	15½-16⅛

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NOTES.

Congratulations.—We have to tender our hearty congratulations to Mr. Sidney Rentell, the editor of *Electricity*, on his marriage. The happy event took place on Saturday last.

Wireless Telegraph to France.—A successful trial of the Marconi system of wireless telegraphy was made between the South Foreland and Wimereux, a small village about two miles west of Boulogne, on Tuesday last. The distance between the two stations is about 30 miles.

A Motor Maxim.—The 26th Middlesex (Cyclists' Corps) are to experiment with a new gun-carriage at the forthcoming volunteer manœuvres at Aldershot. It is said to be an electric motor tricycle with a service-pattern Maxim gun affixed. Quick movement being essential, the gun can be instantly unlimbered and pulled or carried into position, the weight of the gun and carriage being only some 140lb.

Central Electric Supply Bill.—The Parliamentary Committee of the London County Council have recommended that the above Bill should be further opposed in the House of Lords with a view to obtaining some satisfactory arrangement with respect to purchase of the electric light undertakings, and that a petition should be sealed and presented to the House of Lords with this object against the Central Electric Supply Bill.

More Primary Batteries.—We understand from our contemporary *Electricity*, of New York, that a company called the Chemical Battery, Light, Heat, and Power Company has just been inaugurated at Albany. The company is organised to manufacture and sell to subsidiary companies the right to use what is styled the Roberts primary battery. The capital of the concern is said to be £1,000,000, but we expect that until the subsidiary companies are formed to find the money, the £1,000,000 exists on paper only.

Exhibition at Brussels.—An exhibition of electricity as applied to domestic purposes, including lighting, heating, and cooking, is about to be held at Brussels. The secretary for the exhibition is M. E. Lacomblé, rue Melsens 18, and he informs us that the first floor of the "Hotel des Téléphones" has been granted for the exhibition by the Minister of Railways. We also learn that articles for exhibition will be conveyed by railway at half the usual rates, and that no import duties will be charged. April 10 is the last day for applying for space.

Telephone Royalties.—In the House of Commons last week Mr. Field asked the Secretary to the Treasury whether the Government received 10 per cent. commission from the National Telephone Company, or from any other private telephone company, and whether it was on account of this arrangement that Government refused to take over and make the telephone a public service. Mr. Hanbury replied that the present licensees paid—as future licensees would pay—a royalty of 10 per cent. The answer to the second paragraph was in the negative.

Presentation to Mr. W. J. Johnston.—The past and present employés of the *Electrical World* recently presented to Mr. W. J. Johnston a handsome sterling silver loving cup as a token of their esteem, and to commemorate his connection of a quarter of a century with electrical journalism. On one side of the cup, which has a capacity of four pints, is engraved an appropriate inscription, and on the other the names of the donors—24 in number. Mr. Johnston has now gone on a visit to the scenes in and about Cuba and Porto Rico rendered memorable by the late war.

Preece and Cardew.—Mr. A. H. Preece informs us that a new firm of consulting engineers, under the above name, has now opened offices at 13, Queen Anne's-gate, Westminster. The members of the new firm will be Mr. W. H. Preece, C.B., F.R.S., Pres.Inst. Civil Engineers (late engineer-in-chief of the Post Office); Mr. A. H. Preece, A.M.I.C.E.; Major Cardew, R.E. Ret. (who has been for the last 10 years electrical adviser to the Board of Trade), and Mr. Llewellyn Preece. Mr. A. H. Preece's offices at 39, Victoria-street will be given up. It is, perhaps, superfluous to wish the new firm success, as with such a show of talent and practical experience success is assured.

Third-Rail Systems.—The decision of Mr. George Gould in favour of the third-rail system of electricity for the Manhattan elevated roads has, says *Electricity* of New York, been formally approved by the board of engineers, consisting of the chief engineer, the general manager and the general superintendent, who were appointed by the directors to look into the matter technically. The third-rail system which is here referred to is practically the same as that in use on the Waterloo and City Railway and on the Liverpool Overhead Railway. The third rail may be placed either between the car tracks or on one side, at the option of the company. These details will be left to the engineers.

Cables to Cuba.—Permission to land a cable in Cuba is, says the *Western Electrician*, being sought by the Commercial Cable Company, but as the Western Union claims exclusive privileges under grants from the United States and Spain, the subject has been referred to the Law Department, and the Attorney-General will give an opinion. The fact that the Government has decided not to grant any long-time franchises in Cuba under existing conditions is taken as an indication of its policy in all matters affecting the island. The policy of the Government respecting the recognition of Spanish franchises may be formulated in this decision, as the question is involved in the present controversy.

Obituary.—The death is announced from Leipsic of Prof. Gustav Wiedemann, professor of physics and chemistry in the university of that city. Herr Wiedemann was born at Berlin in 1826. After studying chemistry and physics, he obtained professional appointments at different universities, until at length, in 1871, he was nominated professor of physical chemistry at Leipsic. In 1887 he became professor of physics at the same university. His researches were chiefly in the field of electricity and chemistry, and included the relations between the conductibility of heat and electricity, and between the mechanical and magnetic action of bodies, as well as their dependence on their chemical composition.

Electric Powers Clauses Bill.—A deputation from the Corporations of Arbroath and Kirkcaldy, introduced by Mr. Malcolm, parliamentary agent, had an interview on Friday last with Sir Courtenay Boyle and Mr. Pellham at the Board of Trade offices. Their object was to ask that the clauses in the Electric Power Clauses Bill of the Government prohibiting the transfer of powers to companies obtained by local authorities under provisional orders, should be struck out. Sir C. Boyle admitted that adequate intimation of the intention of the Board to prohibit such transfer had not been given, and if the Corporations insisted that the clause should be struck out that course would be followed, at any rate for the present year.

Royal Institution.—The following lectures, amongst others, have been arranged to be given after Easter at the

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Royal Institution: Prof. Silvanus P. Thompson, two lectures on "Electric Eddy Currents" (the Tyndall lectures); Prof. W. J. Sollas, three lectures on "Geology"; Prof. Dewar, three lectures on "The Atmosphere." The Friday evening meetings will be resumed on April 14, when a discourse will be delivered by Prof. A. W. Rücker on "Earth Currents and Electric Traction." Succeeding discourses will probably be given by Dr. F. W. Mott, Prof. C. A. Carus-Wilson, Dr. W. J. Russell, Prof, T. Preston, the Right Rev. the Lord Bishop of Bristol, Sir William Martin Conway, Mr. H. G. Wells, and other gentlemen.

Electric Lighting in India.—We gather from *Indian Engineering* that a scheme is under consideration for lighting Calcutta Government House and its grounds by electricity. Plans are being drawn up and estimates prepared, and it is expected that work will be completed before the return of the Viceroy from the hills next cold season. In the same issue of our contemporary there is a description of a private installation recently laid down in Calcutta, in which machinery supplied by Messrs. Johnson and Phillips has been used. It provides current for some 200 lamps, and comprises everything required, from the boilers, engines, dynamos, and accumulators to the lamps themselves. Mr. F. M. Short, who also put down the plant at the Burma ruby mines, has been responsible for the carrying out of the work.

Congo Contracts.—A correspondent who is deeply interested in trade on the Congo informs us that the town of Matadi, the terminus of the new railway, and Boma, the capital of the Free State, are both to be electrically lighted shortly. There should be a good chance for English contractors in these districts. We also glean from the same source that the telegraph lines in the Congo Free State, which are ultimately to connect the east coast of Africa with the west, are being subjected to unexpected troubles. The poles used are of iron of T-section, and the herds of wild elephants still left in the districts through which the lines run have begun to use the poles as rubbing posts. For this purpose the iron seems to give more pleasure than trees, but, unfortunately, the poles have not been designed to stand the weight of a full-grown elephant. The language of these animals when a favourite pole gives way is said to upset the telegraph system generally.

Electric Lighting in New York.—The accounts for 1898 of the Edison Electric Illuminating Company, of New York, have recently been issued, and the following few figures will be of interest to those who wish to compare the progress of electricity supply in New York with that in London. The total income from the sale of electricity, etc., for the year amounted to £579,600, while the costs were as follows: generating costs, £224,580; general expenses and rates and taxes, £84,900; depreciation charges, £42,000. Thus the working expenses total up to £351,480. This left a profit of £228,220, to which is added some £27,200 received from other sources. The load on the stations now comprises the equivalent of 886,148 8-c.p. incandescent lamps, some 7,350 arc lamps, and 24,438 h.p. of motors. This brings the total connection in equivalent 8-c.p. lamps up to 1,783,228. This is approximately equal to the loads on all the London companies' mains, but we cannot show anything like such a large motor load.

The Voice of the Thaw.—A few days ago, says the *Electrical World*, nearly every telephone subscriber in Plymouth, Ind., was at the same moment called up with a violent ring, with the result that the air thereabouts was full of "Wells?" "Hellos," and interrogation points, and, probably, exclamation and other points a few moments later, when it was discovered that the alarm was a false one. The cause of this general uprising among the subscribers was an endeavour on somebody's part to thaw out a frozen water-pipe by electricity. The application of an electric current as a means of thawing out frozen water-pipes is quite widely and successfully used in the West just now, and in this particular instance an unlooked-for result developed. The ground-return telephone system is used in Plymouth, and as most of the ground connections are made with the water-pipes, it was quite natural that the telephones should sound the danger alarm the moment a heavy current was applied to the troublesome pipe. It was a realisation of the Munchausen fable of thawing out frozen speech.

Variations in Conductivity.—A few years ago Prof. Sanford announced that he had discovered that the dielectric surrounding a wire was capable of affecting its conductivity. He said that from experiments he had made it would be necessary that Ohm's law should be modified, and that in some instances the difference was as much as ¼ per cent. with certain dielectrics surrounding the conductor. Other investigators have since endeavoured to find whether this is true or not, and various results were obtained, but as these differed, Mr. Merill repeated the experiments in a more refined way, using large lengths of wire and measuring the temperature more accurately. The results are published in the February number of the *Physical Review*. He shows that if there was any change in the conductivity of a wire due to the surrounding dielectric, this change was not greater than 0·01 per cent.—that is, there was no change greater than the probable limits of experimental error. Notwithstanding Prof. Sanford's announcement, Ohm's law has continued to be used, but "it is nevertheless a comfort," says Mr. Carl Hering in his digest, "to know now that it is correct."

Our New Contemporary.—The first issue of the American journal to be styled the *Electrical World and Electrical Engineer* has reached us, and it naturally contains a statement of policy. Thus the great responsibility of the paper is expatiated on. The editors add that "Creditable as were the long careers of the component journals, the standard set for the future of the new one is necessarily still higher—a standard, indeed, unattainable without a concentration of forces. In no branch of industry and in no profession does there exist a higher *esprit de corps* than animates the members of the electrical fraternity, while none more worthily demands the highest and best in its journalistic exponent. The *Electrical World and Electrical Engineer* will, we trust, never be found wanting as a true and loyal advocate of the electrical spirit and ideals. As a representative of the important field which it will cover, it proposes to rank second to no industrial or engineering periodical in the world, and as the best pledge of its success we count in fullest confidence on the cordial co-operation of everyone interested in the advance of the art and science." We trust our contemporary will forgive us if, when quoting from their columns items of interest to our readers, we do not always give their full title.

Reducing Transformer Losses.—The idea of reducing the iron losses of transformers at light loads by using sections of the coils in series, and then putting the sections in parallel at heavy loads, is as old as the hills. Patents on the subjects are held in England, but the idea is largely discounted by the high efficiency now obtainable in transformers. We see, however, that an elaboration of this idea, especially adapted to three-phase work, has been patented in the United States of America by E. L. K. F. Kahlenberg, in patent No. 620,144, issued February 28,

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1899. The three primary windings of a three-phase transformer or three single-phase transformers are connected with a switch by which they may be connected either in the star or delta grouping, the three secondaries being similarly arranged. As is well known, the delta grouping with the same potential difference between terminals gives an E.M.F. to each winding 70 per cent. greater than does the star grouping, the current in the coils being correspondingly less. By adopting the star grouping under light loads, and the delta grouping under heavy loads, the induction in the iron can thus be changed, and a considerable saving in the total loss effected. These facts are taken from the *Electrical World*, but we do not think the invention can be validly patented at this stage of the industry. A similar procedure when starting up three-phase motors has been used for several years in Germany.

Flexible Conduits.—The Sprague Electric Company, of New York, has just put on the market the Greenfield system of flexible metallic conduit for house wiring. This conduit is composed of convex and concave metal strips wound spirally upon each other so to interlock their concave surfaces and present their convex surfaces to both exterior and interior. Thus a smooth and comparatively frictionless surface, both inside and outside, is secured. The Greenfield conduit can be manufactured in any desired lengths, and as the circuit divisions in interior wiring are never of any considerable length, it follows that under this system no necessity exists for a break in the continuity of a division from junction box to outlet. By reason of the great flexibility of the Greenfield conduit, as well as its perfectly smooth and comparatively frictionless interior, it can be led round comparatively sharp obstructions. Another important feature claimed for the conduit is that the outer surface is such that plaster or other surfacing material will rigidly adhere to it, thereby entirely eliminating the unsightly "plaster cracks" so frequently in evidence where rigid conduit is covered by a comparatively thin layer of plaster. The design of the conduit is such that, while affording the greatest ease in bending to a curve formation, it absolutely prevents the possibility of flattening. The interior is thus invariably of uniform diameter and symmetrical proportions.

Mementoes of Dalton.—At the meeting of the Chemical Society on the 16th inst., the president, Prof. Dewar, F.R.S., announced that he desired to present to the society a daguerreotype of Dalton, which was one of two taken in 1842. The daguerrotype came into the possession of Mr. Dancer, a philosophical instrument maker of Manchester, who, it might be interesting to state, constructed Joule's thermometers and apparatus, and it was from Mr. Dancer's relatives that he had acquired the portrait. He felt that so interesting a memorial of such a man ought not to remain in the possession of a private individual, and it seemed fitting that its custody should be entrusted to the Chemical Society. He therefore presented it to the society on the understanding that steps should be taken to ensure its safe preservation. The president also announced that through the kindness of Mr. S. W. Woolley he had received an interesting card, which appeared to have been used by Dalton during the meeting of the British Association at Manchester in 1842. The card bore his autograph and an embossed head. Accompanying it was an engraved sheet of symbols representing atomic combinations, which had been prepared to illustrate a paper read by Dalton at this meeting. These he also desired to present to the society, to be included in the collection of memorials of illustrious chemists which was being gradually formed. A hearty vote of thanks was passed to the two donors.

Electric Elevators.—The electric lifts and elevators at the New South Union Station, Boston, are fully described in the current issue of the *Railway and Engineering Review*, Chicago. This large station contains many new features of interest to railway engineers, as does its system of electric passenger and luggage lifts to the electrical engineer. The passenger elevators are of the ordinary Sprague type, while the luggage hoists were specially designed for this station by the Sprague Electric Company. At this station all the arrangements for luggage are placed underground, so that the passenger traffic on to the platforms is unimpeded by the usual luggage trucks. In consequence, a lift has to be provided on each platform to bring the luggage up to the surface for loading into the train. For this purpose, a lift with the platform 15ft. wide by about 6ft. is provided, driven in the following way: At one end of the lift an electric motor is clamped on to the under side of the station platform; this motor drives, by means of two worm and wheel gears (which are respectively right and left handed), the two steel shafts which travel the full length of the lift platform, one being placed at either side. On each of these longitudinal shafts two right and left handed worms are provided, round which ½in. chains which lift the platform are wound. The total lift is 16½ft., and the normal load is 3,000lb. at a speed of 15ft. per minute. The controlling devices of this lift are very simple, and are so interlocked with the gates at the top that it cannot be moved unless these gates are closed. The lifts were designed to make one trip per minute, which has been easily obtained in practice. The motors used are rated at 12 h.p., and run at 750 revolutions per minute.

Temperature and Light.—Prof. Elihu Thomson has sent to the *Electrical Review* of New York an interesting letter on the much-discussed question of the action of the Welsbach mantle. He claims that from experiments he has made it is clear that the light given out by a mantle is not due merely to its being brought to a high temperature by the hot gases of the burner. He found that the material, when introduced into the flame of an arc, and very highly heated, did not shine with any greater light than a piece of carbon filament would under similar conditions, and that what was necessary to develop the light-giving quality was to immerse the material of the mantle in gases undergoing combustion—*i.e.*, in gases containing combustible and free oxygen. This was illustrated by the use of an ordinary blow-pipe flame; when a piece of a mantle was placed in the reducing flame it glowed brightly, but when carried out to the point of the flame (where the combustion was completed) it glowed far more faintly, though the temperature of the gases was doubtless as high in one case as in the other. This led Prof. Thomson to make other experiments, which, in general, confirmed the view expressed "that the light given out by a Welsbach mantle is, apparently, largely due to union of the gases taking place within the pores." Gases may possibly be condensed within the pores and there caused to unite, producing high temperatures, or the material of the mantle itself may be intermediary in a set of chemical changes, which result in the oxidisation of the carbon and hydrogen of the flame. Prof. Thomson also supports his contention by pointing out how important it is with a limelight to arrange the jet of oxygen and hydrogen so that it impinges on the lime before combustion is quite completed.

Gas Testing.—An editorial comment in the *Journal of Gas Lighting* on a recent report of the Public Control Committee of the London County Council discloses the most disgraceful special pleading we have seen for some

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years. The report in question states that the result of tests with a portable photometer showed that 85 per cent. of the gas tested was below the parliamentary standard. Our contemporary explains that during the period of test the results found at the usual testing station placed on feeding mains show that good gas was being delivered. It proceeds to argue that "the fixed testing stations are all on live mains, and are intended to permit a record to be made of the gas actually being sent through these mains. The services to the stations are carefully kept clean, with the same object. In the words of Section 8 of the Gas Companies Acts Amendment Act, 1880, the results of the testing at a station are to show 'the illuminating power of such gas on that day at such testing place.' Not everywhere. If the Act had been intended to ensure that every consumer should have the gas tested as it is actually sent into his premises, according to the plausible language of the report, it would have said so." So our contemporary advances the barefaced plea that the consumer was not considered when the 1880 Act was passed, and that the standard was fixed for the benefit of the testing station only. Surely, it would be better to argue that so long as the gas company send round approved samples of gas to the testing station by hand each day, it might supply any quality of gas it likes through its mains. If the companies are specially careful to keep pipes going to testing stations clean, they are knowingly defeating the objects of the Act. Such special pleading is a disgrace to the gas industry.

Liquid Hydrogen.—At a recent meeting of the Chemical Society, Prof. Dewar, F.R.S., read a paper on "The Boiling Point of Liquid Hydrogen as Determined by a Rhodium-Platinum Resistance Thermometer." In his paper the author referred to the difficulties in liquefying hydrogen caused by the presence of air in the gas, and explained some experiments which had for their object the removal of this fruitful source of trouble. This is by no means easy, as quantities amounting to only a fraction of a per cent. accumulate in the solid state, and eventually choke the nozzle of the apparatus, necessitating the abandonment of the operation. Recently, the author had succeeded in obtaining 250 cubic centimetres of colourless liquid hydrogen, and this had been employed in a redetermination of the boiling point. Earlier observations, made with a pure platinum resistance thermometer, had given – 238deg. as the boiling point, and a new thermometer constructed from pure platinum from a different source gave practically the same result. As this might be affected by some constant error, the determination was checked by employing a thermometer constructed from an alloy of rhodium and platinum, containing 10 per cent. of the former. Alloys had been shown by Prof. Fleming and the author to differ from pure metals in showing no sign of becoming perfect conductors at the absolute zero of temperature, and a study of the rhodium-platinum alloy had shown that the change in conductivity produced by cooling from 0deg. to the boiling point of liquid air is regular, and may be represented by a straight line. As determined by the rhodium-platinum thermometer, the boiling point of hydrogen was found to be – 246deg. Two ways of explaining the discrepancy between the two determinations suggested themselves. Pure platinum, although its resistance may be represented by a straight line almost down to the solidifying point of air, shows signs of a departure from regularity at about this point, and the curve may become asymptotic at lower temperatures. On the other hand, the resistance of the rhodium-platinum alloy diminishes less rapidly at these lower temperatures, and is much higher than that of pure platinum under similar conditions. It follows that its resistance temperature curve, in all probability, deviates less from a straight line than is the case with platinum. Either cause would explain the differences observed, but the lower boiling point, – 246deg., or 27deg. absolute, seemed to be the more probable, as it agreed very fairly with the value for the boiling point calculated by the author from Wroblewski's results and that arrived at by Olszewski. As the use of other pure metals or alloys could not lead to more satisfactory results, the problem must be attacked in a different way by means of an "air" thermometer containing hydrogen under diminished pressure. Since the body of the paper was written, the author had made a first attempt at determining the boiling point by a constant volume hydrogen thermometer working under diminished pressure. The result was that this thermometer, which gave the boiling point of oxygen as 90·5deg. absolute or – 182·5deg., gave for hydrogen 21deg. absolute or – 252deg. The three determinations that have been made are, then, as follows: (1) pure platinum resistance thermometer, 35deg. absolute; (2) rhodium-platinum resistance thermometer, 27deg. absolute; (3) hydrogen thermometer, 20deg. absolute. From this it appears that the boiling point of hydrogen is really lower than was anticipated. The experiment will be repeated with thermometers filled with hydrogen prepared from different sources. The boiling point should be determined by the use of a hydrogen thermometer filled with gas obtained from the evaporation of the liquid hydrogen itself.

New Transformer Diagram.—A new method for obtaining the instantaneous valuations of the primary and secondary currents and the magnetic flux of a transformer is described by Mr. Baum in the February number of the *Physical Review*. The article in question is abstracted as follows in Mr. Carl Hering's digest in the *Electrical World*: "Mr. Baum endeavours to express the instantaneous values of these three varying quantities with their angular relations, in terms of the self-inductance and resistance of the two coils and the impressed E.M.F. The resulting diagram is simple and applies to every possible case, and the method of obtaining it is said to be straightforward. The use of the diagram is probably only for giving a mental picture of the whole phenomena, but the algebraic results show that it is no more difficult to solve a transformer problem in this way than any problem in simple alternating-current series circuits. The assumption generally made that the secondary circuit is 90deg. behind the primary is nearly true for a small load, but becomes less true as the external resistance is reduced, and he therefore considers the assumption unnecessary. The paper is highly mathematical in character, but some of the conclusions are of interest. In all problems concerning the primary or the line feeding it he shows that the transformer may be replaced by a single coil of a certain self-inductance, and the same resistance as the primary, the applied E.M.F. being replaced by one having a certain value, and in advance of the true E.M.F. by a certain angle. In this way it becomes possible to solve completely the problems of the multiple transformer circuit, each transformer being replaced by a single coil, the total current being obtained by geometric summation. This is on the assumption that there is a non-inductive load and no hysteresis. In general, however, any transformer may be replaced by a single coil having a certain coefficient of self-induction and equal resistance, and an E.M.F. whose value bears a certain relation to the real one, and at a certain angle. In the same way the solution of problems in the receiver circuit may be solved. He refers also briefly to the case of successive transformations."

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THE ELECTRICALLY-DRIVEN MOUNTAIN ROPE RAILWAY AT MONT-DORE.

The *Elektrotechnische Zeitschrift* contains a digest, signed "F. L.," of an article describing an electrically-driven mountain rope railway at Mont-Dore which recently appeared in the *Revue Technique*. As this railway is claimed to be the sole example of its kind in Europe, we take the liberty of translating the article.

It appears that Mont-Dore boasts a sanatorium for the treatment of lung and throat diseases which has won great favour in medical circles on account of the healing properties attributed to the ozone-permeated forest air of the neighbourhood, and consequently enjoys considerable patronage. Formerly ascent to the mountains could be made only on foot or horse, which circumstance led Mr. A. Girauder to the conception of the electrically-worked cable railway under notice. The electrical portion of the undertaking has been executed according to the plans of Messrs. Guitton and Co., the French representatives of the Oerlikon Engineering Works, Zürich. The requisite motive power is furnished by the Dordogne. In the generating station, which is situated in the valley 2·2 km. distant from Mont-Dore, three-phase current is generated at an initial pressure of 3,600 volts. This current is conveyed direct to an alternate-current motor designed to work at the above terminal pressure, minus, of course, the loss in the leads, so that transformation of the current between generator and motor from high to low tension is thus obviated.

With a minimum consumption of 550 litres of water per second, possessing an effective fall of 31·5m., the turbine installed is capable of developing 1,600 h.p. in round figures, the total length of the water-race being 740m. At present one generator only is coupled to the turbine shaft.

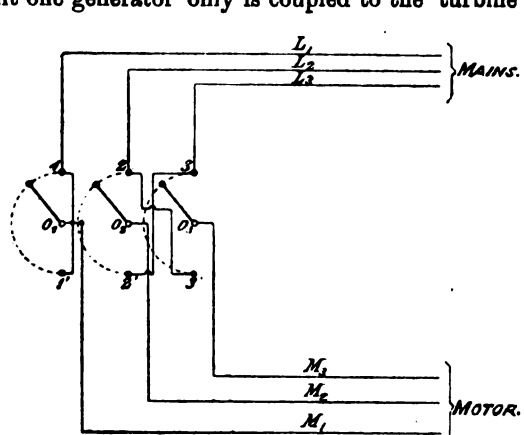

FIG. 2.

This generator is of the Oerlikon inductor type, and is connected to the turbine shaft by means of a flexible coupling. A flywheel weighing 1,800 kg. is further provided, such a steadying medium being considered necessary in order to avoid the excessive jerk which would otherwise occur at the moment of switching the motor in or out of circuit, since the action of switching the motor in circuit may throw a sudden load on the generator of so much as 80 h.p.

The armature coils of the generator being wound separately on formers and secured in position by means of wooden pegs are readily interchangeable. Further, in order to secure the greatest possible degree of simplicity and reliability in running, the machine has been provided with stationary exciting coils. Since there is at present no reserve machine at disposal, it is, of course, important that any necessary repairs may be executed with maximum ease and expedition so as to avoid interruptions in the working of the plant. The further data relative to the generator are as follows:

Revolutions per minute	500
Output in kilowatts	138
Voltage in each phase	2,080 volts.
Line voltage	3,600 „
Normal current in each phase	12 amperes.
Instantaneous current in each phase	22 „
Number of armature coils	18
Frequency	50
Power factor at full load	0·85
Efficiency at full load	92 per cent.

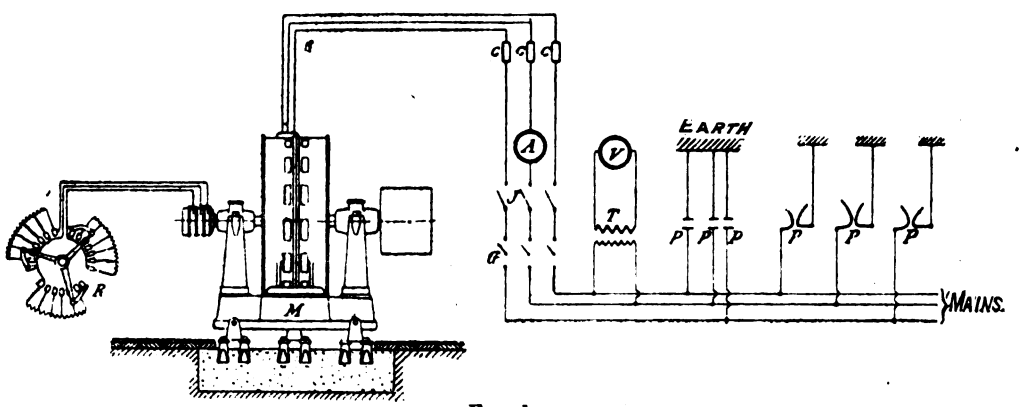

FIG. 1.

The excitation is provided by a small direct-coupled, bipolar, continuous-current dynamo, wound from 12 to 15 amperes at 50 volts terminal pressure. In the station is also a small single-phase alternate-current transformer connected across one of the three phases of the generator which supplies current for illuminating the buildings, and at the same time serves in connection with a voltmeter to indicate the terminal tension of the generator—that is to say, a known ratio of the same.

Fig. 1 shows the general arrangement of the secondary or motor station, where R is the starting resistance; M, motor; C C C, fuses; A, ampere-meter; J, three-pole cut-out; G, three-pole switch (1, Fig. 2); V, voltmeter; T, voltmeter transformer; P P, etc., lightning arresters. The length of the line wires is 3·4 km. These consist of three bare silicum-bronze wires, each of 4mm. diameter, and are carried overhead by wooden masts, to which are attached double-bell porcelain insulators. Under normal conditions the loss of pressure in the leads amounts to 8 per cent.

The motor serving to work the railway is an asynchronous three-phase machine. Its armature has a drum three-phase winding. In order to reduce the magnetic leakage to a minimum, the armature has been given an exaggerated diameter in proportion to its length, while the air-gap amounts to only 0·5mm. The phase windings are connected together on the star principle. Three collector rings are fixed to the shaft of the motor, before which non-inductive resistance consisting of spiral wires is switched upon starting up. The exciting system is 12 polar, and since the frequency of the rotary field is 50, this accordingly corresponds to 500 revolutions per minute with the motor running light. Hence, as the slip amounts to about 2 per cent., it follows that the revolutions at normal load must be 490. At this velocity the motor yields 90 h.p. and consumes 13·5 amperes per phase at a phase pressure of about 2,000 volts. Suppose, now, we reduce the revolutions of the generator to 400 per minute, which corresponds to a frequency of 40, then the motor will suffer a corresponding reduction of speed to 392 revolutions per minute, at which velocity its output amounts to about 85 h.p. with

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a consumption of 12·8 amperes at the constant phase-pressure of 2,000 volts. Starting up on load is considerably facilitated when the ascending car happens at the moment of starting to be located on an incline of 342 in 1,000, and the descending car on a fall of 260 in 1,000, so that a partial balance exists.

During the trial runs, however, it was frequently necessary to start up when the ascending car containing a double load was situate on an incline of 560 in 1,000, while the descending car (empty) rested upon a gradient of only 260 in 1,000. But the motor proved, nevertheless, fully equal to the demand upon it. When the traffic over the line was at its height with a fully-loaded car in course of ascent and an empty car on the descent, the motor consumed 11·5 amperes running at a speed of 490 revolutions per minute. With the armature winding cut out—that is to say, when the motor is at rest—the primary winding takes 4·5 amperes.

Since the two cars attached to the hauling cable make the ascent and descent alternately, it follows that upon the completion of each journey the turning direction of the cable drum, and, therefore, also that of the motor, must be reversed. For this purpose the reversing switch, shown in Fig. 2, is employed. The contacts 1, 2, 3 are connected with the three main leads; O_1, O_2, O_3 represent the lever pivots from which three points branch the conductors, M_1, M_2, M_3, to the motor. The three arms or levers of the reversing switch are actuated through a single handle. The contacts 2^1 and 3, as also 2 and 3^1, are connected respectively together. When the switch arms rest upon the contacts 1, 2, 3, the connections are as follows: L_1 is connected with M_1, L_2 with M_2, and L_3 with M_3, and the motor's armature revolves in a certain direction. But in throwing the switch over to the contacts 1^1, 2^1, 3^1, the following change is effected: L_1 is connected with M_1, L_2 with M_3, and L_3 with M_2; or, in other words, the motor is reversed. No alteration of these connections is possible during running, and the motor maintains its velocity independent of the gradient.

After the two cars have crossed, the descending car enters upon the most abrupt part of its descent and draws the other, whereupon the motor assumes the function of a generator, acting consequently as brake by sending a back current through the leads into the armature of the generator proper. The torque of the motor is transmitted to the cable drum through the medium of a driving belt and two toothed wheels. The speed ratios of the gearing are as follows:

	Revs. per min.
Shaft of the three-phase motor...	490
Countershaft I.	150
Countershaft II.	38
Shaft of the cable drum.....	4·76

The hauling cable is composed of six strands of 19 wires each, the material used being Swedish steel, while the further data relating to the same are:

Diameter of a single wire.....	2·2mm.
Diameter of the cable	33·0mm.
Weight of the cable per metre...	3·9 kg.
Tensile strength of the wire ...	160·0 kg. per sq. mm.
Tensile strength of the cable ...	55,828·0 kg. per sq. mm.
Factor of safety.....	10·0

The length of the track is 458·88m., while the difference in altitude between the two extremities amounts to 177·24m., the highest point being situate 1,246·30m. above sea-level. The line is composed of a single track, except at its centre, where there is a cross-over 38m. in length. Further, the gauge is 1m., and the weight of the rails employed 23 kg. per metre. The rolling-stock consists of two cars, each of which is capable of accommodating 50 passengers. Their net weight is 5·035 tonnes each, of which 3·11 tonnes is represented by the car truck and brakes. The cars have four wheels of 550mm. diameter, are 9m. long, and 2·4m. in breadth.

The above-described railway enjoys the unique position of being the first example of its kind in France, and, indeed, the only motor plant in all Europe driven by means of high-tension three-phase current transmitted from a distance without the agency of transformers. Its success, as will be gathered from the foregoing remarks, is largely due to the excellence of the work turned out by the Oerlikon Engineering Company, Zürich, to which firm the Continent owes a mass of valuable pioneering work, of which the example under notice is but a small fraction.

INSTITUTION OF ELECTRICAL ENGINEERS.

The Hissing of the Electric Arc.

BY MRS. AYRTON.

There are three ways in which any change that takes place in the electric arc may manifest itself: (1) by giving out sounds of various kinds or by becoming silent; (2) by changes in its electrical measurements; and (3) by an alteration in the appearance of the crater, the arc, and the carbons. Only two of the many and varied sounds given out by the direct-current open arc seem to possess much significance—the hum and the hiss—and the causes of these are evidently connected with one another, for the hum never occurs except when the arc is on the point of hissing or has just been hissing, although it is quite possible to make an arc hiss and become silent again without any hum being heard either before or after.

It is proposed in the present paper to discuss the arc as it passes from silence to humming and from humming to hissing, but as the changes that occur when the silent arc begins to hum make themselves perceptible to eye and ear only, and do not sensibly affect the electrical measurements, silent and humming arcs will be included under one head in the portion of the paper dealing with those measurements. It is, however, to the comparatively unexplored region of the direct-current hissing arc that I desire to particularly direct your attention this evening.

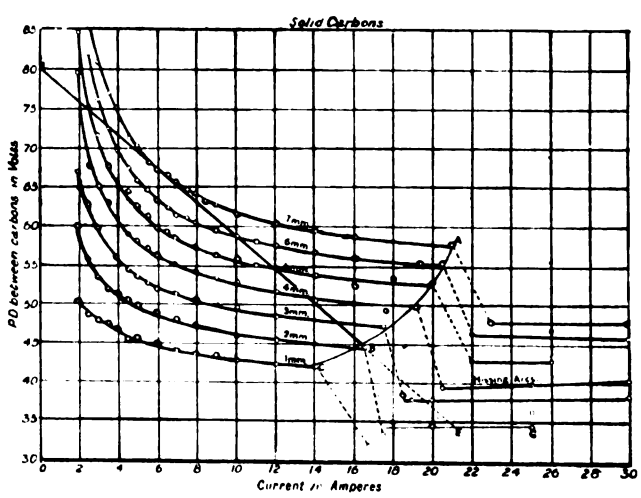

FIG. 1.—Open Arc—Curves connecting P.D. and Current for Constant Length of Arc. CARBONS: Positive, 11 mm.; Negative, 9 mm.

Some of the electrical measurements of the arc burning between two solid carbons 11mm. and 9mm. in diameter are shown in Fig. 1, in which the curves connect the potential difference between the carbons with the length of the arc for several constant lengths of arc, both silent and hissing. It is important to bear in mind that before each observation was made the current and length of arc were kept rigorously constant for a sufficient length of time for the carbons to take their characteristic shape for that particular current and length of arc, and long enough, therefore, for the potential difference to have become constant also. Such an arc I propose to call a normal arc, as contrasted with one arrived at in a haphazard fashion by suddenly giving the current some particular value and the arc some particular length, and making observations without giving the carbons time to acquire their proper forms. All the lines to the left of the curve A B C represent silent arcs, while immediately to the right of this curve are dotted lines denoting a period when the arc is in the unstable condition that always divides the silent from the hissing arc; and still further to the right are the lines representing the hissing arc.

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As we are only dealing with hissing and humming arcs and with the silent arcs that are near hissing or humming, we need only discuss that part of Fig. 1 that is to the right of the line representing, say, 12 amperes, for that part includes all such arcs for each of the constant lengths. An examination of these curves shows that with the carbons used, and with what I have called the normal arc, the following results are met with: (1) when the length of the arc is constant and the arc is silent, it may be made to hiss by increasing the current sufficiently; (2) the largest current that will maintain a silent arc is greater the longer the arc; (3) when the arc begins to hiss, the potential difference suddenly falls about 10 volts and the current suddenly rises two or three amperes; (4) when the current is constant and the arc is silent, shortening the arc will make it hiss; (5) for the hissing arc, the potential difference is constant for a given length of arc, whatever the current.

It was Niaudet who, in 1881, first observed the fall of about 10 volts in the potential difference between the carbons at the moment the hissing began, and, although, perhaps, there is even yet a lingering notion that it is only when an arc is short that it can hiss, I find that as far back as 1889 Luggin showed that however long an arc might be, it would still hiss were the current increased sufficiently. At the congress at Chicago in 1893 Prof. Ayrton first drew attention to the region of instability, or rather the region of blankness (notice the dotted portion of Figs. 1 and 2), corresponding with the impossibility of maintaining any normal arc with a particular range of current for each length. At the same time he pointed out in Fig. 2, shown at Chicago, that whether the potential difference was descending as the current increased for, say, a 4mm. silent arc, or was ascending for, say, a 0·5mm. silent arc, it became quite constant for wide variations of current with a hissing arc. And, lastly, by a comparison of Fig. 2 with Fig. 3 he brought out the fact that the largest current that would flow silently with any given length of arc was increased by using thicker carbons. For the carbons in Fig. 3 have about twice the diameter of those in Fig. 2, and, while the largest silent current for, say, the 2mm. arc in Fig. 2 is 15·5 amperes, that for the same length of arc in Fig. 3 is about 49 amperes, or more than three times as great.

Returning now to the subject of the dotted lines in Figs. 1, 2, and 3, it is plain that these divide the curves into two perfectly separate parts, governed by different laws. For to the left of the dotted part the lines are all curved, and curved differently according as solid or cored positive carbons are used, showing that with silent arcs the potential difference varies as the current varies, and that the law of variation is different with solid and cored carbons. To the right, on the other hand, the lines are all straight, and more or less parallel to the axis of current, whether the positive carbon is solid or cored, showing that with hissing arcs the potential difference is the same for a given length of arc and a given pair of carbons, whatever current is flowing, and that this law is true whether the carbons be cored or solid. In fact, some complete and sudden breakdown appears to occur when hissing begins, upsetting all the laws that have governed the arc while it was silent, and bringing the behaviour of cored and solid carbons into accord. Thus our subject divides itself quite naturally into two distinct portions, the one dealing with the arc when the breakdown is imminent, but before it has actually occurred—dealing, that is to say, with the points at which the current is the largest that will flow silently—the hissing points as I shall call them; and the other dealing with the arc after the breakdown has occurred, and when, therefore, the arc is really hissing.

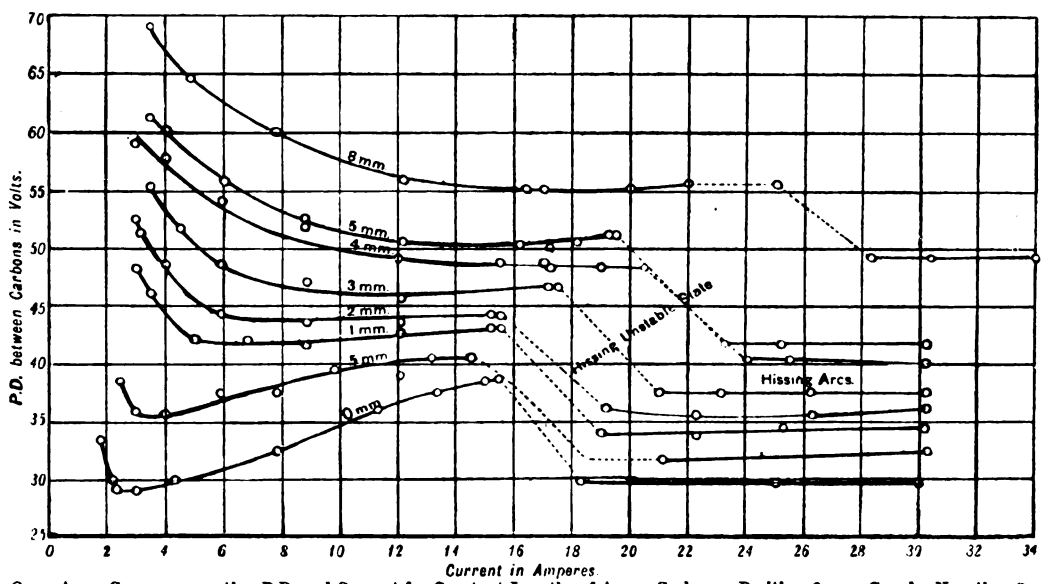

FIG. 2.—Open Arc. Curves connecting P.D. and Current for Constant Lengths of Arc. Carbons: Positive, 9 mm. Cored; Negative, 8 mm Solid.

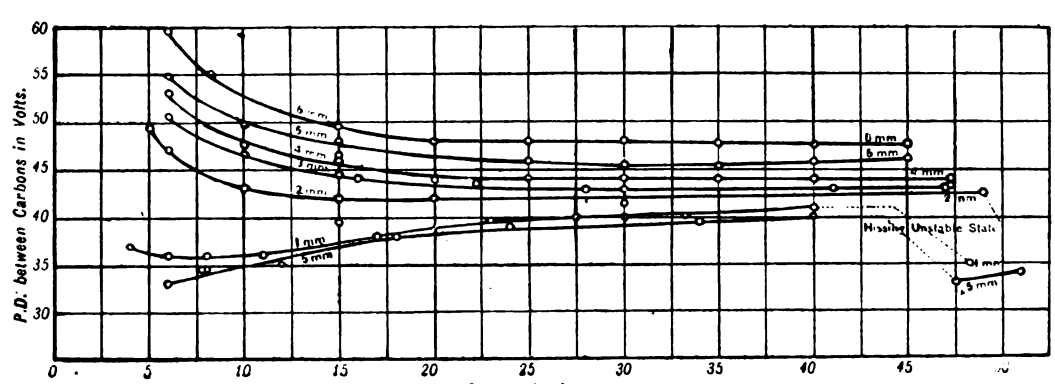

FIG. 3.—Open Arcs. Curves connecting P.D. and Current for Constant Lengths of Arc. Carbons: Positive, 18 mm. Cored; Negative, 15 mm. Solid.

On examination of Fig. 1, the points of which were obtained experimentally with much care, it is seen that the hissing points lie well on the curve A B C, the equation to which I have shown elsewhere to be

$$V = 40{\cdot}05 + \frac{2{\cdot}91\,A - 29{\cdot}02}{10{\cdot}54 - 0{\cdot}416\,A} \quad . \quad . \quad . \quad (1)$$

where V is the potential difference between the carbons in volts, and A is the largest silent current in amperes. Or,

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expressing the potential difference in terms of l, the length of the arc in millimetres, instead of in terms of the current at the hissing points, we have

$$V = 40{\cdot}05 + 2{\cdot}49\,l \quad . \quad . \quad . \quad . \quad . \quad (2)$$

which shows that at the hissing points any given increase in the length of the arc causes an increase in the potential difference between the carbons that is simply proportional to the increase of length—that is to say, for every millimetre that is added to the length of the arc, 2·49 volts is added to the potential difference between the carbons at the hissing point. From the above two equations I deduced the third—viz.,

$$l = \frac{1{\cdot}17\,A - 11{\cdot}66}{10{\cdot}54 - 0{\cdot}416\,A} \quad . \quad . \quad . \quad . \quad (3)$$

and pointed out that, since l was infinite when

$$10{\cdot}54 - 0{\cdot}416\,A = 0, \text{ or when } A = 25{\cdot}3 \text{ amperes},$$

no current greater than 25·3 amperes could maintain a normal silent arc, however long it might be made with the particular carbons used. Hence we may gather that for each pair of carbons the current that will sustain a normal silent arc has a maximum value, and that any current greater than this will make the arc hiss, however long it may be.

To turn now to the arc when hissing has actually begun. It has already been shown that when the arc is hissing the potential difference between the carbons is constant for any given length of arc, and is therefore independent of the current; but no law has yet been given connecting the potential difference between the carbons with the length of the arc when hissing. This can now be found from Fig. 1, by plotting the mean potential difference between the carbons for each length of arc when it was hissing, with the corresponding lengths of arc. In this way we get a straight line, the equation to which is

$$V = 29{\cdot}25 + 2{\cdot}75\,l \quad . \quad . \quad . \quad . \quad . \quad (4)$$

How far equation (4) really sums up the facts may be seen from Table I., which gives the mean value of the observed potential difference between the carbons for each length of hissing arc, the potential difference calculated from equation (4), and the difference between the two.

TABLE I.—HISSING ARCS. Mean Potential Difference between Carbons for Different Lengths of Arc compared with same Potential Difference Calculated from Equation (4). Carbons: Positive, 11mm. Solid; Negative, 9mm. Solid.

Length of arc in millimetres.	Mean P.D. between carbons in volts.	P.D. calculated from equation (4).	Difference in volts.
1	32	32·0	0
2	34·4	34·75	−0·35
3	37·8	37·5	+0·3
4	40·0	40·25	−0·25
5	43·0	43·0	0
6	46·5	45·75	+0·75
7	48·0	48·5	−0·5

Equation (4) shows that, with the hissing as with the silent arc, a straight line law connects the potential difference between the carbons with the length of the arc. There is, however, this vast difference between the law for silent and that for hissing arcs—viz., that for silent arcs the law only holds for constant currents or for the currents at the hissing points, whereas for hissing arcs it holds whatever the current may be. Thus, while for silent arcs the constants which correspond with the terms 29·25 and 2·75 in equation (4) are constant only for each separate current, and change when the current changes, with hissing arcs they remain the same whatever the value of the current may be. For instance, the equation equivalent to equation (4) for a normal silent arc with a current of four amperes is

$$V = 41{\cdot}79 + 4{\cdot}71\,l,$$

and with a current of 12 amperes it is

$$V = 39{\cdot}85 + 2{\cdot}95\,l,$$

but with the hissing arc the equation is

$$V = 29\,25 + 2{\cdot}75\,l,$$

whether the current be one of 20 amperes or of 50, and whether the arc be normal or not.

This brings me to the reason for the great importance of distinguishing between arcs that are normal and those that are not. We have seen that with normal arcs of any given length hissing only starts when all the silent arcs have been used up, as it were—that is to say, when the current is greater than it can be with any silent arc of the same length. But with a non-normal arc of 2mm. I have been able to produce hissing with a current of 11 amperes, and to have a silent arc burning with a current of 28 amperes, the same carbons being used in each case. This apparent anomaly will be fully explained later, when we go into the causes that produce hissing.

We are now in a position to find the law connecting the length of the arc with the change that takes place in the potential difference between the carbons when hissing begins. For if we call V the potential difference between the carbons at the hissing point with any given length of arc l, and V′ the same potential difference when the same length of arc is hissing, then from equations (2) and (4) we get

$$V - V' = 10{\cdot}8 - 0{\cdot}26\,l \quad . \quad . \quad . \quad . \quad (5)$$

which shows that the longer the arc the less does the potential difference between the carbons diminish when it changes from silence to hissing.

In 1889 Luggin found, by measuring the fall of potential between each carbon and the arc, that the principal part of the diminution of potential difference caused by hissing took place at the junction of the positive carbon and the arc. About three years ago, not then having come across any account of Luggin's experiments, I made some of the same sort myself and obtained the same result. I used two solid Apostle carbons, 11mm. and 9mm. in diameter, and the third carbon for placing in the arc was 3mm. in diameter. This last was somewhat thick, but it burnt well to a point in the arc, and thinner carbons burnt away too rapidly with the current I used—25 amperes—to give good measurements. The potential difference between the positive carbon and the arc was found by placing the third carbon in the arc as close as possible to the positive carbon, and measuring the potential difference between the two with a very high-resistance voltmeter. This was easily done when the arc was hissing, but was impossible when the largest silent current was flowing, for then the mere insertion of the third carbon was sufficient to make the arc hiss. Accordingly the potential difference between the positive carbon and the arc when the largest silent current was flowing has had to be calculated from the formula I gave at the meeting of the British Association last year for calculating that potential difference with any silent current—viz,

$$V = 31{\cdot}28 + \frac{9 + 3{\cdot}1\,l}{A}.$$

In Table II. two sets of currents are dealt with—viz., the largest silent current for various lengths of arc, and a hissing current of 25 amperes—and for each of these sets of currents and lengths of arc two potential differences are given—viz., the potential difference between the main carbons, and the potential difference between the positive carbon and the arc itself.

TABLE II.—Potential Difference between Carbons, and Potential Difference between Positive Carbon and Arc with Largest Silent Current and with Hissing Current of 25 Amperes. Carbons: Positive, 11mm. Solid; Negative, 9mm. Solid.

Length of arc in millimetres.	Largest silent current.		Hissing current of 25 amps.	
	P.D between carbons in volts.	P.D. between positive carbon and arc in volts (calculated).	P.D. between carbons in volts.	P.D. between positive carbon and arc in volts.
(1)	(2)	(3)	(4)	(5)
1	42·2	32·1	32·1	24·4
2	44·5	32·2	34·6	25·2
3	47 5	32·3	37·0	25 7
4	49·4	32·4	40·5	25·7
5	53·0	32·5	43·9	27·9
6	55·5	32 6	45·9	27·2

Now, in order to compare the change in the potential difference between the main carbons caused by hissing with the corresponding change in the potential difference between the positive carbon and the arc, we must subtract column (4) of Table II. from column (2), and column (5) from column (3), and compare the differences. These differences are given in Table III.

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TABLE III.—Diminution of Potential Difference between Carbons due to Hissing compared with corresponding Diminution of Potential Difference between Positive Carbon and Arc. Carbons: Positive, 11mm. Solid; Negative, 9mm. Solid.

Length of arc in millimetres.	Diminution of P.D. between carbons due to hissing.	Diminution of P.D. between positive carbon and arc due to hissing.
(1)	(2)	(3)
1	10·1	7·7
2	9·9	7·0
3	10·5	6 6
4	8·9	6 7
5	9·1	4 6
6	9·6	5·4

Thus for the lengths of arc dealt with, hissing causes a mean fall of about 9·7 volts in the total potential difference between the main carbons, and a mean fall of about 6·3 volts in the potential difference between the positive carbon and the arc. Hence of the whole diminution of the potential difference between the carbons caused by hissing, about two-thirds takes place at the junction of the positive carbon and the arc.

Further, my experiments showed that very little of the remainder of the diminution, if any, was due to a fall of the potential difference between the arc and the negative carbon; therefore this remaining diminution must be attributed to a lowering of the resistance of the arc itself. We may sum up these results as follows: of the total diminution of the potential difference between the carbons caused by hissing, about two-thirds takes place at the junction of the positive carbon and the arc, and the remaining third seems to be due to a lowering of the resistance of the arc itself.

From Fig. 1 it might be supposed that, given the length of the arc, the increase of current that abruptly occurs as the arc starts hissing was as definite for that length of arc as the diminution in the potential difference. And this, for a long time, I imagined to be the case. But, while trying to find out what law connected the smallest hissing current with the length of the arc, I saw that the value of that current really depended on the circuit outside the arc. For, let

E be the E.M.F. in volts of the generator, which we will assume to be constant and independent of the current;
r ,, resistance in ohms of the whole circuit outside the arc;
l ,, length of the arc in millimetres;
A ,, largest silent current in amperes;
V ,, corresponding potential difference between the carbons in volts;
A′ ,, smallest hissing current in amperes;
V′ ,, corresponding potential difference in volts;

$$\text{then } E = V + A r \text{ and } E = V' + A' r, \quad \therefore \frac{A' - A}{V - V'} = \frac{1}{r};$$

that is, the sudden increase of current when hissing begins equals the product of the sudden diminution of the potential difference into the conductance of the circuit outside the arc.

$$\text{Again,} \quad \frac{A'}{A} = \frac{E - V'}{E - V}, \quad \text{or } A' = \frac{E - V'}{E - V}$$

But for a given hissing point, for example, B (Fig. 1), V, V′, and A are all constants; therefore for such a point, A′ depends simply on E.

In fact, for a fixed point, B, and a fixed line, F G, the position of the point F merely depends on the slope we give to the line E B F—that is, on the point on the axis of potential difference we select for E. And a consideration of the figure shows that the distance between this point E and the axis of current measures E, the E.M.F. of the dynamo. Consequently it now appears that the dotted lines in the unstable region constitute records of the particular E.M.F.'s the dynamo was made to give on the various days when the experiments were made with the different lengths of arc, several years ago.

Hence, when the largest silent current changes to the smallest hissing current for the same length of arc, the value of that smallest hissing current depends on the E.M.F. of the generator only.

Thus, it is possible, by choosing suitable E.M.F.'s, to make the sudden smallest hissing current have any value greater than that of the largest silent current for the same length of arc. It is evident from Fig. 1 that the smaller the E.M.F. of the generator, the larger will be the value of the smallest hissing current, for the lower down will E be on the axis of potential difference, and, therefore, the farther will the point F be along the line F G. This explains a circumstance that puzzled me greatly when it happened, but which is now perfectly comprehensible. Some years ago I was using accumulators to maintain an arc, and employing as small a number of cells as possible. I was able to have quite a moderate current as long as the arc was silent, but as soon as it began to hiss, the current rushed up to some huge value, which would inevitably have ruined the cells if I had not had a cut-out arranged to break the circuit. Why the first hissing current should be so much greater than I was accustomed to find it with the dynamos I ordinarily used, I could not imagine, but the reason is now perfectly obvious. The hissing current was so great simply because the E.M.F. of the cells was so small, and had it been possible to maintain a silent arc without any resistance in the outside circuit except that of the cells, which is what I was trying to accomplish, I might, except for the cut-out coming into operation, have had practically an infinite current when the arc began to hiss.

We now pass from the consideration of the electrical measurements of the arc to the appearance of the crater, arc, and carbons. Every alteration of the current and of the distance between the carbons naturally produces a corresponding modification of all parts of the arc, but until the value of the current attains a certain magnitude, which depends only on the length of the arc with a given pair of carbons, this change is one of degree merely, and not of character. A greater current simply produces a larger crater, a larger arc, and longer points to the carbons. When the special current is reached, however, a change which is no longer merely one of degree takes place in the crater. Instead of presenting a uniformly bright surface to the eye, this becomes partly covered with what appear to be alternately bright and dark bands in one or more sets of concentric circles, moving round different centres in opposite directions. The directions of rotation and the entire positions of the images change continually, and the motion grows faster and faster as the current is increased. It is impossible that these figures, which do not move too fast to be clearly seen by the eye in an image of the arc magnified only 10 times, should have escaped the observation of all those who have made a study of the arc, and yet, after a careful search, I can find no mention of them anywhere. When the current is so much increased that the motion becomes too fast for the eye to detect, the arc begins to hum, and then, as Mr. Trotter first showed in 1894, it rotates at the rate of from 50 to 450 revolutions per second. These rapid revolutions, which the unaided eye is incapable of observing, he discovered by the use of a disc having alternate arms and spaces, and kept in rapid rotation; but, in his account of his observations, he makes no reference to the relatively slow rotations which precede the hum. In fact, the rotations observed by Mr. Trotter appear to begin just where those I have been describing become too quick for the eye to see unaided, and end just as the arc begins to hiss, for he mentions that at 450 revolutions per second the arc breaks into a hiss. As soon as hissing begins the whole appearance of the crater changes again; a sort of cloud seems to draw in round a part of it, moving from the outer edge inwards, and varying continually in shape and position. Sometimes but one bright spot is left, sometimes several, but always the surface is divided into bright and dull parts, giving it a mottled appearance, as is slightly indicated in (*b*) Fig. 4. If, then, the current be diminished, so that the arc becomes silent again, the whole surface of the crater grows dark for an instant, then brightens in spots, and finally becomes bright again all over.

The vaporous arc itself undergoes fewer modifications; it preserves the ordinary characteristics of the silent arc while dancing circles hold possession of the crater, but when humming begins a green light is seen to issue from the crater, and with hissing this becomes enlarged and intensified, till the whole centre of the purple core is

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occupied by a brilliant greenish-blue light, as is indicated in Fig. 5. The shape of the arc now alters also. While it is silent or humming, no great difference can be observed in its form. With solid carbons it is rounded or pear-shaped according to its length, and has an appearance of great stability. But as soon as hissing occurs the arc seems to suddenly dart out from between the carbons and to become flattened out, as if under the influence of a centrifugal force acting at right angles to the common axis of the two carbons. In Fig. 5 this flattened appearance is well marked, as it is also in (*d*) Fig. 6; and, indeed, these figures show that every part of the vaporous arc itself is involved in this flttening—the purple core, the shadow round it, and the green aureole—as if they were all revolving with great rapidity round a common axis. And what

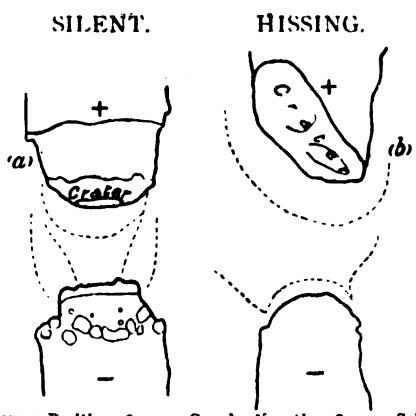

FIG. 4.—Carbons: Positive, 9 mm. Cored; Negative, 8 mm. Solid. Length of Arc: (*a*) 5 mm.; (*b*) 8 mm. Current: (*a*) 8·5 amperes; (*b*) 34 amperes.

more likely than that this is the case, since, as has already been mentioned, the arc is revolving at the rate of 450 revolutions per second at the moment that it starts hissing? As regards the carbons themselves, the only important modification of the negative carbon that appears to be due to hissing is the formation of the well-known "mushroom" at the end of that carbon with a short hissing arc. This mushroom, of which a good example is seen in Fig. 5, is well named, not only because of its shape, but also because of the rapidity of its growth, which is so great that while it is forming the carbons often have to be separated, instead of being brought together, to keep the length of the arc constant.

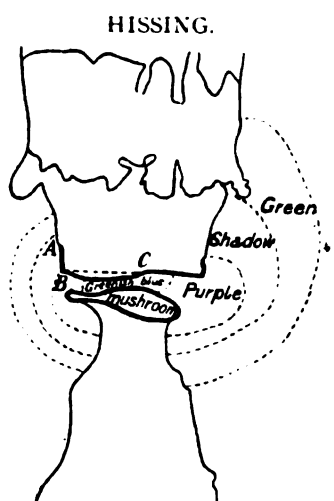

FIG. 5.—Carbons: Positive, 11 mm. Solid; Negative, 9 mm. Solid. Length of Arc: 1·5 mm. Current: 28·5 amperes.

And now we come to the most important of all the changes that take place when the arc begins to hiss—viz., the alteration in the shape of the positive carbon. During the course of his 1889 experiments, Luggin observed that the arc hissed when the crater filled the whole of the end of the positive carbon. He was thus the first to call attention to the fact that there was a direct connection between hissing and the relation between the area of the crater and the cross-section of the tip of the positive carbon. My own observations in 1893 led to a conclusion somewhat similar to Luggin's, but yet differing in an important particular. It seemed to me that with hissing arcs the crater always more than covered the end of the positive carbon—that it overflowed, as it were, along the side. How far this is true will be seen from an examination of Figs. 4, 5, 6, and 7, which show the shaping of the carbons under various conditions with silent and hissing arcs. These figures have all been made from tracings of the images of actual normal arcs burning between carbons of various sizes. For Fig. 4 the diameters of the carbons were the same, but the currents and lengths of arc were different. Fig. 5 is the image of a short hissing arc. For Fig. 6 the positive carbons were all of the same size, and the arcs of the same length, but the current had four different values, while for Fig. 7 the current and the length of the arc were the same for both (*a*) and (*b*), but the diameter of one of the positive carbons was twice that of the other. The figures were carefully chosen with special reference to the shaping of the positive carbons. For with normal arcs the shape of the end of a

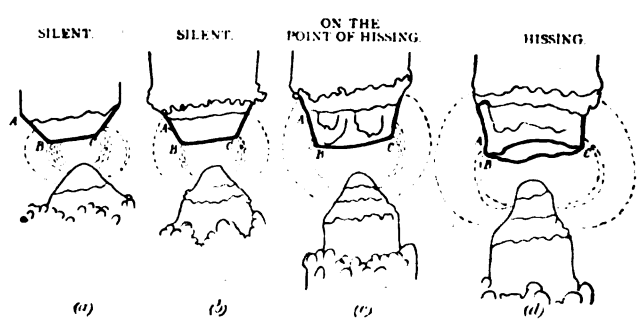

FIG. 6.—Carbons: Positive, 11 mm. Solid; Negative, 9 mm. Solid. Length of Arc: 2 mm. Current: (*a*) 6 amp.; (*b*) 12 amp., (*c*) 20 amp.; (*d*) 30 amp.

positive carbon, even taken quite apart from that of the negative carbon and of the vaporous arc itself, is capable of revealing almost the whole of the conditions under which the arc was burning when it was formed. It is possible, for instance, with a normal arc to tell from a mere drawing of the outline of the positive carbon and of its crater, whether the arc with which it was formed had been open or enclosed, short or long, silent or hissing, burning with a large or with a small current for the size of the carbon. Take, for example, Fig. 4, and note the difference in the shape of the positive carbon with a current of 3·5 amperes as in (*a*), and with one of 34 amperes, as in (*b*). In the first case the tip of the positive carbon is rounded, so that the crater lies in its smallest cross-section; in the second, the tip would be practically cylindrical for some distance

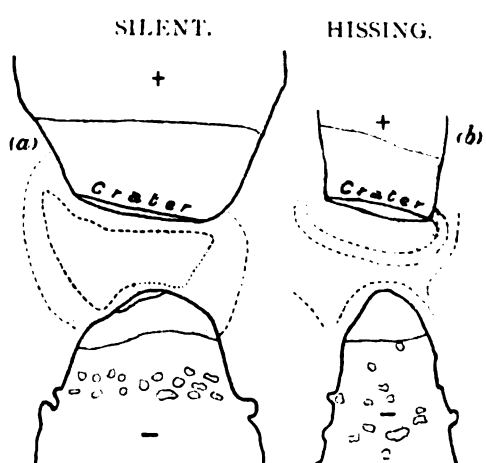

FIG. 7.—Carbons: (*a*) Positive 18 mm. Cored, Negative 15 mm. Solid; (*b*) Positive 9 mm. Cored, Negative 8 mm. Solid. Length of Arc: 5 mm. Current: 25 amp.

but that the crater has burnt away a part of the cylinder, making the tip look as if it had been sheared off obliquely. Comparing now the tips of the positive carbons when the arc is silent and when it is hissing in all the four figures, 4, 5, 6, 7, we find the same difference. With all the silent arcs the tips are more or less rounded, and the crater lies in its smallest cross-section, and consequently is less in area than any but the smallest cross-section. With all the hissing arcs, on the other hand, the tip of the positive carbon is practically cylindrical for a short distance at least, or would be but that it is sheared away by the crater;

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consequently the area of the crater is greater than the smallest cross-section of the tip, or, indeed, than the cross-section of the tip for some little distance along its length.

We have now arrived at the real, the crucial, distinction between a silent and a hissing arc. When the crater occupies the end of the positive carbon only, the arc is silent; when it not only covers the end, but also extends up the side, the arc hisses. Hence, the arc must be at the hissing point when the smallest increase in the area of the crater will make it begin to cover the side of the positive carbon, and this can only be when the tip of that carbon has very nearly the same cross-section for some little distance from its end—in other words, when its sides are nearly vertical. I shall now proceed to show that the extension of the crater up the side of the positive carbon is not the effect but the cause of hissing; that, in fact, hissing is produced by the crater becoming too large to occupy the end only of the positive carbon, and by its, therefore, extending up its side. This seems an absurdly simple and inadequate cause to produce such complicated phenomena as those belonging to the hissing arc, but it is the true one nevertheless. Before I proceed to prove this I will show how the laws for the largest silent currents with normal arcs, which have been already obtained from the electrical measurements, may be deduced on the above hypothesis from Figs. 6 and 7. In Fig. 6 we have a series of four normal arcs of the same length, burning between solid carbons of the same diameter, but in (*a*) the current is 6 amperes, in (*b*) 12, in (*c*) 20, and in (*d*) 30 amperes. The bluntness of the tip of the positive carbon may be measured by the obtuseness of the angle A B C. In (*a*) the tip is very blunt, and the area of the crater is certainly less than any but the smallest cross-section of that tip, therefore the arc is certainly silent. In (*b*) the tip is less blunt, but the arc is still evidently silent; in (*c*) the angle A B C is much more nearly a right angle, and it is plain that a very small increase in the area of the crater would cause it to burn up the side of the tip, therefore the arc is near the hissing point. In (*d*) the angle A B C is practically a right angle, the tip of the positive carbon is cylindrical, and the crater has evidently burnt partly up its side. Thus, keeping the length of the arc constant and gradually increasing the current must gradually bring us to a hissing point.

Next, I have shown elsewhere that with a constant current the end of the positive carbon becomes rounder and blunter, and occupies a larger portion of the entire cross-section of the carbon rod the more the carbons are separated. Hence, the longer the arc, the greater must be the area of the crater, and consequently the greater must be the current, before the crater extends up the side of the positive carbon. Consequently, the longer the arc the greater is the largest silent current. Thirdly, it follows that when the current and the length of the arc have been increased to such an extent that the tip of the positive carbon occupies the whole cross-section of the carbon rod itself, no further increase in the size of the crater is possible without a part of it extending up the side of the positive carbon. Hence the largest silent current for a positive carbon of a particular diameter cannot exceed a particular value, however long the arc may be made. And, lastly, similar reasoning used in conjunction with Fig. 7 tells us that the thicker the positive carbon the greater must be the largest silent current for a particular length of arc, which was one of the results deduced from the curves in Figs. 2 and 3. Consequently, the fact that hissing occurs when the crater covers more than the end surface of the positive carbon and extends up its side, combined with our knowledge of the way in which the positive carbon shapes itself in practice, is sufficient to enable us to deduce all the laws given which govern the largest current that will flow silently with the normal arc under given conditions. It is also now obvious why, when the arc is not normal, it may be made to hiss with small currents or be silent with quite large ones. For suppose, for instance, the end of the positive carbon were filed to a long fine point, then a very small current would make a crater large enough to extend up the side of the point, and produce a hissing arc. Whereas, on the contrary, if the end were filed flat, so as to have as large a cross-section as possible, quite a considerable current could flow silently even with a short arc, for in that case it would require the current to be great for the crater to be large enough to fill up the whole of the end of the positive carbon.

We come now to the question, why should the arc hiss when the crater burns up the side of the positive carbon—what happens then that has not happened previously? In pondering over this question, the possibility occurred to me that, as long as the crater occupied only the end surface of the positive carbon, it might be protected from direct contact with the air by the carbon vapour surrounding it, but that, when the crater overlapped the side, the air could penetrate to it immediately, thus causing a part at least of its surface to burn instead of volatilising. Many circumstances at once seemed to combine to show that this was the true explanation. The dancing circles I had observed, and Mr. Trotter's stroboscopic images; how were they caused but by draughts getting into the arc? Then the humming noise, which I long ago described as sounding like the wind blowing through a crack, was not this probably caused by the air rushing through a slight breach in the crater already getting near to the critical size? This air, pouring in faster and faster as the breach widened, would cause the arc to rotate faster and faster, sometimes in one direction, sometimes in another, according as the draught was blown from one side or the other. Then finally the air would actually reach the crater, burn in contact with it, and the potential difference would fall and the arc would hiss. In the open arc, whether silent or hissing, the outer envelope of the vaporous portion is always bright green. With the hissing arc the light issuing from the crater is also bright green, or greenish blue. What so likely as that the two green lights should have a common origin—viz., the combination of carbon with air. For the outer green light is seen just at the junction of the carbons and carbon vapour with the air, and the inner one only appears when air can get direct to the crater.

(To be continued.)

Discussion.

The President of the Institution (Mr. J. W. Swan, F.R.S.) once more assumed his customary possession of the chair. It should be mentioned that he was cordially greeted on making his appearance, as was also Mrs. Ayrton, who was frequently applauded as she proceeded with her paper. Particularly was this the case when she explained more fully her meaning by pointing to a diagram, or by a reference to the various phases assumed by an arc lamp in its silent or hissing moods when shown on a screen. At the close of Mrs. Ayrton's observations

The **President** said that if they followed the ordinary course of procedure, they would at once proceed to the discussion of the paper to which they had listened; but he felt that this was not an ordinary occasion, and thought the concluding words of Mrs. Ayrton justified him in departing so far from the customary usage as to reciprocate the expression of her sentiments on behalf of all present. She said she felt honoured by having been allowed to contribute this paper to the Institution. He was sure that they on their part felt equally, and more than equally, honoured by Mrs. Ayrton having made this communication to them—a communication of a not ordinary description—a communication based upon elaborate, painstaking, exact observation and experiment, and on a reasoning followed out in the clearest way, and forming altogether, he thought, quite a model of scientific method of research. Perhaps he might be allowed to say before they proceeded to the cold-blooded part of the business—namely, that of criticising the paper—which, however, it would be difficult to criticise—perhaps he might be allowed to say he felt very much astonished at the great progress that had been made and the perfection that had been realised in the arc method of electric lighting. He remembered the time when the arc light was a perfectly new thing. He remembered the first arc lamps, and he remembered the spurtings and the hissings and the expansions in the earlier period of electric lighting by means of the arc, and which, as they now knew from the paper which had been read, were not due to the defects of the lamps, but in some considerable measure to the carbons themselves, for they were cut square, diagonally, or in some other way quite different from Mrs. Ayrton's carbons. The arc light had now reached a point of perfection which, considering the many circumstances which tended to its instability—circumstances which had been beautifully illustrated that evening by these series of experiments—showed a high degree of perfection, but one which might probably advance much further. Having referred to the practical applications of Mrs. Ayrton's discovery—for he could speak of it in no other terms—he went on to say that he was not going to move a formal vote of thanks, but would like to express, on his own behalf and on behalf of all present, their sense of the high honour done them by that lady in

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coming there and giving them a most valuable contribution on electrical engineering procedure. He would now ask anyone who desired to make observations on the paper to do so.

Prof. Silvanus P. Thompson having been invited to speak, remarked that as he did not wish to remain on that occasion an entirely silent arc, and as he had no wish to become a hissing arc, but desired rather to appear as an adulatory arc, he would like to take that opportunity of joining in the congratulations the President had expressed on the fact of this important paper having been given to the scientific world. With the President's permission he proposed to take up one or two points dealt with, and make a few observations on them. In the first place, it was clear that they had now got practically a new definition of the term "hissing arc." Having, with some little pleasantry, enumerated in detail what such an arc was capable of doing, including making a noise, showing a green colour, spurting, growing mushrooms, and so forth, he proceeded to ask whether an arc could be really considered a hissing arc when you could not hear the hissing? He then proceeded to make one or two humorous references, particularly to the open and enclosed arcs as shown on the screen, and to their behaviour in regard to the drop of potential and to their hissing. Amid some manifestation of mirth by those present, he expressed a hope that Mrs. Ayrton would make it quite clear henceforth what was really to be the definition of this hissing arc. Adopting a more serious vein, he went on to discuss other points suggested by the paper, remarking that there remained a good deal to be discussed. Though it was proved that the hissing of the crater was undoubtedly connected with chemical action at the sides, yet there was much more to be explained. He concluded by again expressing his very high appreciation of the remarkable piece of work Mrs. Ayrton had presented to them.

Mr. W. M. Mordey said the President had so well expressed the feelings of them all as to the value of the paper and the admirable way this had been dealt with that he need say nothing on those points. He thought it was a record which would have practical results both on physics and also on the side which particularly affected them—electrical engineering. The interesting physical questions which had been dealt with were particularly important to them all, because of their bearing upon the question of the light-giving power of the arc. Mrs. Ayrton had not made it clear to him, however, whether instability was always an accompaniment of hissing—whether it was necessarily an accompaniment of hissing. If it was not, they need not always mind whether an arc did hiss. He had only once been in a lighthouse when the light was on, and a hissing was apparent the whole of the time. He alluded to the fluted carbons used, remarking that Sir James Douglas, a former member of that Institution, introduced to Trinity House this fluted form of carbon, and he believed it was always used in lighthouses round our coast. These carbons, he thought, always hissed. But in this case there was an alternating current. He hoped Mrs. Ayrton would give them a paper on the hissing of the alternating arc, and on the physics of the alternating current generally. Going beyond the scope of the paper, he would like to mention a circumstance that attracted his attention, and which Mrs. Ayrton might be able to explain at some future time. There was in connection with alternating arcs a dark band seen which would, under certain conditions, increase or decrease in breadth. This had nothing to do with the mechanism or with the electromagnet. But he would not touch further upon this, as it was beyond the scope of the paper. He merely mentioned it in order that they might have from Mrs. Ayrton, now that she had given them a paper on the hissing of the arc lamp, one on alternating currents. Might he also ask her to explain the cause of the granular appearance of the luminous surface of the carbons in the enclosed arc. This was very marked, and he would like to have the explanation.

The discussion was then adjourned until April 13.

RUNNING ALTERNATORS IN PARALLEL.

As is well known in connection with the running of single and multiphase alternate-current generators in parallel, it is necessary, previous to the operation of paralleling a fresh machine, to bring the same into synchrony with and up to the same terminal voltage as the machine already working on the 'bus bars. The attainment of the latter condition is facilitated by the use of voltmeters, while the first is usually accomplished through the medium of incandescent lamps connected between the terminals of the machine already on the 'bus bars and the one to be paralleled, whereby the extinguishing of the lamps indicates the moment for paralleling. This method has undergone improvement in many respects, so that it is possible to recognise which of the two machines is running the quicker. For convenience in paralleling, artificial resistances have hitherto been employed, in which case the machine to be paralleled, which is first of all run up light, besides being brought up to the same terminal pressure and phase as the generator already on load, is put on an artificial load consisting of resistance wires, since this plan conduces to steadier running than would otherwise be the case. Such artificial loads have in general proved efficacious. The one great drawback belonging to resistances of this nature is constituted by the high initial cost of plant to which they largely contribute. However, the arrangement enables alternators to be satisfactorily paralleled, though other methods have been devised calculated to more or less facilitate the operation of paralleling.

But besides the difficulty common to the paralleling of alternators, there exists a further obstacle which repeated attempts have hitherto failed to satisfactorily overcome. This latter difficulty consists in separating two parallel-connected machines without affecting the terminal potential of the one which is to remain on the 'bus bars. The method patented by G. Dettmar, of Linden, near Hanover, described below, aims at removing this difficulty, while it is, at the same time, also adapted to facilitate the paralleling operation, being, moreover, considerably simpler than the artificial load method with resistance wires. The invention, it may be added, is the outcome of exhaustive experiments and investigations bearing upon the problem in question.

As is well known, the speed of such engines as have hitherto found employment for driving alternators does not correspond at every instant. The reason of this want of uniformity in motion is obvious from the design of the steam-engine and the gas-engine. If we represent the momentary speed of a steam-engine within one complete revolution of the flywheel, we obtain, assuming we have to do with a single-cylinder double-acting engine, the curve *a*; the straight line *b* represents the mean velocity. Now, it may be shown that the uniform running of a machine belonging to this type depends upon its load, and, indeed, the uniformity approaches nearer to a maximum the heavier the machine is loaded. Let us now imagine two similar steam-engines, to each of which an alternator is directly coupled, whose momentary speeds on full and light loads are represented by the curves *a* and *c* respectively (Fig. 1). The mean speed of the two machines

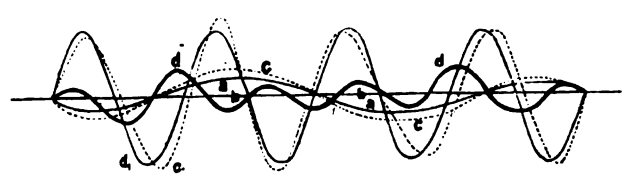

FIG. 1.

is represented by the line *b*. Since the potential difference between the terminals of the alternators, assuming a constant magnetic field, is dependent upon the velocity or rate of cutting the field, it follows that this difference of potential must vary in the two machines at different moments during a complete cycle when one of the same is running on full and the other on light load, although the mean tension as shown on the voltmeter may agree. As, moreover, the moments in which the pressure generated by the alternators pass through the zero point are also governed by the velocity, it is obvious that these moments do not follow in equal succession—that is to say, the periods occupied by the successive pole-changes during a complete cycle are of various duration. Assuming that the alternators possess each eight poles, and the potential difference generated between the terminals of the loaded machine be represented by curve *a*, it follows from the above conditions that the curve belonging to the machine running light will have another form. The latter machine, as is apparent from curve *c*, runs slower during the initial half of a revolution than the loaded machine. Hence the potential difference generated during the first half of a revolution is less than that generated in the loaded machine; further, the period occupied for a complete change of poles is correspondingly greater, and we obtain the potential difference between the terminals of the machine running light represented by the line c_1.

As is obvious from the above representation, two machines which indicate differences of the above nature cannot be easily paralleled. The difference between the respective terminal tensions is represented by the line *d*. This difference is so small as not to be discernible through the medium of the phasing lamps. The resistance of the

* From the *Elektrotechnische Rundschau*.

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only circuit present in which a balancing of the difference between the respective terminal tensions can occur is very high, which condition excludes the origin of considerable currents. Moreover, the resistance offered by the phasing lamps is very high in comparison with that of the other resistances comprising the circuit. Suppose we now parallel the two machines. The one previously running light will immediately take up a portion of the load, at the same time attaining to a much greater degree of uniformity in its running. But the phenomena differ when an artificial load is employed. Should this be the case, the two driving engines then possess an equal degree of uniformity—or, rather, want of uniformity—in running; while the alternators, on their part, consequently possess like curves, and may be paralleled in the usual manner without difficulty. Should it be a question, on the other hand, of withdrawing a machine from the 'bus bars, similar differences in the curves of the two machines to those instanced above will make their appearance, which it is impossible to remove in the same way. In withdrawing one of the alternators the output of the same is reduced by means of switching resistance into its exciting circuit, and at the same time partially shutting off steam to the driving engine until the load has been entirely thrown upon the other alternator. But when this stage is reached, a difference between the curves representing the tension existing between the terminals of the respective machines necessarily makes its appearance as before, and although the tension represented by the curve d compared with the effective tension of the machine a_1 is relatively small, the current which it originates is nevertheless very considerable, since the resistance and self-induction of the short-circuit, in which a balancing of the difference now takes place, is extremely low. Hence, even though the machine may run in perfect synchrony without delivering current to the external circuit, it cannot be maintained on the 'bus bars without current in its armature. In order to maintain the machine without current, the origin of the latter—*i.e.*, the difference of tension, d—must first of all be removed. But this is possible only under the condition that the driving engine of the alternator to be withdrawn be provided with a load equal to that of the machine remaining under steam. However, for this purpose recourse cannot be had to the artificial load previously mentioned, since this would necessarily furnish load also to the alternator, thus preventing its armature current from being reduced to zero. There remains but one alternative at disposal—viz., the provision of an ulterior load. This is accomplished by Mr. G. Dettmar in a most simple manner—namely, by means of a magnetic brake arranged to act upon the flywheel of the driving engine. By regulating the magnetisation of this brake it is, of course, possible to vary the limits of magnetic induction, consequently also the momentum of the flywheel, and hence the load on the engine.

But although we are compelled in providing for the satisfactory withdrawal of the alternator from parallel running to furnish a load for the driving engine independent of the former, this load may be made to serve also for the paralleling, since in the latter operation it is essentially a question of obtaining similar conditions relative to the momentary speed of the two driving engines.

ELECTRIC LIGHTING BILLS FOR LONDON.

(*Continued from page 379.*)

The County of London and Brush Provincial Electric Lighting Bill.

The Select Committee of the House of Commons over which Sir William Coddington is presiding commenced the consideration of this Bill on the 22nd inst. The measure proposes extensive new works, amongst the number being generating stations at Camberwell, Wandsworth, in the parish of St. Luke, Middlesex, and in the parish of St. Thomas, Southwark. The counsel for the Bill were Mr. Pember, Q.C., Mr. Balfour Browne, Q.C., Mr. Moon, and Mr. Shaw. There were a large number of petitioners against the Bill.

Mr. PEMBER, Q.C., opened the case, and said that the promoting company had a number of districts, some on the north side of the Thames and some on the south. In the north there were two fairly well defined groups of districts—viz., Clerkenwell, St. Luke's, Holborn, and St. Giles's and Mile End Old Town, St. George-in-the-East, and the Limehouse district. The southern district included Putney, Wandsworth, Streatham, Clapham, Tooting, Camberwell, St. Olave's, St. Saviour's, etc. The company's district of supply included a large number of parishes, and they had a very difficult outline, or series of outlines, to deal with in the way of mains and generating stations. The fewer generating stations a company of this kind could manage to do with the more economically would they be able to supply the large bundle of districts within their area. It was also essential, if the districts were to be supplied in the most economical way, that the company should be able to carry their mains from point to point by as short routes as were practicable. These were two axioms which underlay a proper and effective and economical supply of electricity. The object of the Bill was to enable the company to purchase additional land for the extension of its generating station at the City-road, on the Regent's Canal. They proposed also the extension of their generating station at Wandsworth on the River Wandle, and they asked the committee to give them power to purchase by compulsion a site for a generating station in the parish of Camberwell on the Surrey Canal. Powers were also sought to enable the promoters to lay mains to connect their various stations with outlying areas of supply through the intervening districts where necessary. Lastly, the promoters proposed to modify the provisions of Section 9 of the Electric Lighting Act of 1882 as to the accounts to be rendered by the company.

Mr. WORSLEY TAYLOR, Q.C. (for the London County Council), said that, in order to save the time of the committee, the various petitioners had held a preliminary consultation. Practically the whole of the opponents were present, and they had come to such an arrangement as, he ventured to think, would materially shorten the labours of the committee. The Bill was an exceedingly complex one, and there would, no doubt, be individual points raised; but the petitioners had grouped themselves as well as they could, having come to the conclusion that there were certain petitions which involved substantially the same point.

Mr. PEMBER, in drawing attention to the report of the Committee on Electrical Energy, which sat last year under the presidency of Viscount Cross, said that the committee had, after due consideration, arrived at the conclusion that the proved public advantage of an electrical supply sufficiently warranted the granting of compulsory powers for the acquisition of sites to local authorities or corporate bodies for the purpose of supplying electrical energy. The committee had also reported that, after examining the question whether a site for a generating station should be given where it was not within the area of supply, they were of opinion that powers of compulsorily acquiring sites for stations, and of the lands or easements necessary for the laying of mains, should be conferred on condition that the district authority affected should have the same right of petitioning or opposing as though they were an authority within the area of supply, and that like powers should be given to the authorities through whose districts pipes were laid. In regard to the opening-up of streets between such outside generating station and the area of supply, the report recommended that such power should be given, but that the local authority should have the option of themselves opening-up the streets at the undertaker's expense. It was also recommended that, where the area of supply extended over numerous districts, the granting of such compulsory powers should depend upon whether sufficient public advantage could be shown in the laying down of plant for high voltage. He would not have troubled the committee with these matters had not the promoters' area of supply run into a number of districts, and had he not thought that the report of Viscount Cross's committee had a bearing on some of the allegations made in the petitions. Then, as to the power of purchase by the local authorities at the end of 42 years, the committee had departed from the principle of the Act of 1882, electrical energy no longer being confined to lighting purposes, and reported that it seemed undesirable that local authorities should purchase an undertaking supplying energy in bulk with a few mains at a high voltage as a system with distributing mains at a low voltage, and to provide for any cases where it might be desirable it was suggested that power should be given to the Board of Trade to insert a purchase clause if satisfied that there was good reason for so doing. The promoters did not wish to go beyond or unduly press the report of the Electrical Energy Committee, which did not, of course, over-ride the decision of the present committee, but he had no doubt that proper weight and consideration would be given to the conclusions that committee had come to. After a detailed examination of the petitions against the Bill, the learned counsel said that among the main objections urged against the Bill was that put forward by the London County Council, which deemed it faulty in not providing a power of purchase by the local authority. But the County Council did not seem to learn anything. The Acts of 1882 and 1888 quoted by them were passed when electrical energy was in its infancy, and, besides, the Council

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were not the purchasing body, but the local authorities, who were independent of the Council. The objection set forth in the Bethnal Green petition, that it was unnecessary for the promoters to come into their district, as the supply generated there would be for use in other districts, had, as he had pointed out, been considered and dealt with by Viscount Cross's committee.

Mr. PREECE, chairman of the Institution of Civil Engineers, and consulting engineer to the Post Office, was the first witness called, and, examined by Mr. MOON, said there were upwards of 30 electrical generating stations in London, and if small stations continued to be erected they would by their number ultimately become a nuisance. A far preferable plan would be that electricity should be supplied in bulk from a few central stations scattered along the river or by the main lines of railway. The larger the station and the more continuous the output the cheaper per unit would be the electricity. The proposed sites he had inspected, and he considered them to be admirably suited for the purposes for which they were to be used. They would enable a supply of electricity to be afforded for some years, and they were not likely to be a nuisance to the neighbourhoods in which they were. If the plant could be kept at full work for 24 hours, the price at which electricity could be supplied would be 1d. per unit. If the works at a generating station could be kept in full work for 15 hours, the price might be brought down to 2d. With the plant only in full work some three hours a day, as at present, the supply could not be given at less than 4½d. per unit. He looked to the Metropolitan Railway Company using electricity in the future, and also to the London County Council using that motive power for its tramway system. There would then be a large current required, and the supply would be obtained in part from some of the proposed works.

If your expectations are realised, what will the cost of electricity be reduced to?—If we assume that the electric light now could be supplied at 4½d. per unit, and if we could from these great central stations secure the supply of current for tramway and electric railway purposes during 12 or 14 hours a day, the cost of electric lighting in London would come down to 3d. per unit or 2½d.

Cross-examined by Mr. WORSLEY TAYLOR: He did not know a case in which Parliament had been asked to sanction a generating station for purposes partly unauthorised by Parliament.

By Mr. LEWIS COWARD (for the Fulham Vestry): Seeing that Fulham was taking measures to supply electricity itself, it would look like unfair competition for the promoters to go into that district.

The proceedings were adjourned.

On Thursday, March 23, Mr. LAWSON, C.E., examined by Mr. Pember, Q.C., said he was engineer and manager to the promoting company, and had been so during the construction of the whole of their works. They had generating stations at St. Luke's and Wandsworth, and were seeking power to establish another in Camberwell. The present generating stations of the company in St. Luke's had a capacity of 70,000 8-c.p. lamps. The proposed addition would give them a capacity for supplying 120,000 lamps. The demands on the company were largely increasing in St. Luke's, Clerkenwell, and also in Holborn and St. Giles, and in Wandsworth. At the latter place, when the present site was enlarged, they would have a capacity to supply 240,000 8-c.p. lamps and would possess 10,600 h.p. At Camberwell they would get under the Bill, with their existing works, about the same capacity as at Wandsworth. But in all cases 25 per cent. must be taken off for reserve. The demand of Wandsworth would be for 180,000 lamps in five years, in Camberwell 100,000 lamps, and in St. George-the-Martyr and St. Olave parishes (supplied from Camberwell) 30,000 lamps, making, altogether, 310,000. In all the areas the demand in five years was expected to reach 440,000 lamps. With regard to the proposed Camberwell station, it would be situated on the Peckham branch of the Surrey Canal belonging to the Surrey Commercial Dock Company. The site was a good one for the purpose. The company would be able to get all the water they required for condensing. All the water taken for condensing purposes would be returned into the canal, the water for the boilers being taken from the water company's mains. The site would not only be convenient as affording an access to water for condensing, but would be advantageous as affording cheap carriage of coal, and both these conveniences formed important factors in the economical production of electricity. The company did not at present want to connect their works north of the Thames with those on the south side. They did, however, desire to connect all the works on the north side, and to connect all these on the south side with each other. It was necessary to go through part of Bermondsey to supply St. Olave's and St. George-the-Martyr. St. George's-in-the-East was asking for a supply of electric lighting, but the company could not get there without the compulsory powers sought in the Bill. With regard to the petitions against the Bill, those of the landowners and occupiers whose property would be interfered with in the main resolved themselves into questions of compensation. In the matter of charges, the company had offered an all-night supply for 3d. per unit, the ordinary charge being 7d. for the first hour and a half and 3d. afterwards. As to account keeping, at St. Luke's there were three separate systems of accounts, two of which applied to the one district of Holborn. They had to do that because the company had obtained three orders. The supply for the whole of that district came from one place, being produced by the same set of engines. In the case of Camberwell the circumstances were different, as the company had a separate purchase claim in regard to that place. They had therefore excluded it from the accounts clause in the Bill.

By Mr. Castle, Q.C. (for St. Luke's, Middlesex): There was room at the St. Luke's generating station for two more sets of engines. The works were sufficient for the district at present. But even if they were not proposing to supply the outlying districts they would have to come to Parliament for power to extend their works.

By Mr. Worsley Taylor, Q.C. (for the London County Council): The company were seeking to supply 12 new districts, covering 28,000 acres, with a population of 1,213,000. He did not think that the company would require further generating stations for these districts. They would extend the existing stations.

By Mr. Earle (for the Vestry of St. Mary, Battersea): The company had illegally laid down mains in the Battersea district, but the Court of Appeal had allowed those mains to remain. The promoters had applied for an order to supply Battersea, but it had been refused. They were not asking for permission to supply Battersea in the present Bill. The Battersea Vestry had been most vindictive in their treatment of his company.

By Mr. Arnold Statham (for the parishes of St. Mary, Islington, and of Lambeth): The promoters were seeking to traverse the district of Islington in order to supply Hackney. They had applied to the Board of Trade for an order to supply Hackney.—What is to prevent you in the future saying, "We have got our mains close up to the houses in Islington. Why should we not supply them?"—We will, if you like, give you an undertaking not to do that.

By Mr. Talbot (for the Camberwell Vestry): The Camberwell Vestry had a purchase clause in the company's original provisional order relating to that district. It was proposed to use the new generating station in Camberwell for the supply of the whole of their southern districts in case of emergency. It was not proposed to go east of Camberwell.

By Mr. Dickinson (for the District Board of Wandsworth): The Wandsworth generating station would be used if necessary for the supply of outside districts. The local authority had the right to purchase after a specified period, but only that part of the undertaking used for the supply of Wandsworth. When the proposed works were carried out it would be impossible to dissociate the part of the works supplying Wandsworth from the part supplying other places.

On Friday the cross-examination of Mr. Lawson was continued.

Cross-examined by Mr. Vesey Knox (for Shoreditch and Lee), WITNESS said the company proposed to carry their mains through Shoreditch to supply districts beyond, the object being to secure economy. He had estimated what it would cost to put up generating stations and to lay cables under the Bill. The cost of the extension in St. Luke's would be £33,000 or £35,000. The total cost of the cables which they should run under Shoreditch would be less than £10,000. The total expenditure contemplated under the Bill would be something like what it had been in the past. They might want to spend some £432,000. The company had spent £58,866 in the northern district and an additional £15,000 in Holborn. In Wandsworth they had spent £243,312 and in Camberwell £45,900. The total expenditure of the company—which included expenditure in the provinces in connection with other undertakings—was £562,587. The total called-up capital of the company was £400,000 of ordinary shares and £200,000 preference shares at 6 per cent., on which they got a substantial premium. They had also £200,000 out of the authorised £400,000 of 4½ per cent. debentures issued at 108. Those totals referred to other districts besides London. They had not paid any interest up to the present on the ordinary shares. They did a financial business as well as the business of an electric lighting company.

What has been your total amount of profit apart from that which you have made by financial operations?—Last year, after deducting rents and establishment charges, etc., we made £17,375. We had no financial operations last year. Our financial operations consisted in finding capital for undertakings in the provinces and in London.

And for promoting electric lighting companies?—Witness demurred.

The CHAIRMAN: I do not think we need go into this.

Mr. VESEY KNOX: But it serves to test the *bonâ fides* of the proposal. We say this is all a promoters' scheme for the purpose of finance, and for no other purpose.

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WITNESS: So far as London is concerned this is an electricity supply company, and it seeks its power in that capacity alone.

Cross-examination continued, WITNESS said the company last year supplied in London, to a population of 830,000, 917,000 units of electricity. If the company had a station on the Thames they would be able to obtain their coals at 1s. 6d. less per ton. But they could not obtain land for a station on the Thames. Besides, the cost would be prohibitive.

In re-examination by Mr. Pember, Q.C., WITNESS said the proposed increases and the construction of the new generating station at Camberwell were necessary for the supply of the company's present district, whether they got fresh ones or not. With regard to the charges made by the company and those of the local authorities who supplied electricity, it should be borne in mind that a local board could get out of a good deal of capital expenditure by using existing offices, by employing its present servants in connection with the supply of electricity, and by arranging their accounts how they liked. Last year, he believed, Shoreditch had borrowed £20,000 from the rates, for which they had paid no interest. Then their machinery was not rated, though they took uncommon good care to rate the company's.

By the Chairman: The company did not propose to take any new areas of supply under the present Bill. They only asked for rights of way and sites for extension of existing stations and for a new station.

By Mr. Colville: If the committee did not pass this Bill, the company would not have legal power to extend their station at Wandsworth so as to enable them to meet the demands which would in the future be made on their resources from Camberwell.

Sir FREDERICK BRAMWELL, examined by Mr. Balfour Browne, Q.C., said he had visited the site of the proposed extensions and of the proposed new generating station at Camberwell, and he agreed with what had been said by the last witness as to the necessity for and the capacity of the sites. In his view they were admirably adapted to the purpose, in St. Luke's and Wandsworth with respect to those portions now at work and the additions proposed to be made, and in Camberwell, where the site was practically a repetition of that at St. Luke's. It was important that the company should have water for condensing and for the carriage of coal and machinery and materials. The proposed new station would be on the Surrey Canal. To have it there would conduce to economy of production, which would be to the benefit of the public. If it was not there, they would have to go without water and use non-condensing engines. The number of generating stations should be as few as possible. There would be no danger of electrolysis to the mains of the Chelsea Water Company.

Mr. VIGERS, surveyor, gave it as his opinion that in the case of none of these sites proposed to be acquired was there any circumstances of such peculiarity as would render adequate compensation impossible.

Mr. LAWSON, recalled, said that the £35,000 he had mentioned would be for the cost of extending the buildings along the canal, but not for laying the mains. The total expense under the Bill would be some £200,000.

This concluded the promoters' case.

Mr. CRIPPS, of the firm of Gooddy, Cripps, and Co., who were petitioners against the Bill, gave evidence to the effect that the acquisition of his wharf under the Bill would ruin his business as a marble merchant. This district was the seat of the marble trade, four-fifths of the London business being done in the neighbourhood. His firm did two-fifths of the whole business, and if they were driven from the canal it would be to the advantage of their rivals.

The committee then adjourned until the next day.

BRIGHTON ELECTRICITY WORKS.

The Brighton electric lighting accounts for the year ended Dec. 31, 1898, have just been published. The total expenditure to this date amounts to £237,987. 3s. We give herewith the revenue account, general balance-sheet, and statement of electricity generated, sold, etc.:

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£7,104	6	2			
Oil, waste, water, and engine-room stores	952	2	1			
Wages at generating station	3,423	14	0			
Repairs and maintenance: buildings, £391. 14s. 8d.; engines, boilers, dynamos, accumulators, etc., £1,352. 11s. 7d.	1,744	6	3			
				13,224	8	6
Distribution of Electricity.						
Wages and other remuneration to linesmen, fitters, labourers	626	2	11			
Repairs, maintenance, and renewals of mains of all classes, including materials and laying the same	149	9	3			
Repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises	607	1	5			
Outlay for works executed on account of customers	500	14	7			
				1,883	8	2
Public Lamps.						
Street-lighting installations	366	9	10			
Attending public lamps, and repairs, including materials supplied	3,437	7	9			
				3,803	17	7
Rates and taxes				1,208	19	7
Management Expenses.						
Salaries—engineer's department	1,932	7	6			
Stationery and printing	233	19	10			
Registrar of stock, and stamp duty	181	9	4			
General establishment charges	236	0	7			
				2,583	17	3
Special Charges.						
Insurances	134	8	6			
Law expenses	7	15	0			
				142	3	6
Total expenditure				22,846	14	7
Amount carried to net revenue account				19,200	0	0
Balance to be carried to next account to provide for bad debts				147	16	5
				£42,184	11	0

Cr.	£	s.	d.
Balance from last account, £110. 13s. 4d.; less bad debts written off, £51. 16s.	58	17	4
Sale of current per meter: 820,985 units at 7d., £23,945. 7s. 11d.; 1,277,811 units at 1½d., £7,986. 6s. 3d.	31,931	14	2
Public lighting: 56,475 units at 7d., £1,647. 3s. 9d.; 493,130 units at 1½d., £3,083. 18s. 9d.; attending, etc., £3,437. 7s. 9d; installation works, £366. 9s. 10d.	8,535	0	1
Rental of meters and other apparatus, work executed on account of customers, rents, and miscellaneous charges	1,668	19	5
	£42,194	11	0

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital—amount received, £223,155. 0s. 2d.; less premiums, etc., on stock issued, £9,611. 6s. 9d.; and amount appropriated for extinction of stock and accumulations of interest thereon, £21,984. 11s. 11d.	191,559	1	6
Premiums on stock issued, £13,118. 3s. 1d.; less discounts and costs and expenses of issuing stock, £3,506. 16s. 4d.	9,611	6	9
Sundry creditors	10,628	9	8
Customers' deposits	974	5	4
Interest accrued due	903	11	6
Proportion of appropriation in respect of sinking funds accrued due	4 474	7	9
Revenue account—balance at credit thereof	147	16	5
Net revenue account—balance at credit thereof	6,802	0	7
Treasurer	4,130	1	4
Reserve fund	6,937	11	5
Surplus account—viz., contributions to loans fund for extinction of stock and earnings of fund to Dec. 31, 1898, £22,523. 10s. 5d.; less premiums and costs of stock purchased for extinction, £538. 18s. 6d.	21,984	11	11
	£258,153	4	2

Cr. Assets.	£	s.	d.
Capital account—amount expended for work	237,987	3	0
Stores on hand at Dec. 31, 1898: coal, £208. 3s.; oil, waste, etc., £289. 15s. 2d.	497	18	2
Sundry debtors for current supplied to Dec. 31, 1898	12,779	18	6
Other debtors	72	5	2
Engineer's advance	50	0	0
Reserve fund investment	6,765	19	4
	£258,153	4	2

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		3,242,017
Quantity sold	Public lamps	549,905
	Private consumers by meter	2,098,796
Total sold		2,648,701
Quantity used on works		158,198
Total quantity accounted for		2,806,899
Quantity not accounted for		435,118
Number of public lamps (257 arc lamps, 941 incandescent lamps)		1,198

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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COMPETITION IN THE CITY.

The Board of Trade enquiry which has been commenced this week at the Guildhall with respect to three applications for electric lighting provisional orders for the City of London opens up the general question of whether in this case competition is advisable. The three applicants for powers to break up the streets have a stiff battle before them, as they have not only to prove that competition is advisable, but also that they individually are the best able to take up the work. The relative merits of the three electric lighting companies which are seeking to obtain the valuable concession we do not propose to discuss, but rather prefer to look at the matter from the general public's point of view. In the first place, the great contention put forward in favour of granting a second company power to compete is that the present charges are high. This is correct, but unfortunately it cannot be said that the present company is paying unduly large dividends. The reduction in charges effected by the sliding scale of prices put in force last year has resulted in a reduced dividend, which, although partly due to the open winter, is mainly accounted for by the lower price obtained for the electric energy sold. This now stands at 6·22 pence per unit. This average figure is not the highest for Greater London, but is exceeded by three other companies. The fact remains, however, that with lower prices, higher dividends have been earned elsewhere, and the general public rushes to the conclusion that the City of London Electric Lighting Company is badly managed. This charge cannot, in our opinion, be justified, as the nature of the demand for lighting in the City is the chief factor in the above results. To put the matter briefly, nearly 75 per cent. of the lamps connected to the mains in the City are on, at the same time, as against 50 per cent. in other London companies. This means that the capital of the City Company must be practically 50 per cent. more than it would be elsewhere, and consequently for equal rates of charge proportionately less dividends are to be expected. The company has naturally adopted the other alternative and kept up the prices. Assuming that another company does get powers in the City, and does charge lower rates, it will not in consequence change the office hours of business men, and presumably, therefore, the financial results will be none too good. The new concerns will have to lay mains in all streets, and we believe that the capital required for a given output will, owing to the crowded state of the ground under the narrow streets of London, be even greater than that of the present company. The ultimate advantage of the ratepayer is what we have to consider, and hence the disturbance to business during the laying down of these mains must be taken into account. This is a very serious matter, and entails an indirect loss, which has to be borne by all, whether electric light consumers or not. Assuming, however, that the competition is allowed, and that the present company reduces its charges, we have even then no guarantee that the two rivals will not maintain equal rates, so that

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competition will quickly cease. The argument that the proposed reduction to fivepence as a maximum is quite enough is not correct. Even on the present year's balance-sheet such a reduction would not much more than wipe off the balance used for dividends on the preference and ordinary shares. In fact, we believe that the lower rates would pay the present company well, owing to the greatly increased demand. Finally, we come to the question of the Corporation's position as regards repurchase of the electric light undertakings in the future. In this respect the introduction of competition is to be strongly deprecated. On the whole, we believe that the interests of the ratepayers in the City are in this case served by keeping the electric lighting of the City in the hands of one company, or, better still, by the Corporation taking over the present company and doing the work itself.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

QUESTIONS AND ANSWERS.

If the gentleman who has written to us from Bristol with respect to the above will send his name and address we shall be pleased to forward his letter to "J. C. R."—ED. *E. E.*

ELECTRIC LIGHT EXTENSIONS AT HAMMERSMITH.

The inauguration of the first extension of the electric station and the street arc lighting took place on Monday last, March 27, when the members of the Vestry were shown over the generating station, under the guidance of the consulting engineer, Mr. A. H. Preece, A.M.I.C.E. The extensions consist of a new engine-room, 40ft. long by 27ft. wide, with rectifier and pump-room annexe, designed by the Vestry's surveyor, Mr. Hugh Mair, M.I.C.E.; two engines of 600 h.p., built by Messrs. Robey and Co., Lincoln; two alternators of 300 kilowatts capacity, built by the Electric Construction Company, Wolverhampton; one Ferranti main feeder switchboard; one water-tube boiler of 250 h.p., built by the Babcock and Wilcox Company, and a 500-h.p. evaporative condenser, by Ledward and Co.; and three pumps, by W. H. Allen, Son, and Co., Bedford. The plant for switching on the completion of the lighting of the main thoroughfares in Hammersmith consists of two 50-light Ferranti patent rectifiers, one two-panel Ferranti patent switchboard, and 60 Brockie-Pell arc lamps in the streets.

Mr. PREECE, in explaining the extensions, said they had been called there that evening to witness the switching on of the street-lighting extensions. He wished to say that during the past year the progress had been very satisfactory. The first plant laid down was sufficient for 10,000 lamps. The two engines to be started were each capable of supplying 10,000, thus making a total capacity of 30,000. The expenditure had, of course, increased in like proportion. The number of lamps connected reached 20,000, and they had nearly 5,000 more promised and awaiting connection. The street-lighting had increased from 100 arc lamps to 150. Mains had been laid in nearly all the main thoroughfares in the parish. The expenditure on capital account reached £75,000, and the Electric Lighting Committee had asked for £65,000 more, and had got it without the least trouble, the works being such a good investment. That March completed the first 12 months' working. The revenue for that period had been nearly £9,000. The working expenses for the same period had amounted to £5,500, leaving £3,500 clear profit.

The three new circuits were then switched on by Major Cardew Mr. Ebbs (chairman), and Mr. Glazier (vice-chairman). The members then partook of light refreshments in the old committee-room, after which carriages were in readiness to take them round the streets to view the various extensions.

AMERICAN PRACTICE IN DYNAMO CONSTRUCTION.

In the *Elektrotechnische Zeitschrift* we find an interesting and, at the same time, instructive article from the pen of Mr. B. A. Behrend, of Erie, Penn., in which a brief comparison is made between American and European practice relative to the construction of electrical machinery. The author deals first of all with continuous-current dynamos, remarking, by the way with perfect truth, that the enormous development of electric traction in the United States has given to designers of such machines a very extensive field for experience and improvement. Whilst about six years back generators capable of 1,000 kw. output were rare, to-day, on the other hand, machines are unhesitatingly constructed for outputs up to 2,000 kw. As is well known to designers of continuous-current machines, it is necessary, in providing for large outputs and considerable intensities of current, to so proportion the number of poles that the current per armature conductor does not exceed a certain value. In England, continues the author, where the bipolar machine has held its ground, one has been obliged to seek an alternative way in dealing with large currents. It is the practice in England to provide the armature with two, three, or even four independent windings, which are paralleled through the brushes. This method has met with excellent results, and the writer's experience with two four-pole machines, provided each with two independent armature windings, has shown that the arrangement also yields good results when applied to multipolar machines. In America, however, this type of construction is not met with. The small number of poles with which machines are furnished over there in proportion to their outputs is calculated to astonish the European designer who compares notes. For instance, the Westinghouse Company constructs a generator for 1,500 kw. output with 14 poles; the current given amounts to 2,730 amperes at a terminal pressure of 550 volts. Hence in this machine 195 amperes traverses each armature bar. Now, sparking at the brushes is, of course, not solely dependent upon the intensity of current in an armature conductor, but this intensity constitutes one of the principal factors which limit the output of a machine. In all the larger generators there lies, naturally, between two commutator segments one winding, or two bars only, so that we may without hesitation take the current intensities per armature segment as a means of comparison.

In constructing a continuous-current generator on similar lines to those enjoying general favour in Europe, it would be impossible to turn out a steady-running machine for the above-mentioned output with a single armature winding and only 14 magnet poles. While European engineers have devoted considerable attention of late to the theory of sparkless running, American engineers have, on the other hand, relied more on practical tests, to which circumstance is due the origin of laminated pole-pieces in continuous-current machines. The pole-pieces employed in all continuous-current machines turned out by the Westinghouse Company are built of thin plates, which are cast in to the magnet frames. These plates have the forms A and B (Fig. 1), which are placed together alternately. A very high degree of saturation in the plates is assumed, and since the cross-section of the pole-corners is only half iron, it follows that the same become fully saturated. This high degree of saturation prevents the flux through those of the pole-corners which are magnetised by the armature in the same direction as by the exterior field from being increased through the armature reaction. The armature tends to demagnetise the remaining pole-corners; through this demagnetisation the saturation is diminished and the

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permeability of the iron increased, while the resultant magnetic flux is only slightly less than when the machine is running light. As nearly all machines are provided with compound windings, we may without appreciable error assume that the magnetisation remains constant at all loads, or, what is still better, that the induction, B, in the air-gap possesses the same value at all points. A further advantage of laminated poles is the diminished self-induction of the magnetic circuit, which allows a quick adjustment of the magnetisation to suit the resultant ampere-turns. The larger currents carried per armature bar necessarily entail greater slots, but this has no detrimental influence, since the laminated poles prevent the generation of eddy currents. The Westinghouse Company utilises this advantage by placing so many as six and eight conductors in one groove—three or four side by side as the case may be—in two layers. The coils then consist of three or four windings with three or four branches to the commutator, as shown in Fig. 2. Binding wires for keeping the armature windings in place are entirely dispensed with in the machines turned out by the Westinghouse Company, the coils being held by means of keys or wedges of hard fibre, a method which, it may be added, is also frequently employed by the Allgemeine Elektricitäts-Gesellschaft. The continuous-current machines turned out by the General Electric Company do not differ materially from those of European construction.

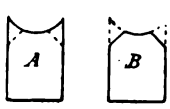

Fig. 1.

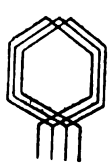

Fig. 2.

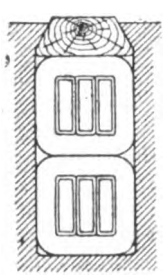

Fig. 3.

Alternate-Current Generators and Motors.—Alternating current, so it is said, was discovered in America, but the writer knows not how far this statement may be correct. One thing is, however, certain—namely, that two great American companies hold the patent rights for all constructions coming under this category. The frequency most generally employed over there is 60, although frequencies of 25, 30, 40, and 80 are also to be met with. In Europe we find, on the other hand, that a periodicity of 50 has found the most general adoption. Messrs. Brown, Boveri, and Co., however, employ 40 $\frown\smile$, a frequency which just allows the connection of arc lamps, while it is more favourable than 50 $\frown\smile$ for the construction of motors, as with the same diameter of armature and an equal number of revolutions the number of poles is smaller in the ratio 40 : 50, whence the pole-arc is greater in the ratio $\frac{50}{40}$. As a result of this, the coefficient of leakage turns out about 20 per cent. less. Alternate-current generators of the Westinghouse make betray a preference for the rotary armature as against rotary fields; with the exception of the 5,000-h.p. generators for St. Lawrence, the writer saw no machine with a rotary field. Both types of construction are, however, sufficiently well known in Europe, though it is worthy of notice that splendid work is executed here in connection with windings of copper strip set on edge for exciting coils. Copper ribbon 25mm. in width by 3mm. thick is bent cold over a template, the radius of the finished bend measuring 19mm. The apparatus employed for this work is extremely simple and ingenious. All generators turned out by the Westinghouse Company up to capacities of 300 kw. are over-compounded, and designed to give four times the normal current on short-circuit with the maximum excitation. In regard to the internal loss of E.M.F., the machines turned out by good European firms are without doubt superior to the American article. But in regard to workmanship the tables are reversed, the Westinghouse machines being undoubtedly superior to European machines in this respect. Nor is this to be wondered at when we consider that American firms are frequently entrusted with orders to supply 100 or even 1,000 machines of one particular type. Under these circumstances it naturally pays to construct expensive formers by which to wind the armature coils.

The alternate-current motors turned out by the General Electric and Westinghouse Companies respectively possess several features in common—*i.e.*, in both types of motor the field winding is stationary, besides which all coils are easily removed without it being necessary to deform the same. The writer emphasises this because the attempts hitherto made in Europe to design interchangeable coils have always overlooked this point. The field winding is disposed in two layers as by a continuous-current armature; this arrangement renders it possible to place the coils in the grooves without applying force. The General Electric Company's motors are started up through a resistance attached to the axle shaft of the motor and rotating with the same. This resistance is cut out at the right moment by a short-circuiting arrangement similar to that employed by the Oerlikon Engineering Company for single-phase motors. The Westinghouse Company employs exclusively short-circuit armatures, and provides for starting up the motors by means of auto-converters.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. Questions may be sent at any time. Answers must be written on one side of the paper only.

Questions.

153. Describe a reliable form of oil switch, to be placed in a road box, for the purpose of isolating a section of high-tension concentric cable; also what kind of oil should be used. If the outer conductor is earthed, should the switch be of a single or double pole type?—E. L.

154. Define the terms indicated horse-power, actual horse-power, nominal horse-power, brake horse-power, and electrical horse-power. Explain their respective units, and their relation one to each other. Also what is meant by the electrical and commercial efficiency respectively of a dynamo?—H. M.

Answers.

Question No. 147.—What are the advantages of lagging boilers, steam-pipes, etc.? Give tests.

Best Answer to No. 147 (*awarded* 10*s.*).—The advantages of covering by means of some non-conducting material the boiler and steam-pipes of any steam power plant are of greater importance than would be supposed by one who has not given careful consideration to this matter. The principal sources of loss are, of course, by radiation and condensation, and with the introduction of higher steam pressures these considerations have assumed greater importance. Moreover, to supply the engines with steam as dry as possible is conducive to economical working, and for a similar reason—namely, in order to reduce initial condensation—the steam-chest and cylinders are lagged in a similar manner. The presence of water, especially in the case of high-speed engines, presents an element of great danger and renders breakdown, possibly a complete wreck, liable.

The actual amount of loss in steam-mains in ordinary working is dependent upon the following conditions: (1) efficiency (as a non-conductor) of the covering material; (2) thickness of the covering material; (3) diameter of the steam-pipes; (4) length of the steam-pipes; (5) steam pressure employed.

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1. A suitable material must be a good "heat insulator," easy and convenient for application, cheap, and should present a neat and finished appearance. It should also be fireproof. Reliable tests are difficult to obtain, but the following table is a summary of results of tests by Prof. Ordway and communicated to the Institution of Civil Engineers. The materials are set forth in order of efficiency, No. 2 being a covering much used in practice.

TABLE I.

Material.	Thickness of covering in inches.	Heat units lost per square foot of surface per hour.
*Hair felt and burlap	2·68	51·0
Fossil meal and cork dust	2·56	64·8
Slag wool and straw board	2·37	66·6
*Silicated pine charcoal	2·62	78·3
*Cotton batting	2	79·7
Fossil meal and hair	2·37	83·9
Cork in strips	1·81	105·3
Asbestos paper	2	131·2
Clay and vegetable fibre	2·62	146
Naked pipe	—	1,555·1

Those marked thus * are inflammable.

2. It is obvious that the thickness of the covering has a very important bearing on its efficiency. By means of the accompanying curve (Fig. 1) the ratio of loss with bare pipe as unity we see the value of various thicknesses very clearly, and it is evident that this thickness should be not less than 2in.

3. The diameter of the pipe, bearing as it does a constant ratio to the circumferential surface, naturally influences the extent of the loss. The straight chart in Fig. 1 is

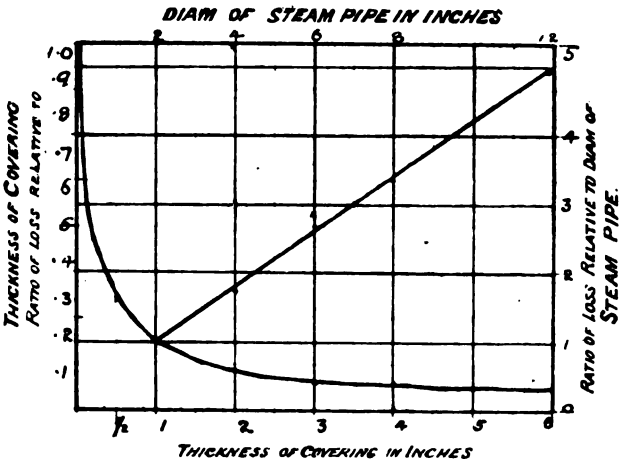
DIAM OF STEAM PIPE IN INCHES
THICKNESS OF COVERING
RATIO OF LOSS RELATIVE TO
RATIO OF LOSS RELATIVE TO DIAM OF STEAM PIPE.
THICKNESS OF COVERING IN INCHES

FIG. 1.

plotted from the results of Table II. (obtained from Mr. H. R. Kempe's "Engineers' Year Book"), and shows that the increase in loss is fairly regular, but not quite in direct ratio to the increase in diameter.

4. The influence of length of steam-pipe has also to be considered, and from Table II. we can ascertain that the length per horse-power lost does not decrease in inverse ratio to the increase in diameter.

5. Increased pressure means increased temperature, and thus an increase in the difference of temperature between the steam-pipe and the surrounding air.

Prof. Jamieson, of Glasgow, has carried out some tests for "thermal conductivity" of several coverings, which he contributed in a paper to the Institute of Civil Engineers. The method adopted was to observe the fall of temperature in a known weight of hot water contained in a vessel coated on all sides with a certain thickness of the material under examination, the outer surface of which was maintained at a constant temperature by a continuous flow of cold water through a water jacket. Seven competitions well known in Glasgow were tested—first, a composition of fossil meal, consisting of 60 per cent. of kieselguhr and 40 per cent. of binding material. In two hours the temperature fell 21·5deg. C., the conductivity as compared with dry still air being 4·82. The next was silicate cotton or slag wool, produced by blowing steam into melted blast-furnace slag, the fall in temperature being 29deg. C., conductivity 6·95. The third, kieselguhr, from German mines, with 10 per cent. binding material, gave 29deg. C. and 7·77 respectively. The fourth was a cement consisting of fine blue clay mixed with flax, jute, and woollen waste, or cowhair, in equal proportions, surrounded by a layer of hair felt and canvas. Fall in temperature was 30, conductivity 6·47. Fibrous composition of clay from Glasgow district, mixed in a similar manner, gave 34·5deg. C., and conductivity 7·98. Two *papier maché* samples gave a fall in temperature of 35·5deg. C. and 37·5deg. C. respectively, the conductivity working out 7·93 and 8·99 respectively.—A. M. O.

Answer to No. 147 (*awarded* 5*s.*).—Whenever the slightest difference of temperature exists between two bodies, there is a tendency to an equality of temperature, by a transfer of heat from the hotter to the cooler body, and the greater the difference of temperature between the bodies, the greater is the tendency to transfer heat. In the case of unlagged boilers and steam-pipes, this loss of heat by radiation is productive of no useful work, and has to be compensated for by an increased combustion of fuel, which means an increased cost of power. In the case of steam-pipes, there are the additional losses due to condensation, fall in pressure, and delivery of wet steam in the cylinders of engines. By using a good non-conducting material for lagging the radiating surfaces, much of this waste of power may be prevented. Prof. Kennedy found that the loss by radiation from an unlagged boiler amounted to 750 B.T. units per square foot of surface per hour, equal to about 19 per cent. of the total heat transmitted from the fuel to the boiler. The loss from the same boiler when lagged amounted to 9·5 per cent. only. The horse-power lost per square foot of surface may be obtained from the following formula:

$$\text{H.P.} = \frac{T - t}{2{,}560} K;$$

where T = temperature inside pipe, in degrees F.;
„ t = temperature of surrounding air, in degrees F.;
„ K = constant = 3·5 for uncovered surfaces;
= 2·0 „ indifferent covering;
= 1·0 „ average „
= 0·5 „ good „
= 0·25 „ best „

The relative conducting powers for heat of various materials, as determined by J. J. Coleman, F.C.S.*, are as follows:

Silicate cotton	100	Charcoal	140
Hair felt	117	Sawdust	163
Cotton wool	122	Coke breeze	230
Sheep's wool	136	Wood and air space	280
Infusorial earth	136		

The following table of the loss of heat and condensation in uncovered and covered pipes shows the advantage of

* *Proceedings* Philosophical Society of Glasgow for 1884.

TABLE II.

T.	2in. diameter.			4in. diameter.			6in. diameter.			8in. diameter.			12in. diameter.		
	Loss.	Ratio.	Feet.	Loss.	Ratio.	Feet.	Loss.	Ratio.	Feet.	Loss.	Ratio.	Feet.	Loss.	Ratio.	Feet.
0	219·6	1·0	152	390·8	1·0	86	624·1	1·0	53	729·5	1·0	46	1,077·4	1·0	31
¼in.	100·7	·46	331	180·9	·46	182	—	—	—	—	—	—	—	—	—
½in.	65·7	·30	507	117·2	·30	284	187·2	·300	177	219·6	·301	151	301·7	·280	114
1in.	43·8	·20	761	73·9	·18	451	111·0	·176	300	128·3	·176	259	185·3	·172	179
2in.	28·4	·13	1,173	44·7	·11	745	66·2	·106	504	75·2	·103	443	98	·091	340
4in.	19·8	·09	1,683	28·1	·07	1,186	41·2	·066	808	46	·063	724	60·3	·056	553
6in.	—	—	—	23·4	06	1,424	33·7	·054	989	34·3	·047	972	45·2	·042	735

T = thickness of covering, in inches. Loss in heat units per foot run per hour. Ratio of loss compared with bare pipe as unity. Feet in length per horse-power lost.

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lagging pipes, etc. The table has been arranged from a considerably longer and more extensive one,* but for the sake of brevity the data for 6in. to 12in. pipes only are given. The lagging used was woollen felt, and steam pressure was 115lb. absolute = 338deg. F. Surrounding air = 62deg. F.:

A.	Uncovered.			Covered woollen felt.			
	B.	C.	D.	E. ½in.	F. 1in.	G. 1½in.	H. 2in.
6	5/8	1·8981	1,221	361	192	153	108
7	3/4	2·2253	1,420	419	221	175	122
8	3/4	2·4871	1,580	466	245	192	134
9	3/4	2·7489	1,738	513	268	210	146
10	7/8	3·0762	1,935	571	297	232	160
11	7/8	3·3380	2,093	618	320	249	172
12	1	3·6652	2,290	676	350	271	186

In the above table,

Column A = internal diameter of pipe, in inches;
B = thickness of pipe, in inches;
C = area of outside surface, in square feet per foot length;
D = thermal units lost per foot length per hour, unlagged;
E, F, G, and H = thermal units lost per foot length when pipes are lagged to a depth of ½in., 1in., 1½in., and 2in. respectively.

A comparison of columns D and E will make the advantage of lagging very evident, even when there is but a thin covering of material.

The advantages of lagging may be briefly summarised as follows: Considerable saving of fuel, water, and labour; smaller condensation in pipe main, giving higher efficiency in plant all round; diminution of the risk and bad consequences of "picking up water"; advantage of cooler engine and boiler-rooms for the staff.—F. S.

Question No. 148.—In selecting a site for a generating station, what are the chief points to be considered?

Best Answer to No. 148 (*awarded* 10*s.*).—The chief points to be considered are:

1. The position as regards the area to be supplied. This depends on the system to be employed. If it is to be low tension it is necessary for the station to be fairly central, otherwise the cost of feeders and the energy lost in them becomes excessive. If the high-tension system is to be used, a less central position will do equally well and will probably be cheaper and more convenient. This constitutes one of the most convincing arguments in favour of high tension. The most modern practice appears to be: for small and medium sized towns, a low-tension system with fairly central site; for large towns, a high-tension system with the generating station at some considerable distance from the centre of the lighting area, supplying low-tension continuous current from sub-stations.

2. The land available for extensions. This is a most important consideration, as everything appears to point to large extensions being required in the near future. The introduction of electric traction, the current for which will probably be supplied by the local lighting station, should also be taken into consideration.

3. The supply of coal and disposal of ashes. On this to a very large extent depends the cost of working the station, and it should therefore receive careful attention. Probably the best position is alongside a canal or navigable river, as then the coal can be brought by barge and tipped straight into the stores or bunkers by means of a crane, and the ashes can also be removed by barge. Another good site is one where it is possible to run a railway siding into the works without incurring great expense.

4. The feed and condensing water. A supply of suitable feed water is of the greatest importance, for if the water contains impurities the boilers will require frequent cleaning and repairs. There will also be a considerable loss in efficiency owing to scale. A liberal supply of condensing water is a great advantage, though a deficiency in this respect may be overcome to a certain extent by using cooling devices, such as towers or ponds.

5. The nature of the ground. The cost of the foundations depends largely on this point. If the ground is wet and sandy it will probably have to be piled, and this is a costly operation. In other cases, though piling may not be necessary, very deep excavations may have to be made before a good foundation is obtained.

6. The possibility of injunction for nuisance. This usually only applies to sites in thickly-populated districts, the two principal causes of offence being smoke and vibration. The former can generally be overcome by using mechanical stokers or by careful firing with good Welsh coal. The latter is reduced to a minimum by using high-speed engines on good foundations, or by using steam turbines. Nevertheless this may be a serious trouble, as several recent cases in London prove.

7. The cost. It may generally be taken that, within reasonable limits, a really good site is worth a high price. A central site will nearly always be more expensive than one outside the town. This is another argument in favour of a high-tension system. Although in the largest towns there is a tendency towards establishing stations at some distance from the lighting area, the difficulty of extensions and coal and water supply have probably quite as much to do with it as the high cost of land. Finally, it may be pointed out that there are no hard-and-fast rules for the selection of a site, and everything depends on the judgment and experience of the engineer.—B. N.

Answer to No. 148 (*awarded* 5*s.*).—The price at which electric power can be supplied to consumers depends to a very great extent on the cost of generation; therefore, everything that tends to the reduction of the cost of production must be carefully attended to. Now, the chief items in the production of electric power are coal and water, and these two should in a great way govern the site of the station, though there is another point which will be mentioned later.

To begin with the coal. A site should be looked for that is near a canal, river, or railway, so that the coal may be brought close to or right into the station direct from the colliery. If the trucks can be arranged to run on to a line, so that they can deliver their contents on to a conveyor or elevator that will carry the coal to the furnaces or to the coal stores as may be desired, they should by all means be made to do so. The handling of large quantities of coal is an important item in central-station work. The station should also be arranged so that coal can be brought in in carts in cases of necessity, and in this case the road into the station should be as direct as possible, and careful attention paid to the levels of the surrounding roads. In all cases when choosing a site it is most important to consider the site from the point of view of the completed station as far as is possible, for what may seem good for the commencement may be anything but good for future extensions. Care must be taken when Lancashire or other large boilers are used that the boiler-house is so placed that these can be brought into or taken out of the station with the least amount of trouble, though this is really a point to be considered when the buildings are being designed.

The second point is also one of much importance. Station engineers are beginning to see the advantages of condensing engines in the engine-room. These have many advantages, one of which is that for a given floor space it is possible to get larger engine power when condensing than when non-condensing. The proposed site should be near a supply of water that is plentiful and cheap enough to carry out surface condensing, if possible, as this is beyond all doubt the most efficient method of condensing. If the water is taken from a river or canal it should be taken from it at one point and returned to it at a lower point, so that there is no chance of the warm circulating water re-entering the pumps. It will be best to arrange a settling tank from which the pumps can draw the water. This may also be used as an auxiliary feed tank when the condensers are not working.

The third point is by no means the least, and that is, that the station should be, as nearly as possible, in what will eventually be, as far as can be seen, the "centre of load" of the area supplied with power. If tramways are contemplated this will be a very important point, more so than if lighting is carried out alone, as when the station

* "Practical Engineer Pocket-Book,"

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is so situated the feeders are of the shortest, and the "drop" in the return feeders is more easily kept within the B.T. limits. It may also do away with the necessity of sub-stations.

The above are some of the chief points to be considered when choosing a site for a station, but local circumstances in all cases must be taken into consideration, which may very materially modify the above. The ideal site is one which combines all three, but these are, as a rule, rare and costly, but when obtained the saving in working costs will soon repay the extra initial outlay.—T. H. C.

Answer to No. 148 *(awarded* 5*s.).*—The selection of a site for a generating station calls for most thorough and careful consideration, as the comparative success or failure of the undertaking will depend in no small degree on the position of the works.

In the first place, the site should be of sufficient area to accommodate all the plant which will be required to cope with the probable ultimate output of the station, or, in any case, for the extensions which are likely to be carried out for a number of years. Experience has proved that such demand has been woefully underestimated in the past.

Secondly, the site should be as far removed from a residential neighbourhood as possible, or constant friction will result between the undertakers and the owners and occupiers of the surrounding property, who will complain of vibration, noise, smoke, and steam, even if such alleged nuisance exist only in their disordered imagination. These complaints may, of course, lead to prosecutions and injunctions, with all their attendant worry and expense. The site must also not be too far removed from the area of supply, so that the cost of the feeder cables may be kept as low as is reasonably practicable, and in order to reduce the coal bill, it should either be in direct connection with a railway or with a navigable river or canal. The nature of the subsoil, too, must be carefully ascertained or trouble may ensue in the erection of the buildings and chimney shaft.

The quality of the water available for boiler feed purposes, the expediency of sinking a well as an alternative source of supply, the prospect of obtaining a sufficient and reliable quantity of condensing water, the adaptability of the site for the most efficient arrangement of the plant generally, the methods to be adopted to save handling of coal and stores, and to facilitate the removal of ashes and clinker, are all points which tend to make the choice of a site an exceedingly complex problem, whilst the relative price of the different sites must also influence to some extent the final decision of the engineer. In the case of municipalities the desirability of erecting the generating station in conjunction with other undertakings, such as refuse destructor, sewage, or water works, is a point which must not be lost sight of, especially in the case of small towns.

The ideal site is, of course, to be found on the banks of navigable waters, with railway accommodation in addition, if possible. The price of land in such a position may be high in the case of a large town, and there may be trouble with the foundations of the buildings. Against these disadvantages must be set the value of a site so placed that there is little likelihood of complaints arising from vibration, noise, or smoke, while the coal supply will be water borne—the cheapest means of carriage. The river or canal water will be available for condensing purposes, though such an arrangement is, in many instances, not so easy as might be expected, and the ashes and clinker can also be expeditiously barged away. If railway accommodation is available, it will prove a valuable second line of defence. Unfortunately, such sites are rarely obtainable, having regard to their proximity to the area of supply. In the case of large towns, however, the supply of electricity must undoubtedly become a most extensive business, and the policy of obtaining a site removed from house property is a sound one.

Most of the metropolitan local authorities and companies have either already secured, or are endeavouring to secure sites for generating stations on the banks of the river or on canals, and their example will doubtless be followed wherever commercially possible.—A.M.I.Mech E.

Question No. 143.—The answers to this published on the 17th inst, were not satisfactory, and since going to press the following letter has been received, which we are pleased to publish:

Sir,—As neither of your correspondents appear to have answered this question fully, or from actual experience, a few details as to an actual example may prove of interest to your readers. The first installation of this kind in England is that of the Leeds Corporation, erected in the early part of last year under the supervision of the late Dr. Hopkinson, and reference is made to it in his last report—that to the Newcastle-on-Tyne Corporation, published in your issue of Sept. 9, 1898. There are 40 10-ampere Brockie-Pell lamps run in four separate circuits of 10 lamps in series, the lamps being wired alternately. Each lamp is fitted with an automatic cut-out, and a substitutional resistance carried on the hood of the lamp. The current is taken from the trolley wire, the earth being used as a return. Switches and fuses are provided at each end of the line, so that the lamp circuit can be isolated. The voltage is 500 volts, and as each lamp takes about 43 volts, a small line resistance is inserted in the circuit. The objection as to flickering is not found in practice in a well-designed tramway system. The sudden variation of voltage does not exceed 2 per cent.; this distributed over nine or ten lamps is not noticeable. The great saving in the cost of erecting seems to have been overlooked by your correspondents. First, the usual return cable is entirely dispensed with; secondly, the leads between the lamps can be (as at Leeds) light uninsulated wires stretched between the posts and carried by insulators fixed on the bracket arms similarly to the trolley wire, thus dispensing with the usual excavating work required for underground mains. One point in connection with the lamps themselves is that all external parts should be carefully insulated, as owing to the proximity of the carriers and posts, which are in connection with earth, "shorts" easily take place. The one serious objection to running lamps by this method is that the lamps cannot be run unless the trams are running, therefore in most cases the light is not available throughout the night. Enclosed arcs have also been run on this circuit five in series, but I do not know with what success.—Yours, etc., C. Vernier.

The following answer to the same question was also received from America too late for consideration:

Arc lamps are commonly connected in series between trolley feeders and the rails or return circuits of electric railways. Lamps so connected are frequently used for lighting car-barns, shops, parks, and the streets along which the electric road runs. The proper method of connection is putting in series enough arc lamps to require about 80 per cent. of the total volts between trolley and rails, and with them enough resistance in the form of iron-wire coils to cause a drop equal to the remaining line pressure when the normal current flows through it and the lamps. Open arcs have been much used in this work, and, allowing 45 volts for each, nine are usually connected with the proper resistance to a 500-volt circuit, or a larger number where a pressure of 550 or 600 volts is used. Enclosed arcs are also used on electric railway circuits, when about 80 volts are allowed per lamp, making five lamps on a 500-volt circuit, and the volts not required at lamps are taken up by iron resistance coils as before. The accompanying drawing shows the method of connection of both open and enclosed arcs on 500-volt circuits, resistance being all at one point, but in many cases the resistance is placed in the chimneys of the several lamps. The arc lamps in any series may be as far apart as desired, but the resistance of the wire connecting them should be considered, and the resistance coil so adjusted as to allow the proper volts at each lamp when normal current flows. With open arc lamps adjusted for 10 amperes and 45 volts, and nine on a 500-volt circuit, the lamps require $45 \times 9 = 405$ volts, and the resistance of line and iron-wire coils should be such as to consume $500 - 405 = 95$ volts and 10 amperes, which would require from the formula $10 = 95 \div$ ohms, that ohms $= 95 \div 10 = 9{\cdot}5$. For enclosed arc lamps adjusted for 80 volts and five amperes the voltage drop in line and coils will be $500 - (80 \times 5) = 100$ volts, and with five amperes flowing the ohms are found from $5 = 100 \div$ ohms, therefore ohms for this case are 20.

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This large per cent. of dead resistance is necessary to insure fairly steady working of the lamps, and should not be much reduced.

The arc lamps require for steady working a nearly constant current, but when connected to constant-pressure circuits a drop of the carbons greatly lowers the resistance, and a great increase of current follows unless there is enough resistance in circuit to materially reduce the pressure at lamp terminals as the current increases. Dead resistance reduces the volts at lamps when more than their normal current flows, because the larger the current, the greater the number of volts are required to force this increased current through the dead resistance, leaving less for the lamps.—ALTON D. ADAMS.

BRADFORD ELECTRICITY WORKS.

From the accounts of the Bradford Corporation Electricity Works just issued it appears that the total net expenditure on capital up to date amounts to £164,192. 14s. 1d. We give herewith the revenue account, balance sheet, and statement of electricity generated, sold, etc., for the past year:

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	£160,786	18	9
Sundry creditors	1,915	13	8
Net revenue account—balance at credit thereof	10,326	11	9
Sinking fund account	2,392	4	7
Amount owing to depositors	52	0	0
Owing for interest on loans	1,151	0	0
Owing to bank	1,709	13	7
	178,334	2	4

Cr. Assets.		£	s.	d.
Capital account—amount expended for works		164 192	14	1
Stores on hand at Dec. 31, 1898: coal, £16. 19s. 6d.; oil, waste, etc., £28. 7s. 2d.; general, £1,060. 8s. 6d.		1,105	15	2
Sundry debtors for current to Dec. 31, 1898		12,308	7	8
Other debtors		15	10	5
Cash in bank—sinking fund	661 15 0			
Cash in hand	50 0 0			
		711	15	0
		£178.334	2	4

REVENUE ACCOUNT.

Dr. Generation of Electricity.		£	s.	d.
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£1,932 5 4			
Oil, waste, water, and engine-room stores	461 9 7			
Wages at generating stations	1,561 18 11			
Repairs and maintenance: buildings, £270. 8s. 2d.; plant, etc., £468. 1s. 10d.	738 10 0			
		4,694	3	10
Distribution of Electricity.				
Wages and other remuneration to linesmen, fitters, labourers	227 1 11			
Repairs, maintenance, and renewals of mains, less amounts refunded	76 0 4			
Wages, meter inspection	36 4 8			
Repairs, maintenance, and renewals of meters, switches, fuses, and other apparatus on consumers' premises	140 1 8			
Incandescent lamps for free supply	669 1 4			
Motor and arc lamp department	294 3 11			
		1,442	13	10
Public lamps—attending and repairs		128	0	7
Rents, Rates, and Taxes.				
Rents payable	226 1 11			
Rates and taxes	915 14 2			
		1,141	16	1
Management Expenses.				
Salaries—engineers' department	500 0 0			
Account and clerical staff and stores department	525 8 10			
Stationery and printing	142 0 10			
General establishment charges	459 5 2			
Bank interest and commission	697 14 4			
		2,324	9	2
Insurances, etc.		89	0	0
Total expenditure		9,820	3	6
Amount carried to net revenue account		12,678	6	0
		£22,498	9	6

Cr.	£	s.	d.
Sales of current per meter at per B.T.U.	21,299	2	6
Rental of meters, sale of lamps, etc.	746	17	11
Rents receivable	11	15	0
Hire and sale of motors and arc lamps	440	14	1
	£22,498	9	6

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		1,568,459
Quantity sold.. Public lamps	32,291	1,419,306
Quantity sold.. Private consumers by meter	*1,387,015	
Quantity used on works		33,369
Total quantity accounted for		1,452,675
Quantity not accounted for		115,784
Number of public lamps (20 arcs, 11 incandescents)		31
Total maximum supply demanded (kilowatts)		1,589

* Includes 202,019 for tramways.

ELECTRIC LIGHTING IN THE CITY.

BOARD OF TRADE ENQUIRY.

On Monday, at the Guildhall, Sir Courtenay Boyle opened a public enquiry on behalf of the Board of Trade into applications made by three electric lighting companies desiring to introduce a competitive electric supply to the City. The companies which desired to obtain such access were the Charing Cross and Strand Electricity Supply Corporation, Limited, the Smithfield Markets Electric Supply Company, Limited, and the Metropolitan Electric Supply Company, Limited. The existing company, the City of London Electric Lighting Company, was represented by Mr. Pope, Q.C., Mr. Cripps, Q.C., Mr. Freeman, Q.C., and Mr. Roskill; the Smithfield Company by Mr. Balfour Browne, Q.C., and Lord Robert Cecil; the Charing Cross by Mr. Shiress Will, Q.C., and Mr. Sidney Holland; the Metropolitan Company by Mr. Fitzgerald, Q.C., and Mr. Moon; and the Corporation by Mr. A. J. Walter.

At the commencement of the proceedings a question arose as to which application should be first proceeded with, and after a brief discussion Sir Courtenay Boyle agreed to take them according to the priority of their registration. The application of the Smithfield Company was first proceeded with, Sir COURTENAY BOYLE informing the County Council representatives that he would not deal with mere clause questions.

Mr. BALFOUR BROWNE, Q.C., said there were three separate companies applying for provisional orders, and in each case of course that application involved, if successful, a power to compete with the City of London Company. The Smithfield Company asked for an order to supply St. Luke's and Holborn, but found that the local authorities withheld their consent. Under these circumstances, as there were no special grounds on which they could ask the Board of Trade to over-ride this refusal, they were determined to withdraw that portion of the order, and not to apply for leave in regard to St. Luke's. But a refusal had also been met with in regard to Holborn, and they therefore had now determined to ask the consent of the Board of Trade to allow his company to proceed with the City only. They had decided to ask the Board of Trade to sanction a provisional order for supplying the City and to dispense with the consent of the Corporation. They thought there were special circumstances which justified them in doing this. The City Company was incorporated in 1891 under three separate provisional orders, which were by an Act of 1893 amalgamated into one. They had the exclusive right of supplying for 21 years, granted them by the Commissioners of Sewers, and he urged that the Commissioners had no power to grant such an exclusive right of supply, as the idea of Parliament in the clause in the Act under which electric lighting was carried on was to give the Board of Trade power to sanction at least two companies in one area. Parliament confirmed this in the case of the Marylebone Vestry and the Metropolitan Company. There was no question that competition was to be sanctioned in regard to electric lighting, especially where the competition was between two different systems of lighting, as, for instance, between an alternate current and a continuous current. The City of London Company supplied alternating current; the company which he represented would supply continuous current, because this would be far better for the purposes of power than alternating current. It was a curious fact that the City of London Company, since the orders had been before the Board of Trade, had placed an order in America for a large amount of plant for the purpose of supplying a continuous current instead of an alternating one. The capital of the City of London Company was £1,200,000. They commenced to supply in 1891, and he believed they had received what would be considered very handsome dividends since that time. Under these circumstances the company had gone on very rapidly under the shield of monopoly, which monopoly, however, it was high time should now be broken up. Whether it was a good company or a bad company, whether it had done its duty to the consumers or not, did not

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much matter to Sir Courtenay Boyle, because he thought he would be convinced that competition was a very good thing. It had not been favoured, however, in regard to water supply or gas, but after careful consideration in 1889 the Board of Trade did report that it was to be regarded as beneficial in the case of electricity. The Smithfield Company was incorporated in 1897 with a capital of £100,000 and 50,000 4 per cent. debentures. The primary object of the company was to adopt an agreement dated July 12, 1897, to supply light to the Corporation markets under a concession from the City Corporation. Their opponents said that up to the present—and it was quite true—they had carried on this private business without a provisional order. They were only to supply the avenues of Smithfield Market and the traders who carried on their business there, and they were prepared to place themselves under a Board of Trade order. They had, in fact, all along carried on their business as if they were subjected to the ordinary provisions of the Board of Trade. In 1892 a concession to light the avenues of the market was entered into. Having furnished statistics as to the number of lamps to be supplied, he proceeded to read various clauses of the concession. On Nov. 2, 1893, there was another concession made by the Corporation of what was called "the building agreement." One corner of the market was in the City, and the latter had got an admirable *quid pro quo*, because the free lighting of the avenues was calculated to be worth £900 a year. They erected their station and their plant, and the Smithfield Company was formed in 1897 to acquire the concession he had spoken of under the agreement of that year. The company at the present time had £40,000 unissued, and they had power to increase the capital to any extent. He pointed out that there were strong objections to big companies covering large areas, because they put their generating stations outside the districts, and thus evaded the obligations they were under to sell the whole of their plant and generating stations to the local authority. The Smithfield Company would have a site inside the City, whereas the Metropolitan Company obtained powers some time ago to have their station at Willesden. He then referred to the Charing Cross Company, which was at the present time competing with the Metropolitan Company. Sir Courtenay Boyle would hear that because there was no competition in the City prices for electric lighting were high. Even quite recently there had been a reduction given by the City of London Company because of the threat of competition. But the days of monopolies had passed. The Smithfield Company said they were in a better position to supply, and claimed preference as tenants of the Corporation. The Charing Cross Company's objections to them were of the flimsiest kind. They said they did not object to fair competition, and they thought they possessed a greater experience than was possessed by the Smithfield Company. Something like 9,000 signatures had been added to a petition in favour of his company, while the Charing Cross had a petition of 5,000 signatures. As he took it, the City wanted to be left alone with its monopoly.

Mr. COOPER, engineer to the Smithfield Company, stated that since this had begun its operations he had been intimately connected with the work. At the present time they had a station at Charterhouse-street, and light had been supplied to Smithfield Market from the day of the formation of the company. The avenues were supplied with light free of charge by some 100 lamps of 50 c.p. which the Corporation got for nothing. The tenants of the market were also supplied. A low-tension continuous current was used. This was the best system where power was required. He thought there was an opening for a considerable supply of electricity in the City. The City of London had, up to the time of these applications, been charging 7d. per unit, but had now reduced it to 6d. Their system, except in the case of street lamps, was the alternating one. Signatures belonging to 90 insurance offices had been added to the petition in favour of his company, which would be in a position to meet a large demand for light at an early date. They had land sufficient to make a large extension of their premises in Charterhouse-street, and they were in a much more advantageous position to supply at once than either of the other companies. Their plant in Charterhouse-street was in first-rate working order and condition. They had offered to supply at 5d. per unit for light as a maximum with a discount, and they would supply for power at 2¾d. per unit. Their works' cost now was 2½d. per unit produced.

In reply to Sir Courtenay Boyle, the WITNESS said the avenues referred to were the private property of the Corporation. Whether there existed any compulsion in regard to the lighting he did not know. The public were shut out from them when the market was closed.

Mr. SHIRESS WILL: At all events, they are avenues which would have to be lighted at somebody's expense?—Yes.

So that it comes to this—that the private consumers have to pay more for their light than they would otherwise have to do.

In reply to Mr. Walter, the WITNESS said when the contract with his company was drawn up the Corporation were not the lighting authorities of the City, but that the Commissioners of Sewers were. He was not aware that the Corporation had refused to recognise his company. They were tenants of the ground on which the station was erected, subject to six months' notice.

Mr. GEORGE WILLIAM BUTLER stated that he was connected with Barclay's Bank, Lombard-street. The bank at one time had its own plant, but they had since been supplied by the City of London Company, and had 500 lamps. The bank was very dissatisfied with the supply, and were desirous of going to another company which would supply them better.

Mr. SCHENCK said he was one of the directors of the Smithfield Company. The plant they had at present would enable them to begin the supply. There would be no difficulty in obtaining sufficient capital for extension. Cross-examined by Mr. Fitzgerald, he said the shares were now about par, and that he thought the order could be carried out for about half a million. Replying to Mr. Freeman, the witness said the present capital was £110,000, and that it was subscribed twice over at par by the public, and the whole of it was now employed.

This was the case for the Smithfield Company.

Mr. SHIRESS WILL, in proceeding with the application of the Charing Cross Company, said they had £150,000 in debentures, £100,000 in 4½ per cent. preference shares, and £250,000 in £5 ordinary shares. Of the debentures, £70,000 had been issued at 5 per cent. and £80,000 were unissued, and they had borrowed £80,000 at 4 per cent on these. So far as the preference shares were concerned, the first were subscribed for four times over; and of the ordinary shares £250,000 had been issued and fully paid up. The premiums, some £100,000 on the last issue, went to reserve, making this £130,000. In St. Martin's they had 38½ miles of mains, in the Strand over five miles, and altogether they had 104 miles of mains laid. As regards their customers, they numbered among them some of the most important in London, and supplied 20 theatres and many large hotels and clubs. There had undoubtedly been complaints in the City in regard to the electric supply. The Charing Cross Company attributed their success to the undoubted cheapness of their supply and to the even pressure given, and also the readiness of the company to meet the demands of their customers. There had been great complaints in the City, where there were heavy rates, unsteady lights, want of motor power, and unreasonable delay in connecting up. As early as 1897 the Charing Cross Company wrote to the Commissioners of Sewers asking for consent to a provisional order, and telling them what the company were prepared to do and the price they would charge for their light. Nothing came of that, and in 1898 they gave notice to the Corporation that they would apply for a Board of Trade order. Having referred to the circular letter which had been issued to the members of the Streets Committee of the Corporation of London by Mr. Brooke-Hitching, he alluded to other negotiations which had taken place with the City authorities, but which had led to nothing. They had taken steps to ascertain the wishes of the principal merchants and others in the City, and he put in a petition from 5,000 citizens, embracing the great bulk of the trading community. Only the signatures of responsible persons were included, and the petition contained 5,000 signatures. He maintained that no monopoly was intended by the order. It had been found in the past that while competition lowered prices it increased custom, and improved the position of the company competed with. Notwithstanding the high prices charged by the City of London Company, its progress from 1892 to 1898 had been consistent—always increasing—showing the enormous demand there was in the City for electric lighting, and that there was room for more than one company. For lowness of price the Charing Cross Company stood at the top of the tree, their average price being 4·36, as against 6·22 in the City. He suggested that the Metropolitan Company applied for a provisional order because his clients were doing so, while the Smithfield Company were applicants primarily for the same reason. Once there was competition threatened—the existing company immediately lowered the price. The Smithfield Company urged that they would be able to undertake an immediate supply. So would the Charing Cross Company, too. Their credit was good; they had done their duty, and he asked that they would be judged by those standards.

Mr. L. B. MARTIN, in reply to Lord Robert Cecil, stated that he was a director of the Smithfield Company. It was not a fact that the only reason why the Smithfield Company promoted their order was because they heard the Charing Cross Company was going to do so.

Mr. EDMUND WILMOT SEALE, examined by Mr. Holland, said he was secretary of the Charing Cross Company. A portion of their district adjoined the City boundaries. Their lamps numbered 142,000, and there were 104 miles of mains. Several newspapers were supplied with motive power at low tension, and they had the most even pressure in London. He put in a petition 50 yards long in favour of the company, and said his company would supply the City at the rate of from 4d. to 5d. per unit for light and 3d. to 4d. for power. During past years electricity had gone down in cost. The number of his company's lamps had trebled, and the dividends had gone up. Averaging up all the lamps in London, each lamp would be

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alight about 2·68 hours per day throughout the year. The company's stations were at Maiden-lane and Lambeth.

Mr. MOON cross-examined witness as to how the company managed to bring their mains from Lambeth. There was no permission in the provisional order.

Mr. SEALE replied that there was nothing in the order to prevent them.

Mr. MOON remarked that that was quite another thing.

Mr. SEALE said that they were advised by very eminent counsel.

Mr. MOON pointed out that even eminent counsel might be sometimes mistaken.

Mr. SEALE evoked some laughter by remarking that this might be the case.

On being re-examined by Mr. Shiress Will, the WITNESS stated that if his company obtained an order they intended to provide separate stations and plant. Then, if desirable, the Corporation of the City of London could purchase the concern without in the least affecting the other districts.

Mr. DRIVER (of Messrs. Smith, Payne, and Smith, bankers) gave evidence to the effect that his firm used the City Company's electricity, which they found most unsatisfactory. In the daytime, during fog, they had found it almost useless, and had had to resort to gas and candles. He always experienced great difficulty in seeing a responsible official at the company's offices, a porter informing him that he knew all about it and would see to it.

In reply to a question, the WITNESS said personally he had complained three times to the City Company.

Mr. CHARLES HARRIS (of Messrs. Capper, Son, and Co., linen-drapers, carrying on business in Gracechurch-street and Fenchurch-street) said they took their light from the City Company. He had complained of the failure of the light to the suppliers.

Witness was asked when he made this complaint, and he replied just before Christmas. Asked as to whom he complained, he said he did so to three or four clerks.

Mr. TOOBEY (of Messrs. Hitchcock and Williams, St. Paul's-churchyard) stated that their present lighting was sometimes very unsatisfactory. If the cost was 5d. or less per unit, his firm would light their shops and factories by electricity, and instead of using 120 lamps, as at present, they would be able to use 700 or 800. He was strongly in favour of another company coming into the City.

Mr. GEORGE EDWARD LEE, of the Sun Fire Office, was also called, and other evidence having been given bearing on the same matter,

Mr. W. H. PATCHELL, engineer of the Charing Cross and Strand Company, was called. He said they were in active competition with several companies. It was pointed out by the City Company that the advantage of being connected with their mains was that customers would be able to obtain their light on a scale system, the first units being 7d. each, and going down to 4d. The witness clearly showed, however, that if a consumer were to burn his lamps for the 24 hours, the cost could not be reduced below an average of 4·4d per unit.

The enquiry was then adjourned until the following day.

TUESDAY'S PROCEEDINGS.

On Sir Courtenay Boyle taking his seat on Tuesday, Mr. SHIRESS WILL asked permission to call other City witnesses.

Mr. CHARLES WATKINSON, of the Deutsche Bank, complained that the light supply on the premises was unreliable. At times when they wanted it most it failed altogether.

Mr. SPENCE, manager of a business in the Poultry, stated that about 90 lamps were used on his premises. They were not satisfied with the light, which was uncertain. In clear weather, when it was regular, they were not dissatisfied with it. He was in favour of competition in the City in regard to electric lighting. Witness had not heard of any complaints about the light supplied to their business premises in the West-end by the Charing Cross Company. It was cheaper there.

Mr. EDWARDS, chief clerk at the Canadian and Pacific Company's branch, King-street, City, said they were not satisfied with the electric light. In foggy days this was intolerably bad. Only a fortnight ago they were obliged to burn candles. About three years ago they complained about the electric light, but not receiving any satisfaction, they had not complained since. He was perfectly certain that competition would be a good thing.

Mr. WHEATLEY, manager of the *Joint-Stock Company's Journal*, thought competition was preferable. At his office in foggy weather the light had been very bad. They had not made any complaint, because they found this would be of no use.

Cross-examined by Mr. Pope, WITNESS said he sometimes solicited advertisements. He was not always doing this, however, for he sometimes had other duties to perform. He found the light very bad in correcting lists. He could see tolerably well, because he had good eyesight, but persons who had bad eyesight would not have been able to see at all.

Mr. WILLIAM HENRY PATCHELL, engineer of the Charing Cross and Strand Company, continued his evidence of the previous day. The company had at Lambeth and Maiden-lane a capacity to supply 210,000 8-c.p. lamps. No less than 142,000 had been actually connected, and by Christmas they could bring the capacity up to 360,000.

In reply to Mr. Cripps, who wanted to find the rate of increase, Mr. PATCHELL said last year it was 26,694 lamps. The maximum load varied between summer and winter. In winter it was about five o'clock and in summer about eight. In producing electricity, the expensive thing was to have a heavy load for a very short time and a smaller demand for the rest of the period. This difficulty was common with other companies. He rather doubted whether the City Company was in a more difficult position than the Charing Cross Company was in that respect. If the company was going to supply the City, it would ultimately require a distinct and separate generating station from the present establishment.

In reply to Sir Courtenay Boyle, who asked whether, allowing for the growth of St. Giles's and Holborn, their margin of 68,000 lamps would not be eaten up very rapidly, the WITNESS pointed out that at last year's rate it would be about 28,000. But they had further plant coming in which would run up to about 48,000. With reference to another question as to the company contemplating the possibility of acquiring a new generating station, and whether any estimate as to the amount of supply it would produce had been arrived at, witness said they would require 15,000 h.p. for the City, which, allowing for the growth of the City of London Company, would need 300,000 lamps.

Mr. BROOKE-HITCHING said that as a citizen and consumer he proposed to give evidence and make a statement.

Sir COURTENAY BOYLE said he could not refuse to hear him if he deliberately made that request, but he must remember he was a member of the Corporation.

Mr. BROOKE-HITCHING said he did not forget that. He then left the body of the court, and went into the space reserved for witnesses. He stated that he was a member of the Corporation of London, of the Metropolitan Asylums Board, the Marylebone Vestry, the Marylebone Board of Guardians, and other public bodies who were large users of electric light. He was also managing director of a business with premises in different parts of London where electric light was used from various companies. He might say that he was not a shareholder in any of the companies concerned in the enquiry; he was not called by any of them, nor had he arranged with any of them to appear there. With regard to the quality of the light on his premises at Ludgate-hill—comparing the quality of the light of the City of London supply with that with which he received from the Metropolitan Company in Marylebone, the Westminster Company in Regent-street and Knightsbridge, the Kensington and Knightsbridge Company in Knightsbridge—he had no more complaint to make of the City of London supply than he had of the other companies. It was well known that lamps burnt out, and in many business places and offices, and in many private residences, lamps were allowed to be connected longer than they should be. In other words, the lamps if virtually burnt out would give a much less light for the same current than if new lamps were attached. Having been interested in electric lighting for some years, he found that many of the complaints as to the quality of the light and supply might be attributed to the fact that people refused to renew their lamps with that frequency which circumstances demanded.

Sir COURTENAY BOYLE intimated that the witness was going beyond the scope of the enquiry. What was his opinion as a citizen of the City of London as to whether it was desirable that there should be competition or not in regard to the electric supply? That was the broad point.

Mr. BROOKE-HITCHING said he wished to allude to the Corporation's right to purchase, as upon it was based the question of so-called competition. Of course, if he was debarred from entering upon the question, he must submit.

Sir COURTENAY BOYLE declined to allow the witness to go into that matter.

Mr. BROOKE-HITCHING regretted the ruling, because he thought that the matter had an important bearing on the question of competition, which meant the entry of another company into the City with a view to exploiting the pockets of the citizens. He did not agree with the policy of the present company. He thought if they had been more progressive, and had fitted up a larger station, and reduced their prices, that they would have been in a better position, and given greater profit to their shareholders. He was only stating his views as a private individual, and not as a member of the Corporation. Assuming that the Board of Trade agreed to give a competing order to one of these companies, and assuming that Parliament confirmed that order, was it likely that they would have competition, because, after all, that was the point citizens would have to consider. They would have their streets and pavements torn up, but would not get their electric light at a lower rate than at present. The condition of the City was difficult as compared with other areas. There was very little demand for electric light at night, as there were no theatres in the City, and the public-houses then were almost empty. The load was a day load.

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Sir COURTENAY BOYLE said he did not wish to curtail the witness, but there was a difference between making an argumentative speech and giving views as to the desirability of competition, and he expressed a hope that he would confine himself to the latter.

Mr. BROOKE-HITCHING remarked that his experience of competition in districts governed by two or three companies, was that it was impossible to get better terms from one company than another. His opinion was that if two, three, or four companies were coming into the City, some kind of *sub rosa* agreement would be arrived at to keep the prices at one level, thus benefiting the shareholders to the disadvantage of the ratepayers and consumers. He only hoped that the Board of Trade would give no order unless competition could be reasonably assured, otherwise he would strongly protest against the streets being torn up.

Mr. SHIRESS WILL asked Mr. Brooke-Hitching whether a report of a debate which appeared in the Court of Common Council was correct when it said that Mr. Brooke-Hitching could give a considerable number of complaints as to the quality of the light in the City.

Mr. BROOKE-HITCHING replied that it was quite true that he did say so, and he could say the same in regard to every electric lighting company in London. He assisted in promoting a Bill to allow the Marylebone Vestry to compete. By a municipal supply a better supply would be assured. He was connected with an electric lighting company.

Mr. SHIRESS WILL formally mentioned that his case was closed.

Mr. FITZGERALD, in opening the case on behalf of the Metropolitan Company, said that its share capital was £1,000,000, with powers to issue debenture stock at the same amount, so that its existing capital powers at the present moment was £2,000,000. It had actually issued £850,000 share capital, of which £743,530 had been paid up. The debenture stock had only been issued to the extent of £220,000, so that the total amount of paid-up capital was £963,530. There was a reserve of over £1,000,000, and being a limited company it could increase its share capital by special resolution if necessary. The credit of the company was excellent, its £10 shares standing at £18, and it was in a position to execute, so far as credit and capital were concerned, any powers which might be conferred on it. The generating stations actually in work at the present moment were five in number, and in addition, under an Act obtained last year, the company had acquired a large area at Willesden for the purpose of building a large generating station which would ensure an electric supply to the City of London on the most favourable and economical terms. The works were now far advanced, and he was in a position to assure Sir Courtenay Boyle that if the application of the Metropolitan Company were granted they would be able before the close of the year to extend mains from Willesden to the City. It proposed to give a supply on the continuous-current system, through a high-pressure main of 10,000 voltage from Willesden to a transforming station in the City. When the matter of the electric supply of London originally came before Sir Francis Marindin in 1889, he stated in his report that the western part of the City should be allocated to the Metropolitan Company. But, in addition, the boundary of the Metropolitan Company's district was co-terminus with that of the City from Aldersgate down to the Thames embankment. By simply extending its mains into the City boundary it would be in a position to supply at once. There were two questions involved: first, whether competition was to be allowed in the City at all, and, second, which of the three companies was to become the City of London Company's competitor. With reference to the question whether competition was to be allowed, it was only necessary to point out that the Act provided for this, and Sir Francis Marindin in his report was in favour of competition, and the Board of Trade had granted such. While he thought the Corporation was embarrassed by the action of the late Commission of Sewers, which had no power to grant any exclusive right, he did not think in effect that that body did do so, except so far as it was able. It showed that the late Commission and the company knew it was doubtful whether it possessed the power, even if it did not know it perfectly well. It might be, perhaps, that they both bound themselves not to consent to another company competing, but they could not over-ride the powers vested in the Board of Trade. In regard to the second question, the first competitor was the Smithfield Company, whose capital was small, who were barely paying their way, and whose present generating station was wholly unsuitable. He, however, admitted that the Charing Cross Company was in a different condition. This company had two stations, one in Maiden-lane—a most inconvenient place—and another in Lambeth, somewhat across the river. They had a large business. The mains of their new territory had only just been laid down, and all the power of the stations the existing territory would take. The engineer admitted that he must get a station somewhere; but where was he to get it? This proposition was a rare one. What the company ought to have been able to show was the provision of a site, and that they could obtain such a site if a provisional order was given. But the Metropolitan Company was ready to immediately commence a supply to the City. There could be no doubt that as far as that company was concerned the competition would be of the most effective character, because the maximum price would be below that which the City of London Company at present supplied at. The Charing Cross Company had a small compact district, an extremely valuable district, where there was a very large demand for a supply of electric light; but in regard to the Metropolitan Company's district, a great portion of it was not nearly so profitable nor contained the same elements to make profit as the Charing Cross. It was straggling, and it was not fair to take this and compare it with a compact district. If an order were granted to the Metropolitan Company the latter would be in a position to supply electricity at quite as low a rate, if not at a lower rate, than the Charing Cross. He repudiated the idea of there being any sort of alliance with other companies. Having referred to the fire which took place in one of the generating stations of the Metropolitan Company, he had not the least hesitation in saying that so far as supplementing a supply from another company was concerned, there was absolutely nothing in the Electric Lighting Acts to prevent it. It was not essential that the company supplying should be the generating company. Of the three companies which asked to compete, the Metropolitan was the strongest financially, the strongest electrically, and their position at Willesden made it easier for it to supply the City before either of the other companies could do so.

Mr. EDWARD CUNLIFFE OWEN, secretary of the Metropolitan Company, was called. He described the local positions of the company's stations and its financial position. It paid a 6 per cent. dividend in 1897, but last year it was 5 per cent.

Cross-examined by Mr. Shiress Will, the WITNESS said at present they were unable to meet all their demands, and had taken current from the City of London Company. They took as little of this as possible because of the high charge. There was no foundation for the suggestion that there was an alliance between his company and the City of London Company. Competition had been permitted in portions of his own district. The extent of the site at Willesden was 8½ acres, and would enable them to cope with a very large demand. His company first charged 7½d., which had been gradually reduced, until the average rate of charge worked out at rather under 5·2 per unit.

Mr. CRIPPS, cross-examining the witness, said supposing another company came to ask for powers in Marylebone, where the Metropolitan Company had an agreement with the Vestry, would he not look upon it as a rather piratical proceeding? No; not piratical.—Or unjustifiable? No; not in virtue of our agreement.—Do you mean to say that you are willing to welcome competition in Marylebone? We certainly should not welcome it.—You would oppose it to the utmost? We should oppose it certainly.—What is the difference between what you are proposing to do with regard to the City of London Company and what another company might do in Marylebone? I do not think there is any difference.—What do you say to a company coming from outside to compete with a company bound not to go outside the City? Your company might consider it very unfair.—Let me go one step further. Do you not think it very unfair? Answer frankly.—I think it might be considered unfair from your point of view.—No, no. Do you not think it very unfair? If I were in the position of the City of London Company, I should certainly think it unfair.—Do you not yourself think it unfair? I really have not looked at it from that point of view.—I put the proposition to you.—Yes, I think it is unfair up to that point.

The WITNESS, in reply to Sir Courtenay Boyle, said that the Metropolitan Company would not object to competition in Marylebone so long as this competition was not rate-supported.

Mr. W. H. CROSS, examined by Mr. Moon, stated that he was a clerk at St. Bartholomew's Hospital. Electric lighting was not used there because of its almost prohibitive price. Their gas bill was £2,000 a year. Electric light would cost double that amount.

Mr. R. DODD, formerly resident engineer of the works at Willesden, said the company would, if the order were granted, be in a position to supply the City by the end of the year.

In cross-examination by Mr. Balfour Browne, the WITNESS stated that at Lancaster-gate the charge was from 6d. down to 5d. There was no competition there, and where there was competition the charge was 6d. down to 4d.

Mr. DORE said he was a tailor carrying on business in the City and at Holborn. His firm were supplied with electricity by the City of London and the Metropolitan Companies. They had seven branches, and the Metropolitan supply was more satisfactory than that of the City of London Company.

The case of the Metropolitan Company having been closed,

Mr. Cripps called Mr. JOSEPH CECIL BULL, manager and secretary of the City of London Company. This witness said there had been a continuous increase in consumers supplied by his company. He gave statistics to show this increase, which at

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the present time amounted to 7,700. Complaints had been received from time to time, but these came principally from 10 transformer districts, of which there were 23 within the City. Several complaints were received in December. These were due to a series of mishaps from the breaking of machinery, the coal supply, and other causes which were wholly unavoidable. On investigation as to the causes of complaint, it was often found that the fault arose from the fact that the lamps were old, and the company were blamed alike for old lamps, fuses, and for defective fittings.

Mr. SHIRESS WILL asked the witness if he represented that the City was content with his company.

Mr. BULL replied that he could not tell him that. It would be absurd to say that people had not complained. They had heard it *ad nauseam* there. They had had complaints as to price. If the Charing Cross Company came into the City, he supposed the price charged by the City Company would be reduced. That, however, was a matter to be decided by the directors. Complaints as to price had been received and considered by him, and if circumstances had justified it he had always made a reduction. Under the particular circumstances competition would be most unjust. The company's area of supply was quite different from those of the outside companies. They only earned a profit during five months in the year—during the five winter months, but principally in December, January, and February. Nearly 97 per cent. of the company's customers would be tenants of offices, and the demand was restricted to five days in the week.

In reply to Lord Robert Cecil, he said that in 1897 the company paid £352. 1s. in penalties for defective lamps, but that was prior to £20,000 being spent on the renewal of mains. Last year £156 only was paid in fines.

In answer to Mr. Pope, the WITNESS said, that the company's accounts were kept in the manner provided by the Board of Trade, which was more than could be said of the Charing Cross Company's accounts. One obligation the company was under to the Corporation was to lay aside 7½ per cent. for depreciation, and that obligation had been discharged. It was not a question of a monopoly, but of capital, for the City Company had to make double the gross profit per lamp than was necessary in the case of outside companies whose demand was regular. What his company objected to was competition on unfair terms. The competition would be unfair, as the City Company could not go beyond its area.

Replying to Mr. Cripps, he said the proportion of fines paid was £157 on a revenue of £12,900.

Mr. F. BAILEY, the engineer to the company, furnished details respecting the difficulties encountered by the company in consequence of the coal strike. A second cause of inconvenience arose through the non-delivery of steam-pipes for new boilers. No other city was so amply provided with transformer stations as the City was. Competing companies could not ensure consumers against breakdowns. The load in the City was a very short one. A considerable amount of plant had to be provided for a short period of time, and it then remained idle.

Lord ROBERT CECIL asked the witness whether he knew that the three promoters had all agreed not to charge more than 5d.?

Mr. BAILEY: Yes, in gross ignorance of the conditions that exist. Replying, then, to Mr. Pope, the witness referred to the disadvantages the City Company was under in respect to competition. It had to provide for the street-lighting, which meant that they had to invest £120,000 for the benefit of the citizens. There also existed special restrictions—namely, the amount to be set aside for depreciation and the purchase clauses. The competition would not be competition on fair and equal terms. The City Company would be handicapped.

Sir COURTENAY BOYLE, addressing Mr. Walter, remarked that it was very important that the Board of Trade should have some evidence from the City engineer as to the aspect of the present problem, and some information from the committee of the Corporation charged with the business as to whether, supposing any provisional order was given, they had or had not any preference for one or other of the competing companies. The Board of Trade were most anxious to consult the views and wishes of the citizens of London.

Mr. WALTER said the Court of Common Council would have to consider the matter.

The enquiry was then adjourned until Tuesday, April 11.

LEGAL INTELLIGENCE.

AUTOMATIC TELEPHONE COMPANY.

Mr. Justice North, in the Chancery Division, heard a motion on Friday brought by Mr. M. Alexander for an interim injunction to restrain Mr. Max Margowski and the Automatic Telephone Company from acting upon a resolution for removing the plaintiff from his office as a director, the first defendant being the chairman of the company.

Mr. H. Terrell, Q.C., and Mr. Dobb appeared for the plaintiff, and Mr. Swinfen Eady, Q.C., and Mr. Russell were counsel for the defendants.

It appeared that the resolution was alleged to have been passed at an extraordinary general meeting of the company, but the plaintiff alleged that no such resolution was ever put to the meeting, which was of a very disorderly character throughout. If it had been put to the meeting, it was contended on behalf of the plaintiff that there was an overwhelming majority against it.

Mr. Justice North, in giving judgment, said that not a tittle of evidence had been adduced to justify the statement of the chairman (Mr. Margowski) that the resolution had been carried by a tremendous majority. It seemed to him that the meeting had been an irregular one from beginning to end, and it was a disgraceful act on the part of the chairman to declare that the resolution had been carried when it was not put to the meeting at all. The chairman was very well aware of the fact that the resolution had not been carried, and if there had been a show of hands upon the subject it would have been enormously in favour of rejecting the resolution. The chairman and a number of others at the meeting seemed to have forgotten altogether how to behave as gentlemen and men of business. The attempt to remove Mr. Alexander from the directorate had altogether failed, and the injunction would be granted. As all the parties seemed to be altogether wrong on both sides, he would not give either side one penny in costs.

The injunction was accordingly granted without costs.—*Financial Times.*

RIVAL WIRE CABLE MANUFACTURERS.

At the sitting of the Chancery Court of Lancashire in Liverpool on Monday, before Vice-Chancellor Hall, a motion for an injunction was made by Mr. Maberley, on behalf of the firm of W. T. Glover and Co., Limited, of Salford, to restrain the defendants, W. James Glover (established 1818), Limited, Warrington, from carrying on business as electric cable or electric wire manufacturers under any style of which "Glover" formed a part, on the ground that Glover's cables had acquired a significance in the trade, as being electric cables made and sold by the plaintiff company. The defendant company had just been formed, and the prospectus had but recently appeared. The *Liverpool Courier* reports as follows:

The **Vice-Chancellor** said he saw by the papers that the title was established in 1818.

Mr. Maberley said there was a business of W. James Glover and Co. which, he believed, might be carried back to that date, but that was a business which was simply for making cables for haulage purposes, and in no sense was it a business for making electric cables. This action was originated on the 17th inst., and since then an advertisement had appeared in a Manchester paper, stating that, in consequence of these proceedings, the directors would not go to allotment, and that those who had applied for shares would have their money returned to them pending the result of this motion.

Mr. Sutton, who appeared for the defendants, said that his clients would fight the action with all their strength. He suggested that the motion be allowed to stand over for the trial of the action.

The **Vice-Chancellor**: It is a very simple issue in the end.

Mr. Sutton: The question is whether we intend to deceive the public and sell our goods as theirs.

Mr. Maberley said there was more than that in dispute.

Mr. Sutton: The flotation of the company will sleep.

Mr. Maberley: And you must not manufacture cables.

Mr. Sutton: Why should we be prevented from carrying on our business as we have been accustomed to do?

The **Vice-Chancellor**: No. As to what your rights may be afterwards, that is another matter.

The Court then made the order that the motion stand over for trial of the action.

NEW TELEPHONE PATENTS.

Mr. Commissioner Kerr disposed of an action in the City of London Court on the 24th inst., in which Mr. Edwin N. Henwood Great St. Helen's, E.C., sought to recover from the defendant, Mr. Thomas J. Howell, electrical engineer, Barford-street, Liverpool-road, the sum of £40 and a declaration that he was entitled to a tenth of his receipts in respect of a new telephone.

Mr. Shaw appeared for the plaintiff, and Mr. John Black for the defendant.

From the evidence it appeared that the defendant, although blind and very deaf, had invented a valuable telephone transmitter. He wanted to put it on the market, and he came to the plaintiff for assistance. The plaintiff's case was that the defendant signed an undertaking to give him 10 per cent. commission on all money raised at once (funds being urgently needed with which to take out foreign patents), and a tenth share of all future benefits. The plaintiff had introduced the defendant to Messrs. Mercer and Locock, stockbrokers, who were to have formed a syndicate, and who advanced to the defendant £300 on account. The defendant had taken the matter elsewhere, and was about to receive 4,000 shares in a company. The plaintiff asked to be paid the balance of commission on money actually received by the defendant, and to have assigned to him 400 shares. In his evidence the defendant admitted receiving some money, but he said the shares had not been transferred to him. He denied knowing the full extent of

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the plaintiff's commission note. The telephonic transmitter which he had patented had been considered by the Duke of Norfolk, the Eastern Telegraph Company, Mr. Preece, of the General Post Office, and the Corporation of London in reference to establishing a system in opposition to the National Telephone Company. Negotiations has been entered into with the Post Office authorities for granting a license. The plaintiff had assisted him, no doubt, but he had no right to a tenth of the full benefit which might accrue. He did not sign the letter knowing its contents. The plaintiff had taken advantage of his blindness.

Mr. Commissioner Kerr said that was a serious allegation to make against the plaintiff. He could find no ground for it. There must be judgment for the plaintiff for £40 and for a tenth of the shares which were about to be given to defendant by the company, which it had been shown was just coming out to work his patent.—*The Times.*

COMPANIES' MEETINGS AND REPORTS.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING COMPANY, LIMITED.

The fifth ordinary general meeting of this Company was held on Monday at Winchester House, Old Broad-street, E.C., the Right Hon. Lord Rathmore (chairman of the Company) presiding.

The report of the directors, together with the balance-sheet and statement of accounts to Dec. 31, 1898 (published in our last issue), was approved and adopted.

The **Chairman,** referring to the London stations, said that a very considerable part of the expenditure on these stations had been up to the present time necessarily unremunerative, but as time went on, and as additional applications for current were received, that expenditure became every day more reproductive. The results of the working of the Wandsworth station had been altogether satisfactory, for out of a total of £11,042 received £4,958 was clear profit. Testing the case by the amount of sales of current, their engineer and manager estimated that the sales in both St. Luke's, Clerkenwell, and the Holborn districts for the present quarter would be equal to those for the December quarter. Their new districts in London—on the north side the new eastern Holborn district, and on the south side the districts of Camberwell, St. George-the-Martyr, and St. Olave's—would, so far as they were able to estimate, prove very remunerative sources of revenue. Referring to the Bill introduced by the Company this session into Parliament in connection with their London stations, he said their reasons for doing so were that the Bill would enable them to cope much better with the demand for the supply of current which had already developed, and also to get across the intervening areas which separated in some cases the central stations from the outlying districts. He hoped that before the next annual meeting of the Company the principal mains would have been laid in Camberwell, St. George-the-Martyr, and St. Olave districts. In the northern part of Camberwell district, and in the districts of St. Olave and St. George-the-Martyr, a brisk demand for power was anticipated. These districts would be worked for the present from the Wandsworth station. During the past year the Richmond Company, besides placing a considerable sum to depreciation account and paying off a large part of the balance of the losses on working the station before it came under their control, had been enabled to declare this year a dividend of 4 per cent., as against 3 per cent. for last year, and the demand was still going on so rapidly in Richmond that it had been necessary to seek for additional machinery to cope with it. At the Dover station the gross revenue had increased by more than £1,000, and it would have been still further increased but for the expense consequent upon the unfortunate coal strike in Wales. At the end of the year 1897 their shares in the old Bournemouth and District Company had been transferred to the new Bournemouth and Poole Company, reserving for themselves a considerable interest in those shares in the new company. There had been a steady advance in the revenue of Bournemouth, resulting in a 4 per cent. dividend for the last year. Their issue of £200,000 4½ per cent. debentures at 108 had been subscribed nine times over, which, he thought, was a very satisfactory circumstance, and they were only sorry that it had not been possible for them, regarding the interests of the Company, to give a greater proportion than they did of these debentures to their own shareholders.

Mr. J. B. Braithwaite, jun. (deputy-chairman), in seconding the motion, referred to comments which had been made as to the working of the London stations being unsatisfactory. These ideas largely arose from a misconception. These stations had doubled their net profit last year. With regard to St. Luke's station, the fact that the net earnings for the past year were £500 less than for the same period in 1897 was due to their only having commenced working that station at the beginning of October, 1897, so that they had but three months' expenses as compared with 12 months in 1898. It had also been stated that the ordinary shareholders of the Company had been waiting eight years for a dividend, the Company having been registered in 1891; but as the prospectus inviting capital for this Company had been issued to the public on March 28, 1894, this time was reduced by three years.

The **Chairman** then moved: "That the payment of the interim dividend upon the preference shares of the Company at the rate of 6 per cent., less income tax, for the six months ending June 30, 1898, be now confirmed, and that a further dividend upon the said shares at the same rate for the six months ending Dec. 31, 1898, be now declared, the same to be paid forthwith to all registered proprietors on the books of the Company at March 31, 1899."

Mr. F. E. Savory seconded the resolution, which was carried unanimously.

On the motion of **Mr. J. B. Braithwaite, jun.**, seconded by **Mr. A. A. H. Sanderson**, the retiring directors (the Right Hon. Lord Rathmore and Mr. F. W. Reynolds) were re-elected.

Mr. Lighton proposed, and **Mr. Tuckett** seconded, the reappointment of the auditor, Mr. R. H. Marsh, which was carried unanimously.

A vote of thanks to the chairman, on the motion of **Mr. Henry Whitten**, terminated the proceedings.

NATIONAL ELECTRIC FREE WIRING COMPANY, LIMITED.

The ordinary general meeting of this Company was held at the offices, Charing Cross-road, on Friday, Mr. R. Stewart, C.A., presiding.

The report showed that the business of the Company practically commenced on Oct. 1, 1897, and that the accounts had reference to a period of 15 working months only. The gross profit for that time was £3,244. 11s. 3d., from which had to be deducted expenses of administration, provision for bad and doubtful debts, depreciation, etc., amounting to £2,022. 3s., leaving a balance of £1,222. 8s. 3d., which the directors recommended should be carried forward to the credit of the current year. The Board stated that the business showed every sign of a steady rate of increase. During the period covered by the accounts, 1,260 installations, with an aggregate of 33,017 lamps of 8 c.p., have been completed, of which 746 installations, with an aggregate of 14,650 8-c.p. lamps, were free wiring, and 514 installations, with an aggregate of 18,367 8 c.p. lamps, were contract; while the orders in hand at the close of the year numbered 119 installations, with an aggregate of 2,064 8-c.p. lamps. During the period under review additional free wiring contracts with the Corporations of Taunton, Canterbury, and Lincoln, and with the Blackheath and Greenwich, Fleetwood, and Prescot Electric Supply Companies had been completed, and, since the books were closed, with the Corporations of Tunbridge Wells and Redditch, and with the Salisbury Electric Light and Supply Company. Terms of contract had been arranged with the companies supplying electricity in Chiswick, Aberystwyth, and Northampton, and negotiations with other authorities were in progress.

The **Chairman,** in moving the adoption of the report and financial statement, said that, considering the business was a new one, they had every reason to be satisfied with the progress made. Referring to the revenue account, he said the amount did not look large, but a more favourable aspect was put upon it when he stated that out of 680 installations completed at the end of the year, only 85 bore revenue for the whole of that period. Having alluded to the importance of some of the contracts at Liverpool, West Ham, and other places, he said that their system of wiring meant that in meeting all the requirements of the new rules it was equal, if not superior, to all others. They had a hire-purchase system by which customers might become possessors of installations on easy terms of payment extending over one, two, or three years.

Mr. J. W. Swan seconded the motion, which, after a brief discussion, was carried.

At an extraordinary meeting subsequently held, the title of the Company was altered to that of the National Electric Wiring Company, Limited.

Replying to a vote of thanks, the **Chairman** expressed a hope that he would be able next time they met to declare a dividend.

EASTBOURNE ELECTRIC LIGHTING COMPANY, LIMITED.

The ordinary general meeting was held on Monday, Mr. G. Boulton (chairman of the directors) presiding.

The report of the directors, which recommended the declaration of a dividend for the past half-year of 20 per cent., making, with the interim dividend declared in June last, a dividend for the year of 12½ per cent., was adopted. Alderman Skinner was re-elected as director, and the auditors were reappointed.

On the proposition of the **Chairman,** seconded by **Mr. Goble Champion**, a sum of £50 was set apart for contributions to local and other objects, the directors being authorised to appropriate the same in such manner as they may deem desirable.

Subsequently an extraordinary general meeting was held for the purpose of considering an amended offer on behalf of the Eastbourne Town Council for the purchase of the Company's undertaking. The draft agreement of purchase, which provides that the Corporation will pay £2 for every £1 of capital subscribed and £2,000 as compensation to the officers of the Company in the event of their services not being continued, was agreed to. The date fixed for the transfer is Jan. 1, 1900, the Company having all benefit of the present year's trading. The total amount of the offer is over £80,000. The Corporation will assume the responsibility for all machinery already ordered by and not yet supplied to the Company.

BUENOS AYRES AND BELGRANO ELECTRIC TRAMWAYS COMPANY, LIMITED.

The first annual general meeeting of this Company was held last week at Winchester House.

Mr. John Morris, who presided, said that during the past year only a portion of the new line worked by electricity had been

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completed, and the results of the working had been very satisfactory. In December last they obtained permission from the municipality of Buenos Ayres to lay down at once their own double independent track over the whole of the length of the new Belgrano electric lines, an important section of which, connecting Government House (Plaza Mayo) with Palermo Park, had recently been opened. They had also obtained a concession for a new line about one mile and a half in length, forming an alternative and more direct route to Belgrano. For the first four weeks of the working of the section of the new line which had been completed there had been an increase in the receipts equal to the rate of £40,000 a year gross. They had always looked forward with extreme hope to the working of the new electric lines, and the result so far had certainly come up to their most sanguine expectations. The new line to Belgrano would be finished in a few weeks.

The report was adopted, and a dividend was afterwards declared at the rate of 6 per cent. per annum on the amounts paid on the A preference shares of the Company.

RICHMOND (SURREY) ELECTRIC LIGHT AND POWER COMPANY, LIMITED.

The fifth ordinary general meeting of this Company was held at Moorgate-court, Moorgate-place, London, E.C., on the 23rd inst. Mr. F. W. Reynolds, J.P. (chairman) presided. The report of the directors, published in our last issue, together with the balance-sheet and statement of accounts at Dec. 31, 1898, was approved and adopted, and a dividend of 4 per cent. on the ordinary shares was declared. A vote of thanks to the chairman terminated the proceedings.

ISLE OF MAN TRAMWAYS.

The annual meeting was held at Douglas last week, Mr. Alexander Bruce presiding.

In moving the adoption of the report and accounts, previously published by us, the **Chairman** commented on the increasing sources of revenue from the extension of the line from Laxey to Ramsey, and to the saving in expenditure which is anticipated by utilising water power, whereby for eight months in the year the systems can be worked without steam power at generating stations.

The report and accounts were adopted, and the dividend of 6 per cent. on the ordinary capital was declared. Dr. Farrell was re-elected a director, Mr. Joseph Drake Rogers elected in place of the late Mr. Pittar, and Mr. John Robert Cowell was added to the directorate.

BABCOCK AND WILCOX, LIMITED.

The annual report of the directors, with accounts for the half-year ended Dec. 31 last, to be submitted to the general meeting to be held in London on April 5, states that the profit for the half-year, after deducting the amount written off purchase of business account, amounts to £53,422, which, with the addition of the balance brought forward from last account of £5,912, makes a total of £59,334. The following dividends are recommended to be paid for the half-year: on the preference shares 6 per cent. per annum, from which income tax to be deducted, absorbing £3,000; on the ordinary shares 20s. per share, free of income tax, requiring £22,000. It is proposed to place £2,500 to the reserve fund, which will leave a balance of £9,334 to be carried forward.

COMMERCIAL CABLE COMPANY.

The report for the year 1898, just published, shows an increase in the net traffic earnings from cables and land lines of 107,409dol. over the previous year. Out of the balance to credit of revenue account a sum of 350,000dol. has been transferred to the reserve fund, and an amount of 100,000dol. to the fund for insurance of stations, apparatus, and repair steamer. The net revenue, including the amount brought forward, amounts, after providing for reserves and expenses, to 1,908,758dol., out of which have been paid interest on the bonds and debenture stock 704,296dol., and dividends and bonus on the capital stock 800,000dol., leaving a balance of 404,462dol. to be carried forward.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN

Edinburgh.—The Corporation invite tenders for water-tube boilers by April 3.

Salford.—The Electric Light Committee are prepared to receive tenders for the various stores.

Bristol.—The Electrical Committee require tenders for high-tension switchboards, instruments, etc.

Wimbledon.—The Urban District Council are about to call for tenders for wiring the electric lighting station.

Tynemouth.—The Corporation are prepared to receive tenders for the various electrical plant. Tenders by noon on April 15.

Belfast.—The Electric Committee invite tenders for the supply and erection of various plant. Tenders by 12 noon on April 20.

Edinburgh.—The Corporation invite tenders for installing the electric light at the City Chambers (extension buildings). Tenders by April 10.

West Ham.—The Tramways and Electric Lighting Committee of the Town Council will shortly advertise for tenders for engines and alternators.

West Ham.—The County Borough Council invite tenders for engines, alternators and exciters, or steam alternators and exciters. Tenders by 4 p.m. on April 25.

Peterborough.—The Corporation are prepared to receive tenders for the supply and erection of the plant for the municipal electricity works. Tenders by April 20.

Bradford.—The Corporation invite tenders for the supply of a complete battery and switchboard for the electric light station, Bolton-road. Tenders by April 12.

Madrid.—The Public Works Department are inviting tenders for the building of an electric tramway in the city. Applications must be sent in by p.m. on April 14.

Southend-on-Sea.—The Corporation are prepared to receive tenders for the temporary transfer of their powers under the Southend Electric Lighting Order, 1891. Tenders by April 6.

Dublin.—The Directors of the Great Northern Railway Company (Ireland) invite tenders for the various works in connection with their line between Sutton and Howth, near Dublin. Tenders by April 20.

Greenwich.—The Blackheath and Greenwich District Electric Light Company Limited, invite tenders for the wiring of 3,000 lights in 500 installations of six lights each in their area of supply. Tenders by noon on April 6.

Manchester.—The Lancashire and Yorkshire Railway Company invite tenders for the supply of the following articles during 12 months ending April 30, 1900: (No. 25) signal and telegraph fittings; (26) signal, telegraph and electric light wires. Tenders by April 3.

Poplar.—The Board of Works invite tenders for engine and pump room equipment and all electrical plant in the works except the battery, boiler-house equipment, battery and battery stands, and public street lighting. Tenders by 10 a.m. on April 25.

Nelson.—The Trustees of the Primitive Methodist Chapel and School, Scotland-road, Nelson, invite tenders for the installation of the electric light, decorating, sundry plastering, and joiner's work. Persons wishing to tender are to send their names at once to Mr. Fredk. W. Dixon, architect, Trevelyan-buildings, Manchester.

Aberdeen.—The Corporation are prepared to receive tenders for the following: (1) two Babcock and Wilcox boilers; (2) one 180-kw. steam dynamo, engine to be of Messrs. Belliss's or Messrs. Willans and Robinson's make, with steam and exhaust pipes; one 75-kw. balancing set. Tenders to Town Clerk, marked "Tender for Electric Plant," by April 5.

Leeds.—The Markets Committee of the Leeds City Council invite tenders for electric lighting required at the new dead-meat market and abattoir, now in course of erection in New York-street, Leeds. Particulars may be obtained upon application at the offices of Messrs. Walter Hanstock and Son, architects, Branch-road, Batley. Tenders by April 8.

Edinburgh.—The Lord Provost, Magistrates, and Council invite tenders for installing the electric light at the City Chambers (extension buildings). Specifications, etc., can be obtained at the office of the Resident Electrical Engineer, 5, Dewar-place, Edinburgh, on deposit of £2. 2s., which deposit will be returned on receipt of a bona fide tender. Tenders by April 10.

Derby.—The Corporation invite tenders for the works in excavations, foundations, engine-bed and retaining wall in connection with extensions to the electric lighting station, Derby. Specifications, etc., may be obtained on payment of £2. 2s. (to be returned if a bona fide tender be made) on application to the office of Mr. Arthur Eaton, architect, 6, St. James's-street, Derby. Tenders by 12 noon on April 10.

Dudley.—The British Electric Traction Company, Limited, invite tenders for the construction of about 2½ miles of tramway permanent way from Dudley to Cradley Heath, Staffordshire. Specification, etc., may be obtained from the Company's permanent-way engineer, Mr. W. Howard-Smith, A.M.I.C.E., Donington House, Norfolk-street, Strand, London, W.C., on payment of £2. 2s., to be refunded upon return of documents. Tenders by April 14.

Perth.—Applications will be received at the City Council Office from persons desirous of applying for a concession for the installation and working of a system of electric lighting for the municipal buildings and streets of the city of Perth, as well as house-to-house lighting. Conditions of contract and full particulars may be obtained on application to the Agents-General for Western Australia, 15, Victoria-street, Westminster, London, or Gordon and Gotch, St. Bride-street, Ludgate-circus, E.C. Tenders by May 2.

Rochdale.—The Guardians invite tenders for a complete electric light installation at the workhouse buildings and cottage homes. Specifications, etc., may be obtained from the consulting engineers, Messrs. Crews and Handford, Cross-street-chambers, Manchester, on payment of a deposit of £5 Bank of England note. Deposit will be refunded to each unsuccessful contractor as soon as the work is placed, providing a bona fide tender has been received within the stated time and is not withdrawn subsequently. Tenders by April 12.

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Cape of Good Hope.—The Controller and Auditor-General of the Colony is prepared to receive at his office at Cape Town alternative tenders for the construction of a light or ordinary railway, with or without permanent-way materials and bridge-work, from Sir Lowry Pass Station to Caledon, about 53 miles in length. Further particulars, as soon as they shall have been received from the Colony, will be obtainable by intending contractors upon application at the office of the Agent-General for the Cape of Good Hope, 112, Victoria-street, Westminster, S.W. Tenders by noon on April 17.

RESULTS OF TENDERS.

Beckenham.—The Urban District Council have sealed a contract with the British Insulated Wire Company for electric light.

Middlesbrough.—The Council have accepted the tender of Messrs. Davy Bros., of Sheffield, for the electric lighting plant at about £7,000.

Central London Railway.—The Safety Tread Syndicate, Limited, have secured the contract for the supply of their treads throughout all the stations on this railway.

London, S W.—The Fulham Vestry have accepted the tender of Mr. F. G. Minter for erection of an electric light generating station in Townmead-road, Fulham, at £22,970.

Kingston.—The Town Council have accepted the tenders of Messrs. J. and F. Howard at £47. 7s. 6d. for the tramrails, and £7 for the tipping wagon, for the electric works coal yard.

Gillingham.—The District Council have accepted the tender of Messrs. Priestly and Taylor, of Leeds, for fitting up the Technical Institute with appliances for the electric light at £107. 17s.

BUSINESS NOTES.

Halifax.—The Booth Town route will probably be available for traffic by Easter.

Gloucester.—The purchase of a site for the electricity works has been completed.

Southampton.—Mr. Manville has prepared estimates for extension of the electric lighting.

St. Albans.—The first meeting of the Electric Lighting Committee will take place during the next week.

Woking.—The District Council have decided not to purchase the local electric light undertaking at present.

Sale of Country Station.—A small country central station is for sale on the Thames. Particulars elsewhere.

Douglas.—The Town Council are considering the purchase of a site for electric lighting works at a cost of £7,000.

Central London Railway Bill.—This Bill passed Mr. Lowther's Committee of the House of Commons on Tuesday.

Exeter.—The National Telephone Company have agreed to the Council's conditions for placing their wires underground.

St. Marylebone.—At a meeting of the Vestry on Friday it was resolved to withdraw the Vestry's Electric Lighting Bill.

Beckenham.—The Urban District Council have sealed a contract with the British Insulated Wire Company for electric light.

Islington.—The Vestry have received from the London County Council the sanction for the loan of £38,750 for electric lighting purposes.

Dover.—The total receipts for the year's working of the municipal electric tramways is stated at £9,000, showing a profit of over £2,000.

Leigh.—The Local Government Board have sanctioned a loan of £10,000 for electricity works. These are expected to be ready next winter.

Canterbury.—A Local Government Board enquiry was held on Tuesday in regard to the sanction of a further loan of £12,000 for electric light.

Sligo.—A public meeting has been called for Saturday to discuss, *inter alia*, the advisability of an electric lighting system for the town.

Epsom.—The specifications and plans for the proposed electricity supply works at Epsom having been completed, tenders will now be advertised for.

Hartlepool.—The provisional order made by the Board of Trade under the Electric Lighting Acts of 1882 and 1888 relating to Hartlepool has been read a first time in the House of Commons.

Manchester.—The Electricity Committee of the Corporation have received the sanction of the Board of Trade to plans for the supply of electricity to the districts of Levenshulme, Moss Side, and Withington.

Windsor.—On Saturday last the Mayor and several members of the Corporation witnessed the inauguration of the system of lighting the streets by arc lamps, under contract with the local electrical supply company.

Direct United States Cable Company, Limited.—The directors have decided to pay an interim dividend of 3s. per share, free of tax, being at the rate of 3 per cent. per annum, for the quarter ending March 31, payable on April 26.

Dewsbury.—At Tuesday's meeting of the Town Council the Electricity Committee reported an increase in the use of electricity, and also that further cable mains had been ordered, some for repairs and some for extensions in Oxford-road.

Liverpool.—The Tramways Committee have decided to obtain tenders for 80 new electric cars with outside seats, 40 to be delivered in September and the remainder in December.

Bilston.—The Urban District Council was fined last week for neglecting to post an abstract of the Factory Act in the Market Hall, which was held to be a factory because electricity was there manufactured for the purpose of lighting the stalls.

Exeter.—A gross profit of £5,500 has been earned during the last year in the electricity department. The previous year's gross profit was £1,250. The net profit is £500 this year, as against £192. A loan of £10,000 is to be applied for for extensions.

Wellingborough.—The Highway Committee have received reports and estimates from Messrs. Beaman and Deas and Messrs. Horafall, and have instructed the surveyor to visit a place where a destructor of a type most suitable to Wellingborough can be seen.

Kew.—The breaking of the ground for the electric line took place near the Grand Junction waterworks in Kew Bridge-road last week. Mr. Clifton Robinson, jun., son of the managing director of the London United Tramways Company, Limited, performed the ceremony.

Cardiff.—The Tramways Committee have adopted an agreement with the Cardiff Tramways Company relative to certain alterations in the lines in St. John's-square, Cowbridge-road, etc. The town clerk has been asked to report upon the power of the Corporation to run motor 'buses.

Somerset.—The County Council have passed a resolution agreeing to defray out of the county fund the expense of opposing in Parliament the Weston-super-Mare, Clevedon, and Portishead Tramways Bill, and the Great Western Railway Bill, as to the Castle Cary and Langport proposed railway.

Finchley.—The Highways Committee of the Urban District Council have under consideration an enquiry by a London syndicate as to whether the Council would be prepared to entertain a proposal for the construction of an efficient and cheap working system of electric tramway or light railway in the district.

Glasgow.—The dispute between the Corporation and the Postmaster-General regarding the demand of the Post Office authorities to lay pipes underground for the purpose of affording facilities to the National Telephone Company for the connection of local exchanges will form the subject of an enquiry on the 19th prox.

Norwich.—The Tramways Committee has been requested to report upon the present position of the Corporation and the Norwich Electric Tramways Company with regard to the construction of a tramway through St. Stephen's-street, and when the Council may expect to be asked to consent to the construction of such tramway.

Kendal.—A small meeting of gentlemen connected with the business of the town was held last week to take into consideration the question of the electric lighting of Kendal. A resolution was passed to the effect that the meeting earnestly requested the Corporation of Kendal to take immediate steps to supply electric lighting to the town.

Edinburgh.—The number of lights applied for since Feb. 23 last is reported as equivalent to 5,471 8-c.p. lamps, and the number connected with the supply from 1st to 17th inst. as equivalent to 6,570 lamps of 8 c.p. An estimate amounting to £8 827 has been accepted for the formation of a subway between the M'Donald-road power station and Picardy-place.

Ross.—The Rural Council are looking favourably at a proposal made by a private party residing in the district to apply to the Board of Trade for a provisional order for the supply of electric light to the urban and rural divisions of the town. It is stated that the promoters are prepared to commence the work at once, providing the necessary capital themselves.

Baker-street and Waterloo Railway Bill.—After a protest by Sir G Fardell, who stated that the Vestry of Paddington had petitioned against the power proposed to be taken by the company to erect a generating station at Paddington, and to take land for a terminal station and yard, the Bill was read a second time in the House of Commons on Monday.

Herne Bay.—On Friday last Major Cardew, of the Board of Trade, made an official examination of the arrangements and working of the electric tramcar on the pier. The inspector appeared to be fully satisfied on every point, and the trial trip was accomplished with perfect ease. The establishment has now passed out of the hands of the contractors, and business has commenced.

English Illustrated Magazine.—The April number of this bright little monthly has its usual complement of entertaining short stories. Sandwiched between these we note specially two articles on submarine boats. We look forward with great interest to the account promised for next number of a voyage under the sea by a passenger. The illustrations are remarkably well executed.

Nottingham Corporation Bill.—This Bill was considered by the Unopposed Bills Committee of the House of Commons last week. It authorises, *inter alia*, the use of electricity as a motive power on tramways. The committee amended the Bill by allowing 50 years instead of 60 years (as proposed by the Bill) for the repayment of loans for the proposed extension of the water undertaking.

North London Light Railways.—The adjourned enquiry into the projected Finchley, Hendon, and District Light Railway, the Hampstead, Finchley, and Edgware Light Railway, and the Highgate, Finchley, and Wood Green Light Railway was concluded on

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Tuesday before Lord Jersey, Colonel Boughey, and Mr. Gerald FitzGerald. The Commissioners decided that none of the schemes should be proceeded with.

Keighley.—The directors of the Keighley Tramways Company appear to be willing to consider the question of traction by electricity, and as to the provision of new cars, the Corporation will be asked to supply the current. As far as can be learnt, the question of selling their interest in the tramways outright is not likely to be entertained. The supply station of the Corporation installation is to be at Low Bridge.

Bradford.—The Tramways Committee have decided to recommend the City Council to increase the salary of the manager of the electric tramways (Mr. C. J. Spencer) by £50 per annum. The contract for the advertising on the electric cars has been let to Mr. A. Burnley, of London, from May 1 to Jan. 31, 1893, when the leases of the lines now worked by the other tramway companies expire, at £25 per car per annum.

Maryport.—Mr. F. F. Bennett, consulting engineer, of Manchester, has brought before the District Council a proposal by a London company to construct an electric railway from Whitehaven along the Cumberland coast through Workington to Maryport, to be used for passengers. The company also intend supplying Maryport with electricity for lighting purposes at the prices charged by the Whitehaven Corporation.

Personal.—Mr. Frank Little, late installation superintendent for John A. Edmondson, Leeds, has been appointed manager of the Bradford branch of the National Electric Free Wiring Company, Limited, Faraday House, London, W.C.—Mr. John Eades, jun., deputy manager of the Manchester Carriage and Tramways Company's works in Pendleton, has been appointed manager for the car building and repairing works of the Manchester tramways.

Paddington.—At the last meeting of the Vestry, a letter from the Board of Trade was referred to the Electric Lighting Committee stating that the Metropolitan Electric Supply Company had appealed to them under Section 14 of the order in respect of the disapproval by the Vestry of Paddington of certain works proposed to be executed by the company, and that the Board of Trade had appointed Major Philip Cardew, R.E., to enquire into the matter.

London Gazette.—The last day for receiving proofs of claims for dividends in the estate of F. Jones (carrying on business under the style of F. Jones and Co), electrical engineer, Wandsworth, has been fixed for April 11. Mr. A. Mackintosh, 24, Railway-approach, London Bridge, is the official receiver.—Mr. William Marsden Richards, 52, Belvoir-street, Leicester, has been appointed trustee in the estate of F. Marson (trading as F. Marson and Co.), Leicester.

Smoke Nuisance.—The Charing Cross and Strand Electric Supply Corporation, Limited, were summoned on Tuesday under the Public Health (London) Act for disobedience to an order requiring them to abate a smoke nuisance upon their premises. Sir James Vaughan adjourned the summons *sine die* that the defendants' furnaces might be examined as to their efficiency by an expert to be nominated by the president of the Institute of Civil Engineers.

Appointments Vacant.—The Vestry of St. John, Hampstead, require a clerk at the electric lighting station, Stoneyard, Lithos-road, Finchley-road. Salary 30s. per week. Application must be made by 10 a.m. on April 8.—The Corporation of Wolverhampton invite applications for the appointment of mains superintendent, who will be required to take charge of the outdoor work of the department, at a commencing salary of £104 per annum. Applications by April 4.

Newington.—At a meeting of the Vestry on Wednesday a report was submitted from the Electric Lighting Committee recommending that the committee be empowered to appoint the requisite working staff at the station; that the price per unit for current supplied for lighting purposes be at the following rates: 6d. for the first hour, 4d. for the second hour, 3d. for any time after; and that the charge for motive power be at the uniform rate of 2½d. per unit.

Middlesbrough.—Messrs. Davy Bros., of Sheffield, have secured the contract for the electric light installation, amounting to nearly £7,000. This includes a set of three-cylinder triple-expansion engines, of about 500 i.h.p., together with smaller engines to drive the auxiliary dynamos. The electrical plant will be made for Messrs. Davy Bros. by Messrs. P. R. Jackson and Co., of Manchester. The consulting electrical engineer to the Middlesbrough Corporation is Mr. Robert Hammond.

Bath.—At the last meeting of the Electric Light Committee it was decided not to make any reduction in the charge for the light at present. The extension for public lighting in Lower Bristol-road was altered to one of incandescent instead of arc lamps, and it was decided to add the Upper Bristol-road to the proposed extensions of cable. A joint committee's report recommending that application be made for an order under the Light Railways Act with the view of establishing electric trams in the city, was approved.

Greenock.—At a special meeting of the Police Board held last Friday for the purpose of considering the report from the deputation sent last week to London to oppose the Tramways Bill, the following resolution was carried: "That the Police Board learn with regret that the majority of the deputation have failed to carry out their remit, thereby introducing a precedent which in the future might seriously imperil the best interests of this community, and that the report be remitted to a sub-committee for consideration and report."

Ramsgate.—The Corporation have adopted the following recommendation: "That the engineer be instructed to report on the subject of the electric light, such report to give information under the following headings: (1) the desirability of such lighting being undertaken by the Corporation or placed in the hands of an independent body; (2) the probable initial cost of the installation in either case; (3) the best system to be employed, having regard to extensions. As this report will involve out-of-pocket expenses, the engineer be allowed a minimum charge of 30 guineas on that account."

Harrow.—The directors of the Harrow Electric Light and Power Company, Limited, have from the 25th inst. reduced the price of electric energy. The price charged for current for lighting purposes is now 7d. per Board of Trade unit instead of 8d., and the consumer may, at his option, have a demand indicator fixed on his premises, whereby he will be charged 8d. per unit up to the number of units corresponding to a consumption at the rate of his maximum demand for two hours a day in the winter and one hour a day in the summer, and 6d. per unit for all units over that number.

William James Glover and Co.—We are asked to state that in consequence of the action taken against this company by Messrs. W. T. Glover and Co., Limited, of Salford, challenging the right of this company to use the name "Glover" as applied to "electric" cablemaking, although the firm of Wm. Jas. Glover and Co. has been established for over 80 years, and long before Messrs. W. T. Glover and Co. came into existence, no allotment of shares will take place on the numerous applications sent in, and the money received on application will be returned forthwith. We refer to the case in another column.

Presentation.—A presentation took place in the National Telephone Company's offices at Cork on Saturday on the occasion of Mr. H. D. Shinn, chief electrician, severing his connection with the above company. The presentation consisted of a gold chain and seal bearing a suitable inscription. Mr. J. Donovan, who made the presentation, in a few words referred to Mr. Shinn's capabilities, etc., and to his success in the examination held under the City and Guilds' Institute, for which Mr. Shinn obtained first-class certificates in telegraphy and telephony, magnetism and electricity.

Stock Exchange.—April 12 has been appointed as a special settling day for the British Insulated Wire Company, Limited, 5,530 vendors' 6 per cent. cumulative preference shares of £5 each fully paid, Nos. 1 to 5,530, and a further issue of 7,500 6 per cent. cumulative preference shares of £5 each fully paid, Nos. 20,001 to 27,500; and April 13 for the Brisbane Tramways Company, Limited, £167,900 5 per cent. debentures, Nos. 822 to 2,500. The issue of the Brisbane Tramways Company, Limited, £167,900 5 per cent. debentures, Nos. 822 to 2,500, has been ordered to be quoted on the official list.

Leixlip.—Mr. John H. Ryan, M.I.C.E., held an enquiry on the 23rd inst., on behalf of the Commissioners of Public Works, into the merits of the undertaking from an engineering point of view of the proposed electric tramway from Lucan to Leixlip. Mr. W. F. Clarke, C.E., on behalf of the promoters, stated that the new line was to be laid on the north side of the public road. The total length would be 1¾ miles, and the cost of construction for the adoption of electricity, including the poles, cables, and two motorcars, £4,950. The motive power would be supplied by the Dublin and Lucan Company. The feeders would be both under and over ground.

London County Council.—The Bridges Committee have recommended that the Vestry of Lambeth and the Wandsworth District Board should be asked, as the road authorities, to give their consent to an application being made to the Board of Trade for a license for experimental use of mechanical traction on the tramway between Westminster Bridge and Tooting. Extensions of mains, etc., under Electric Lighting Acts and orders, have been sanctioned upon applications by the London Electric Supply Corporation, the Notting Hill Electric Lighting Company, and the County of London and Brush Provincial Electric Lighting Company (under the Wandsworth Electric Lighting Order, 1892).

Kingston.—At the last meeting of the Town Council the borough electrical engineer submitted an estimate of the additional amount of capital required for the ensuing three years in respect of the electricity undertaking, also a statement of capital expenditure already incurred. The statement of capital expenditure in 1897-1898 showed that the amount sanctioned was £14 319. 19s., which had been exceeded by £3,064. 11s. 1d. The loans already sanctioned and raised totalled £43 426, while the expenditure and liabilities to date amounted to £46,490. 11s. 1d., and the estimated capital outlay for the three years 1899-1901 was £11,935. 8s. 11d., leaving a deficit of £15,000, which the committee now recommended the Council to apply to the Local Government Board for sanction to borrow. This was agreed to.

Bedford.—At a meeting of the Town Council last week the Electric Lighting Committee submitted the statement of accounts for the year 1898 as follows: To capital receipts (loans), £54,598. 11s. 5d.; to sundry creditors, £365. 6s. 1d.; to balance due to treasurer less cash in hand, £6 441. 1s. 10d.—total, £61,404. 19s. 4d. By capital expenditure, £68,300. 1s. 1d.; by stores on hand, £189. 2s. 6d.; by sundry debtors for current and meter rents, £1,934. 5s. 8d.; by net revenue account (balance at debit thereof), £981. 10s. 1d.—total, £61,404. 19s. 4d. It was decided to purchase a new boiler with mechanical stoker at an estimated cost of £1,350; also blocks, shearlegs, vice, and forge at a cost of £20; and that bills be paid amounting to £542. 3s. 9d. The engineer was empowered to order additional high-tension cables,

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Whitechapel.—The work of laying electric lighting mains in this district has been commenced. A sum of £18,000 is to be borrowed from the London County Council, at the rate of 3 per cent. per annum, to defray the cost of the erection of the new destructor; and also a sum of £60,500 in order to carry out portion of the work of erecting the electric lighting installation in the district. This loan is to be upon the instalment system, and not upon the annuity system as at first proposed by the Vestry. It will be repayable in 42 years with interest at the rate of £3 per cent. per annum, provided that not less than £10,000 be taken up at one time, and upon the understanding that if any works fail to be renewed during the currency of the mean period, the cost of renewal shall constitute a maintenance charge, and shall not be made the subject of a fresh loan. The repayment is to commence at the expiration of three years from the quarter-day anterior to the date of the advance of the first portion of the loan.

Penzance.—The Joint Highways and Lighting Committees of the Town Council are considering an offer from the Electrical Power Distribution Company to take a lease of the provisional order upon the terms that upon the expiry of two years' notice given at any time after the end of 10 years, the Council should be entitled to purchase the entire undertaking and goodwill at a value to be fixed by independent valuers. Electricity for public lighting or other purposes would be charged to the Council at 2d. per unit after the first hour's use at 8d. For all-night street-lighting this would average at the very moderate figure of 2½d. per unit. The company state that they are prepared to supply customers at 2½d. per unit after the first hour's use at 8d., and put in free of any additional cost the necessary interior wires in shops and private residences. The low-pressure system of supply was best suited to the district. The company would pay the reasonable costs incurred by the town in connection with obtaining the powers.

Middlesex County Council. — Major-General Hutchinson's award *re* the line proposed by the London United Tramways Company in Hanwell, etc., contains the following paragraph: "The electric wires are to be attached to the posts which carry them at a height not less than 22ft. vertically above the level of the outer rail of the line next and opposite to the post. And I further award and adjudge that the several parties shall pay their own respective costs of the said reference, and that the costs of this award shall be borne and paid as follows: as to 27 forty-second parts by the County Council, as to 10 forty-second parts by the company, as to 5 forty-second parts by the Hanwell Council, and if any one of the said parties should pay the whole thereof, then I award and direct that each of the other two parties shall repay to the said party their share respectively of the said costs." The Council have referred to the county engineer and surveyor to consider in what way they may, in the interests of the county at large, avail themselves, as promoters, of the provisions of the Light Railways Act, 1896, and to prepare and to submit to the Parliamentary Committee a scheme for that purpose accordingly, having regard, in the first instance, to those districts in which the local authorities have expressed their wishes for light railway or tramway schemes.

New Telephone Patent.—With reference to the case heard in the City of London Court on Friday last, a *Daily Chronicle* representative visited the defendant, Mr. Thomas J. Howell, an electrical engineer, of Barford-street, Islington. He says Mr. Howell is an elderly man, whose blindness is the result of an accident during his career as an electrical engineer, in which he says he worked with Mr. Preece and other eminent electricians. It was rather difficult in the absence of the machine to understand what the invention is, but it appears to dispense with the present "ringing up" and the necessity of using the existing mouthpiece. "If," said Mr. Howell, "you have this transmitter fixed and want to call up the exchange, you turn on the switch, call out, and your voice is heard as clearly at the other end as mine is by you now. When the connection is made, you and the person called up can each sit comfortably down and talk away as though you were in the same room. I have fixed the transmitter in various places, sometimes under the table, but it doesn't matter where it is. I have supplied 200 of them which are now working, and I am negotiating with the City Corporation. The transmitter has been tried over long distances. On one occasion I carried my voice a distance of 16,020 miles through a wire which was designed to represent that distance; and on another, when we were talking with Dublin by way of Glasgow and Belfast, we used the ordinary telegraph wires. I claim to be the only man who has beaten the National Telephone Company."

PROVISIONAL PATENTS, 1899.

MARCH 20.

5968. **Controlling moving bodies by wireless telegraphy.** Arthur Alexander Govan, John Trotter, and Walter Jamieson, 15, Renfield-street, Glasgow.

5975. **An improvement connected with magneting machines for extracting iron and steel particles from borings and turnings, etc., of brass, copper, and other non-magnetic metals, also from charcoal and earths.** Frank Bury Parkinson, 11, Fearnleaf-street, Moss Side, Manchester.

6002. **Receiving apparatus for so-called Hertzian waves for transcribing same into perceptible signs.** Johann Christian Schäfer, Eduard Renz, and Paul Lippold, 36, Chancery-lane, London. (Complete specification.)

6016. **Improvements in or relating to electricity meters or indicators** Paul Rissler and Heinrich Bauer, 111, Hatton-garden, London.

6024. **Improvements in and relating to electrical incandescence lamps.** Victor Isidor Feeny, 60, Queen Victoria-street, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

6025. **Improvements in and relating to electrical incandescence lamps.** Victor Isidore Feeny, 60, Queen Victoria-street, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

6026. **Improvements in and relating to electrical incandescence lamps.** Victor Isidore Feeny, 60, Queen Victoria-street, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

6027. **Process for regulating the supply current for illuminating bodies or filaments composed of second-class conductors (electrolytes).** Victor Isidore Feeny, 60, Queen Victoria-street, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

6028. **Process for the production of electrical resistances with small heating capacity.** Victor Isidore Feeny, 60, Queen Victoria-street, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

6032. **Improvements in or relating to electricity registers or meters.** César René Loubery, Emmanuel François, and Henry Kunkelmann, 111, Hatton-garden, London.

6034. **Improved electrical striking attachment for clocks.** George Daniel Granger, 1 and 4, Mitre-court-chambers, Fleet-street, London.

6038. **Improvements in controlling switches and apparatus for electric motors.** Reese Hutchison, 322, High Holborn, London. (Complete specification.)

6052. **Improvements in apparatus for working railway points and signals by electricity.** Francis William Webb and Arthur Moore Thompson, 47, Lincoln's-inn-fields, London.

6053. **Improvements in electric lamps.** Serge Berditschewsky-Apostoloff, 53, Chancery-lane, London.

6054. **Improvements in electric lamps.** Serge Berditschewsky-Apostoloff, 53, Chancery-lane, London.

6062. **Improvements in incandescence lamps.** Karl Lehmann, 46, Lincoln's-inn-fields, London. (Complete specification.)

6064. **Improvements in electric relays.** William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Albert Cushing Crehore and George Owen Squiers, United States.)

6067. **An improved electrical drying apparatus for treating textile fabrics.** Jean Marie Joseph Vignon-Danto, 65, Chancery-lane, London. (Complete specification.)

MARCH 21.

6125. **Improvements in electrically-operated motor road vehicles a part of the invention being applicable to secondary batteries and to their charging connections and the connections of same with their motors.** Philip Middleton Justice, 55, Chancery-lane, London. (The Pope Manufacturing Company, United States.) (Complete specification.)

6129. **Improvements in or relating to electric batteries.** Charles Levetus, 111, Hatton-garden, London.

6142. **Improvements in telephonic exchange apparatus.** Arthur Edwin Lamkin and John George Lemon, 53, Chancery-lane, London.

6149. **Improvements in the manufacture of filaments for incandescing electric lamps and in means applicable for use in such manufacture.** William Lawrence Voelker, Clun House, Surrey-street, Strand, London. (Complete specification.)

6157. **Improvements in electric arc lamps.** Walter Claude Johnson and Adolph Wunderlich, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

6159. **Improvements in or relating to facsimile telegraph apparatus.** Alfred Julius Boult, 111, Hatton-garden, London. (William P. Dunlany, United States.)

6160. **Improvements in or relating to facsimile telegraph apparatus.** Alfred Julius Boult, 111, Hatton-garden, London. (William P. Dunlany, United States.)

MARCH 22.

6205. **Improvements in or relating to electric motor vehicles.** Maurice Loir, 111, Hatton-garden, London.

6213. **Improvements in insulating lining for electrical apparatus and process of making same.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (George B. Painter, United States.) (Complete specification.)

6220. **Improvements in electrical incandescence lamps.** Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske, Aktien-Gesellschaft, Germany.)

6229. **Improvements in column printing telegraphic instruments.** Frederick Herbert William Higgins, 18, Southampton-buildings, Chancery-lane, London.

6250. **Improvements in electrically-illuminated advertising devices.** Charles Baker and Walter Angove Chatworthy, 1, Queen Victoria-street, London.

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MARCH 23.

6258. **Imitation cover for electric glow lamps.** Maurice Patrick MacInnerny, 29, Falkner-street, Liverpool.

6269. **Improvements in electric lampholders.** Robert Frederick Hall, 24, Temple-row, Birmingham. (Complete specification.)

6270. **Improvements in combined electrical switches and lampholders.** Robert Frederick Hall, 24, Temple-row, Birmingham. (Complete specification.)

6271. **Improvements in electric switches.** Andrew Jackson McGeoch, 96, Buchanan-street, Glasgow.

6296. **An improvement in telephone systems.** James C. Slater, 304, Union Trust-building, St. Louis, Missouri, U.S.A. (Complete specification.)

6297. **Improved apparatus for extracting or reducing metals or for making metallic alloys by electrolysis.** Heinrich Bumb, 100, Wellington-street, Glasgow. (Complete specification.)

6303. **Electric safety alarm appliance to clothes hooks to prevent theft of garments and the like.** Rudolf Schmid and Robert Basch, 40, High Holborn, London.

6321. **Improvements in or connected with surface contact studs for electric traction.** William Kingsland, 33, Chancery-lane, London.

6322. **Improvements in or relating to electric cables.** Alfred Whalley, 111, Hatton-garden, London.

6335. **An improved device for producing electric current at sea by the action of the waves.** Max Gehre, 6, Lord-street, Liverpool.

6343. **Improvements in volting machines.** Frank William Purcell, 40, Chancery-lane, London. (Complete specification.)

6344. **Improvements in or connected with apparatus specially applicable for lighting and heating by electricity.** Otto Ovid Domon, 40, Chancery-lane, London.

6347. **Improvements in electric brakes for railway and tramway vehicles** William Lloyd Wise, 46, Lincoln's-inn-fields, London. (The Aktien-Gesellschaft Elektricitatswerke, vorm O. L. Kummer und Co., Germany.) (Complete specification.)

6349. **Improvements in telegraph and such like posts.** Siemens Bros. and Co., Limited, and George William Perry, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

6353. **Improvements in apparatus for the generation and electrolytic application of electric currents.** Francis Edward Elmore, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Partly by John Oliver Surtee Elmore, India.)

SPECIFICATIONS PUBLISHED.

1898.

4929. **Electric railway conduits and conductors.** Boult. (Snyers.)

7862. **Combined globes and shades for incandescent electric lamps, and for electric arc lamps, and for facilitating the application of advertisements thereto.** Böhm.

8140. **Switches for electric circuits.** Wright. (Date applied for under International Convention, Sept. 18, 1897.)

8442. **Electric meters.** Marks.

8489. **Electro-deposition of metal.** Wright.

8932. **Electrical vibrators for telegraphic and other purposes.** Harvey.

9339. **Electrical switching apparatus.** Edmunds.

9607. **Electric arc lamp.** Techieret.

9844. **Adjustable shade supports for electric and the like fittings.** Sturge.

10110. **Electric arc lamps.** Oliver.

11358. **Manufacture of elements or plates for secondary batteries or electric accumulators.** King.

12313. **Secondary batteries or electric accumulators.** King.

15801. **Electric accumulators.** Leimer.

15803. **Electric accumulators.** Leimer.

16129. **Electrolysis of alkali chlorides, etc.** Imray. (Oesterreichischer Verein für Chemische und Metallurgische Production.) (Amended.)

21317. **Magnetic separating apparatus.** Clark. (Metallurgische Gesellschaft A.-G.)

21759. **Control of electrically-propelled trains.** Potter. (Date applied for under International Convention, March 31, 1898.)

1899.

64. **Telemeter apparatus.** Wirth.

925. **Rotary converters for single-phase alternating currents.** Deri.

2175. **Appliance for automatically regulating the frictional pressure on the rails of the driving wheels of electrically-propelled vehicles.** Siemens Bros. and Co., Limited. (Siemens und Halske, Aktien-Gesellschaft.)

2296. **Manufacture of electric accumulators or secondary batteries.** Hathaway.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1899.	Corresponding week 1898.	Increase or decrease.	Total receipts for half-year. 1899.	1898.
		£	£	£	£	£
Birmingham Tramway	Mar. 25	3,395	3,370	+ 25	44,791	41,480
Blackpool and Fleetwood Tramroad	,, 25	174	—	—	2,087	—
Bradford City Trams	Feb. 5	145	—	—	6,733‡	—
Bristol Tramways and Carriage Co.	Mar. 24	2,321	2,397	- 76	—	—
City and South London Railway	,, 26	1,108	1,066	+ 42	14 386	13,992
Dover Tramways	,, 25	124	111	+ 13	1,696	1,277
Dublin U.T., elec. cars	,, 24	821	771†	+ 50	10,300	8,275†
Dublin S.D. Electric Tramways	,, 24	556	417	+ 139	7,361	4,750
Halifax Corporation Tramways	,, 8	301	—	—	9,729*	—
Liverpool Overhead Railway	,, 26	1,269	1,303	- 34	16,911	17,443
South Staffordshire Tramways	,, 24	542	562	- 20	7,092	6,904

* Since June 30, 1898. † Including horse cars. ‡ Since July, 1898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	24½-25½
Bournemouth and Poole Electric Supply, Limited, Ord.	10	13½-14
—— 4½ per cent. Cum. Pref.	10	10½-11½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	19½-20
—— 6 p. c. Cm. Pf., 30,001-40,000 (all paid)	10	13½-14½
—— 5 per cent. Perpetual Debenture Stock	100	126-129
Brush Electrical Engineering Limited, Ordinary	2	1½-2½
—— Non. Cum., 6 per cent. Pref.	2	2½-2⅝
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	102-106
Callender's Cable Company, Debentures	100	114-117
—— Ordinary	5	12½-13½
Central London Railway, Ordinary	10	9½-10½
——	8	7½-8½
—— Pref. Half-Shares	3	3½-4
—— " "	5	4½-4¾
Charing Cross and Strand	5	11½-12½ xd
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	8-9
—— 4½ per cent. Debentures	100	114-116
City of London, Ordinary	10	18-19 xd
—— " 90,001-100,000	10	18-19 xd
—— 6 per cent. Cumulative Pref.	10	15-16
—— 5 per cent. Debenture Stock	100	124-129
City and South London Railway, Consolidated Ordinary	100	68-70
—— Ordinary	3	4½-5½
—— 4 per cent. Debenture Stock	100	133-135
—— 5 per cent. Pref. Shares	10	14½-15½
—— " " '96	10	14-15
County of London and Brush Prov. Elec. Light Co., Ord.	10	11-12
—— " " No. 30,001-40,000	10	11-12
—— 6 per cent. Cum. Pref.	10	14-15
Crompton and Co.	3	3½ 3¾
—— 5 per cent. Debentures	—	98-101
Crystal Palace District, Ordinary 5 per cent. Stock	100	130-135
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2½-2¾
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	97-99
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5½-5¾
Electric Construction, Limited	2	2½-2¾
—— 7 per cent. Cumulative Pref.	2	3-3½
—— 4 per cent. Perp. 1st Mort. Deb.	100	103-106
W. T. Henley's Telegraph Works, Ordinary	10	26-27
—— 7 per cent. Preference	10	18½-19½ xd
—— 4½ per cent. Debentures	100	113-115 xd
House-to-House Company, Ordinary	5	8½-9¼ xd
—— 7 per cent. Preference	5	9-10 xd
Imperial Tramways, Limited	6	24½-25½ xd
India Rubber, Gutta Percha, and Telegraph Works	10	21½-22½
—— 4 per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	13-14
London Electric Supply, Ordinary	3	3½-4
—— 6 per cent. Pref.	5	6½-7 xd
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	105-107
Metropolitan Electric Supply, Limited, Ord., No. 1-62,500	10	16-17
—— " " " No. 62,501-85,000	4	12-13
—— 4½ per cent. First Mortgage Debenture Stock	100	117-120
National Telephone, Ordinary	5	4½-5
—— 6 per cent. Cum. First Pref.	10	12-14
—— 6 per cent. Cum. Second Pref.	10	12-14
—— 5 per cent. Non. Cum. Third Pref.	5	4½-5½
—— 3½ per cent. Deb. Stock, Red.	100	99-101
Notting Hill Electric Lighting Company, Limited	10	16½-17½ xd
Oriental, Limited, 1879	1	1½-1⅝
—— £5 Shares	5	7½-7¾
—— £4½ Shares, New	4½	6½-6¾
Oriental Telephone and Electric Company	1	½-1
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6½-7½
Royal Electrical Company of Montreal	1½	170-190
—— 4½ per cent. First Shares Mortgage Debentures	100	107-109
South London Electric Supply, Ordinary	3	3½-3¾
St. James's and Pall Mall, Limited, Ordinary	8	17-17½
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	38-42 xd
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	100	109-112
Westminster Electric Supply, Ordinary	5	15½-16½

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NOTES.

Blackburn Tramways.—The policy of cheap fares introduced by the Blackburn Corporation upon its newly-acquired tramways is proving highly successful, especially upon the sections now being worked by electric cars, which are immensely popular. Last week, in spite of the occurrence of Good Friday, 44,000 more passengers were carried than in the same week last year, while the receipts were almost £450 more.

The Telephone Bill.—The Telephone Committee of the London Chamber of Commerce has called a joint committee meeting of the Electrical and Allied Trades Section and the Postal, Telephone, and Telegraph Committee for Wednesday next, April 12, to consider what action the council should be recommended to take in connection with the Telephone Bill now before the House of Commons. The meeting will commence at 2.30 p.m.

Telegrams to France.—We understand that in view of the impending expiration of the 10 years' agreement between the Governments of England and France by which the telegraph rates between these countries is fixed at 2d. a word, strong representations have been made to procure a reduction of the rates to 1d. a word. This sum represents the combined inland rates of England and France, while telegrams are sent from England and Scotland to Ireland and to Jersey at inland rates. The Postmaster-General has, however, renewed the agreement at the old rate, but for one year only.

Transactions.—We have received Parts 3, 4, and 5, vol. xv., of the *Transactions* of the North-East Coast Institution of Engineers and Shipbuilders. They form a useful record of the third, fourth, and fifth ordinary meetings at which papers were read. Among the subjects introduced for discussion was a paper by Mr. M. W. Aisbitt on "Some Features of the Repairs and Construction of Iron and Steel Ships," and one by Mr. T. Messinger on "An Improved Method of Strengthening Copper Steam-Pipes." The contents also include an account of a visit paid by the institution to the Central Marine Works, West Hartlepool.

Countershafting.—The disadvantage of the use of large countershafts in electric light or in power works is exemplified by an accident which occurred in the power-house of the Consolidated Electric Light Company of Birmingham, U.S.A. In this power-house a 58in. pulley with a 38in. face recently burst, and wrecked the countershaft and its foundations. Six dynamos, having a total capacity of 920 kw., were being run from the shaft, but were thus rendered idle for over a week. Had independent direct-coupled plants been used, it is difficult to imagine how any one accident would have caused such a complete interruption. It is almost needless to say that the company was very much inconvenienced by the mishap.

Wooden Poles.—The preservation of the wooden poles used for supporting telegraph and telephone lines is a matter which requires careful attention in all countries, and particularly in those like England, where a frequent rainfall greatly assists decay. It is often found that this decay commences at the ground line, and we notice that an American, Mr. H. L. Dubois, has devised a method of protecting the poles at this point. He uses a terra-cotta casing about 2ft. long and from 2in. to 3in. larger in diameter than the pole. This practically resembles a large drain-pipe, except that in the case of a pole already erected it has to be made in two halves. The casing is placed with its upper ends about 2in. or 3in. above the surface of the ground. The space between it and the pole is then filled in with a mixture of clean gravel and pitch, which is put in hot. It is claimed that in this way the life of the pole is very much lengthened.

Curious Incident.—The *Street Railway Review* gives an illustration of a curious occurrence in connection with one of the street railways in America. The line referred to is equipped with very long cars running on two bogies, one at either end. On the day in question a car was approaching the street crossing at which lines went off to the left and right respectively. After the front bogie had taken the switch to the left the switch-points moved, and the rear bogie made for the right-hand street. The electric motors on each bogie did their best to get ahead, but as they were pulling in opposite directions, and the car would not stretch, they came to a standstill with the car's body just about at right angles to the original track. Of course, no damage was done.

Underground Railways in New York.—We understand that at least two large syndicates are endeavouring to get powers from the New York municipal authority to construct underground railways in and around that city. One of these, the Whitney Syndicate, proposes to spend about 10 millions on the work, and suggests that they should be allowed at the same time to provide conduits for other purposes than transport. In this case we are not told what the consideration would be to the authorities, but the Metropolitan Contract Company offers to pay 5 per cent. of the gross receipts into the city treasury. This company, however, only proposes to spend about six millions. From what we can gather, both schemes are at present in the air.

Street Accidents.—The electric tramways, or, as they are called, "electric street railroads," in America are remarkable for speed. As a consequence of this, a number of serious accidents occur which are out of proportion to those occurring on our English lines. We are glad, however, to see a note in the *Scientific American* to the effect that fatalities on the street railroads of Chicago have decreased nearly 85 per cent. since the surface lines have equipped their cable and electric cars with fenders, in accordance with municipal regulations. In the last two months only three persons were killed on the street railways of Chicago, whereas in the same period of 1898 there were eight victims, and the average for half of last year was nine deaths each month. All the surface roads have not as yet fulfilled the requirements of the regulations, and it is probable that the number of fatal accidents will be even smaller when every car is provided with a fender.

Moscow Tramways.—The municipality of Moscow has determined that that city shall be provided with a complete system of electric tramways in the near future, and it asks for tenders for the equipment of these. The conditions of tendering have been conveniently arranged, so that every nationality shall have a chance of competing for the work, but those who wish to do this must send to the municipality word to that effect by the 12th inst. A deposit of £118. 15s. is to be dispatched with the application, and in return full specifications and plan will be forwarded. The specifications in question will be translated into English for the benefit of those tendering, and will also include a priced estimate of the cost showing the extreme limits between which the various details are expected to vary by the electrical advisers of the municipality. When so much consideration has been paid by the Moscow authorities to an English translation of the specifications we hope our electrical firms will make a bold bid for the work.

Telephones in Paris.—The postal authorities in Paris have been convinced by, we presume, the exhibition authorities that the telephone network of the city is quite

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incapable of coping with the enormous number of new connections which will be required by the exhibitors at the 1900 exhibition. As a result, the authorities have decided to commence work immediately on a new exchange in the Avenue de Saxe. The total cost of this exchange, and the wires required to connect it to the exhibition, subscribers, and to other parts of the city, is estimated at £70,000. A good proportion of this amount has already been voted by the Government, and the work is to be commenced forthwith. Our contemporary, *L'Industrie Electrique*, is, however, sceptical as to the Government being capable of getting the work carried out in time to be of service to the exhibition when it opens. It also points out that the exchange should be really available for connection by next October, in order that it may be of service to exhibitors erecting their exhibits.

Gas versus Electricity.—The Electrical Committee of the Bristol Town Council, it will be remembered, opposed the recent Bill of the gas company, and induced the House of Lords to decline to give that company power to lend dynamos in conjunction with gas-engines. At the same time, the Lords' Committee allowed a clause to be introduced under which the gas company might charge what price they liked for gas used for motive power. The price charged is not then to be considered as the lowest given to private consumers when fixing the rate to be paid for gas for public lighting. The Electric Committee urges the Corporation to oppose the clause again when the Bill comes before the committee of the House of Commons. The *Gas World* says that the committee are evidently afraid of competition with the electric motors which are supplied from their mains. As no such fear is expressed in the report, we think that our contemporary reads rather too much between the lines. As far as we are concerned, we are sure that active competition between gas-engines and motors would be good for all parties concerned.

Institution of Civil Engineers. — Mr. R. A. Hadfield, M.I.C.E., read a paper at the Institution of Civil Engineers last week on "Alloys of Iron and Nickel." Dealing first with the physical data relating to nickel and iron, the paper then refers in succession to the preparation of the nickel-iron alloys and specimens; the mechanical tests upon the various cast and forged specimens; the comparison of mechanical tests upon previous alloys; the magnetic and electrical qualities; and the thermal, welding, self-hardening, and corrosion tests. The second part dealt with general considerations regarding nickel-steel and its uses; and the third with the early history of nickel, and the early experiments in alloying nickel and iron. The effect upon iron of gradually increasing amounts of certain added foreign elements had already been investigated by Mr. Hadfield in experiments upon the mechanical and physical properties of alloys of iron and manganese, silicon, aluminium and chromium, both in the cast and forged conditions, and the author now presents the results of a like investigation of the alloys of iron and nickel.

Technical Education.—In a recent issue of the *London Technical Education Gazette* reference is made to the Salomons engineering scholarship at Cambridge. This scholarship will be vacant in 1900, and an examination to fill it will be held at Gonville and Caius College next November. The scholarship, which was founded by Sir David Lionel Salomons, Bart., M.A., is of the value of £70 a year, and is tenable for three years. Candidates must not be more than 19 years of age on Oct. 1 this year, and the candidate elected is required before being formally admitted as a scholar to make a declaration to the effect that it his intention to enter the engineering profession as a civil or electrical engineer. The subjects of examination will be euclid, algebra, plane trigonometry, geometrical and analytical conic sections, elementary statics and dynamics, and differential calculus; physics, including dynamics and hydrostatics, with practical work. Candidates will be required to give proof, by examination or by producing recognised certificates, that their knowledge of classics is sufficient to enable them to pass the university matriculation examination before coming into residence.

Electric Engineering in Russia.—The St. Petersburg correspondent of the *Financial News* states that a large syndicate is being formed with the object of establishing and working electrical undertakings in Russia. The syndicate in question would have a capital of £3,000,000, and is being organised by the largest electrical firms in Germany, who are, as usual, supported again by industrial banks. Amongst the firms in question are the Allgemeine Elektricitäts-Gesellschaft, the Union Elektricitäts-Gesellschaft, and Siemens and Halske. Amongst the banks are the St. Petersburg International Bank, together with a group of Russian concerns, as well as the Deutsche Bank, Messrs. Warschauer and Co., and others in Berlin, Messrs. Rothschild and the Société d'Etudes Russes of Paris, and, finally, the Franco-Russian Electricity Company of Geneva. The board of directors, numbering seven members, was constituted a few days ago at Berlin, but will have its chief offices at St. Petersburg. A strong combination of financiers and technical firms like the above should be able to do splendid business in any country, and we are sure that in spite of the anti-German feeling which is somewhat prevalent in Russia the syndicate in question will do good work.

Perpetual Motion.—Prof. Charles E. Tripler has been devoting a large amount of time, we presume, to the development of machinery for the production of liquefied air. The points which he has succeeded in establishing to his own satisfaction are the following: (1) that liquid air can be manufactured easily, cheaply, and in large quantities; (2) that when liquid air is arranged under proper conditions in a cylinder, it can be made to give an expansive force exceeding that of gun-cotton or dynamite. In this respect, as it cannot be exploded by a spark, it is perfectly safe to handle, and is not liable to be set off by act of concussion. The next point which Prof. Tripler has established to his own satisfaction would be so far an infringement of the law which forbids perpetual motion that we are afraid he will get few to credit his statements. After speaking of the way in which liquefied air can be made to drive machinery, Prof. Tripler describes an engine which he has designed for this purpose, and which he uses to drive a liquefying machine. With this combination he says he can produce 10 gallons of liquid air for every two gallons used in the engine. Of course, it is difficult without more data at command to say whether the learned professor is correct, but we are perfectly certain that unless he introduces energy elsewhere in the circuit he is absolutely wrong in his conclusions. Still, it is not the first time that liquid air has led authors into fallacious reasoning, and we trust that Prof. Tripler will see his way either to explain in detail his experiments or withdraw his statements.

A Long Electric Railway.—As an example of the extent to which inter-urban lines are being equipped in the States, we take the following facts from the *Street Railway Review*: It seems that the Wabash and Mississippi Construction Company, of Salem, Ill., has been incorporated to build an electric railway from Vincennes, Ind., to East St. Louis, Ill., a distance of about 150 miles. The superintendent of construction and right of way states that the

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road will follow the old State road and be almost parallel with the Baltimore and Ohio South-Western Railway, passing through many towns and cities, such as Olney, Clay City, Flora, Carlyle, Trenton, and Lebanon. There are many reasons for believing that the road will be a paying investment and a great accommodation to the public. There is not very much grading to do, since the line will be built on the old Vincennes dirt road. Over 100 miles of this is ready for the rails, but in the low lands the track will require some grading, though on the whole this will amount to very little. The bridges will have to be strengthened and kept in repair. When such long lines as this are equipped electrically, and are provided with a rapid and frequent service, they form formidable competitors to the steam railways, and are likely in the near future to seriously affect the latter financially. As far as experience goes in England, the effect of suburban electric tramways on the suburban railways has been most disastrous. We have little doubt that a number of inter-urban electric lines could also be constructed which would confer a great boon on the inhabitants of the town so connected.

Ealing and Electric Traction.—The London United Tramways Company has had compiled, and recently distributed, a synopsis of the meetings and correspondence which have taken place with reference to the proposed extension of the tramway from Acton to Uxbridge. The existing line only runs from Shepherd's Bush to Acton, and what the people of all the intervening places between the last-named suburb and Uxbridge want is that they should be brought into tramway communication with London. The Ealing District Council, however, refuses to allow a tramway to penetrate its precincts, and in order to enjoy its fancy in this direction, refuses a distinct boon to the inhabitants of half a dozen neighbouring places, including Hanwell, Southall, Norwood, Hayes, Hillingdon, Uxbridge, without mentioning Acton and Hammersmith, the governing bodies of which, as well as the London County Council, have all given their support to the scheme. The two-mile gap through Ealing is all that would be required to admit of a 12 miles track of tramways on which electric traction would be used, and notwithstanding the District Council of that place is busily opposing all applications for this "missing link," still, it is an ironical fact that a recent postcard *plébiscite* has shown that the extension is approved of by a no less majority than eight to one of the Ealing ratepayers. Although a temporary check has been sustained by the promoters of the scheme in their dealings with the District Council of that place, it is the intention of the promoters to seek the authority of Parliament for the construction of this section of the line, which we sincerely hope will be obtained in the near future.

Frequency and Feeling.—Mr. E. W. Scripture sends to *Science* an interesting communication on the "Anæsthetic Effects of a Sinusoidal Current of High Frequency." This experimenter claims to have found that the anæsthetic effect may be produced by sending the current longitudinally along the nerve. Thus, a current sent along one of the nerves of the arm can be used to produce anæsthesia in parts of the arm supplied by it. With a pleasant current of about 28,000 alternations per second passing between the elbow and the hand, a needle can be painlessly run into the forearm. Mr. Scripture also made experiments as to the action of the current on the tongue, with the view of trying how far the theory that the sensation of taste is due to vibration is correct. The experiments, however, showed that alternating currents up to about 29,000 complete periods per second produce no sensations of taste whatever; the only sensation is that of tickling and puckering. The author's conclusions as to the relations between frequency and sensation are as follows: (1) Threshold of sensation of touch at a frequency of about 480 complete alternations per second; (2) threshold of disagreeableness at about 840; (3) threshold of pain at about 960; (4) disappearance of pain at about 1,440, followed by a peculiar, agreeable sensation; (5) disappearance of agreeableness at a point not yet determined, followed by a faint sensation; (6) disappearance of sensation at a point not yet determined. For constant conditions the author claims that these figures are quite constant, the probable error ranging from one-tenth of 1 per cent. to 4 per cent.

The Nernst Lamp.—Since the invention of Prof. Nernst with respect to the use of very refractory oxides for incandescent lighting, it is quite natural that electrical engineers all over the world should devote attention to improvements in the method of preliminary heating these oxides in order to render them incandescent. Mr. Theodore Reyman, of New York, has communicated a method devised by himself for this purpose to the *Western Electrician*. He practically uses an arc lamp in connection with a hollow cylinder of the refractory oxide placed round the carbons. When the switch is turned no current flows through the oxide, but as the carbons complete the circuit the magnet raises the upper carbon, and the arc thus formed heats its jacket of oxide, which soon conducts the electric current under the intense heat evolved, and becomes incandescent. The arc between the carbon electrodes is broken, owing to the increased length of the arc and the reduced current which now passes through the incandescent cylinder of oxide. The upper carbon is fed by gravity when the current is turned off and is prepared to again impart the initial heat. He has successfully operated three such lamps connected in series on 110-volt direct current. Prof. Franklin's ideas on the subject were explained to the electrical section of the Franklin Institute at Philadelphia on the last day in February, when some of the new types of lamps as made by him were exhibited. These lamps consisted of glass tubes about 2in. long by ¼in. in diameter filled with magnesium mixed with powdered glass, a platinum terminal contact being sealed in each end of the tubes. In Prof. Franklin's experiments with these lamps he has secured a very satisfactory light.

Wireless Telegraphy.—The experiment carried out by Mr. Marconi in signalling across the Channel without conducting wires have created a great sensation in the daily Press, but we are afraid it is misunderstood by about half the people who write on it, and consequently by most of those who read what is written. Taking the *Daily News* article as a point of our contention, their correspondent writes on the advantage of wireless telegraphy for fog-signalling at sea. After expatiating on the successful working of the system during the whole of the foggy and changeable weather of last week, the writer goes on to say that the wireless telegraphy installation set up between the lightship and the South Foreland has been such an unqualified success that it is understood that the authorities have in view the early adoption of the system on other parts of the coast. The correspondent then concludes on his own account that "the system is especially adapted for maritime work, and might be made a very valuable additional means of minimising the perils that beset voyagers. As to fog-signalling by means of wireless telegraphy, there is no doubt that there is everything in it to commend it as a means of organising some system of telegraphing between a ship and a dangerous point,

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either an approaching vessel or sands or rocks, in connection with which there is a light vessel or lightship." In this way the public is led to believe that by means of this system of telegraph, messages can be sent from a lightship or the land to a steamer which cannot be seen, informing that steamer of where the lightship is and also of what dangers lie in its course. We must really emphasise the fact again, as pointed out by Dr. Lodge in his admirable lecture, that with the Hertzian waves as at present developed neither direction nor distance can be ascertained from the signals themselves.

Electric Heating.—M. Lalance read a paper before the Society of Civil Engineers of France on the 17th ult. on heating by electricity. He first described in detail the method of constructing an electric heating and cooking apparatus, in which wires are embedded in enamel in order to prevent oxidation, etc. He explained the difficulty that had been found in getting resistance material and enamel with practically the same coefficiency of expansion in order that they might not part company when heated. The author says that when electric energy is produced by water power it is possible for electric heating to compete financially with ordinary methods of heating; and beyond this, as is well known, the electric heating has peculiar advantages from the fact that it does not in any way vitiate the air or cause noxious fumes when used for cooking purposes. The author then proceeds to calculate the cost of performing certain cooking operations and boiling of water by electricity, assuming that the price paid per unit for energy is about 4½d., as is the case in Paris. He points out that, although these prices are high, yet other advantages derived from electric heating makes this acceptable to the public. With respect to the question of the heating of buildings, the author states that it requires about 65 watts for every cubic metre of space which has to be maintained at 22deg. C. above the temperature of the outside air. He gives an instance of one dining-room in Paris that is electrically heated, in which the total cost per annum for electric energy comes out at £6. 5s The total equivalent load, we presume, in 10-c.p. lamps which is obtained from the heating apparatus in the Secteur de la Place Clichy is equal to 5,000 lamps. In the concluding part of his paper the author refers to other systems of heating, such as the use of red-hot rods of silicon in a vacuum.

Electric Traction in Gold Mining.—We notice in *Mining Machinery*, published in Chicago, a precise *résumé* of the progress of electric traction as applied to gold-mining industries in South Africa. The principal field for electric haulage on the Rand is in transporting ore from the shafts to the mill. Underground haulage is rarely necessary, for loads are small, and the main hoist can be made to do most of the horizontal transportation by judicious arrangement of the slopes. The gauge, as a rule, is 18in., but at the Simmer and Jack mine it is wider, and as mills increase the tendency will be towards a wider gauge. Two motors on each locomotive are advised, each to give a draw-bar pull of about 500lb. In this way the locomotive can be relied upon to give at least 1,000lb. starting pull on the level. It is stated that ordinary mine tracks at six miles an hour have a resistance of 25lb. to 30lb. per ton. On clean rails at Kimberley only 16lb. per ton was noted on well-laid rails, the tangent of the slope of no acceleration being ·0078, but 25lb. must be assumed in general practice, so that the above locomotive could haul 20 tons in all, or 17½ tons behind itself. An estimate is also given of the cost of working a small line 2,000ft. long with a limiting gradient of 2½ per cent. Assuming that 200 tons of ore had to be hauled in 10 hours, and that coal cost 16s. per ton, the annual expenses of keeping the service going, including interest and depreciation at 12 per cent., is put down at £670. In this estimate two locomotives are allowed for. Steam locomotives to do the same work are estimated to cost £1,360. In selecting motors for such operations the great essential is that they shall work absolutely sparkless at all loads, and shall be, if anything, too large for the work which is demanded of them. In this way the cost of repair can be kept down to a minimum, and it must be remembered that repairs in places like the Rand are very expensive to effect.

Electricity in the Italian Navy.—Mr. Grulio Martinez contributes to the second number of the *Electrical World* in its enlarged form a critical article on the progress of electricity in the Italian navy during the last three years. We understand that this article is the first of a series, and we are glad to know that in every department electricity is finding employment in the Italian navy. Electric motors are being used for nearly all small power purposes. The standard voltage as now adopted is 110, as against 80 volts in the English navy. It is interesting at the present time to reproduce what the author says about wireless telegraphy. It runs as follows: "Latterly Marconi's system of wireless telegraphy has come into great prominence. The experiments which have been carried on have been kept strictly secret, but from the little that may be stated it is evident that the work of the chief electrician, M. Pasqualini, has accomplished remarkable results. M. Pasqualini conjectured very early that the explanation of the Marconi phenomenon was not to be found in electrical oscillations, and, following out his idea, which met with strong opposition at first, he was able to simplify extraordinarily Marconi's apparatus, of which scarcely a trace remains. The practical result obtained is the ability to transmit with certainty over a distance of 24 miles with apparatus that requires no attention and which is not erratic like Marconi's, which would often cease to work without any apparent cause, and start up again later for no more evident reason." The conclusion of the first article is devoted to a description of the engines and dynamos used on the more modern ships, and the author refers to the fact that the firm of Ganz, which is given as "Garg" in our contemporary, has made some very pretty applications of three-phase currents for the Austrian navy. The subject is receiving some attention in the Italian navy also, but on this point the merchant service has outstripped the navy. He added that he had heard that there are to be some three-phase plants installed on some mail steamers that are building.

Electric Cars.—We are glad to note that at Preston recently the new Electric Railway and Tramway Carriage Works, Limited, was opened in the presence of a large number of leading financiers and engineering experts from all parts of the country. These important works are close to the Albert Edward Docks, and there is every facility for the receiving and dispatch of materials and goods, whether by land or sea. Of the 13 acres of buildings at the works, four or five acres are under cover, and the keynote of the whole of this extensive plant proclaims system, orderly sequence, efficiency, and economy. Already orders are on hand that will take some time to complete, notwithstanding the fact that as many as 700 cars can be turned out annually. All this points to a great development that is taking place in electrical enterprise in England. Such new and well-equipped works are badly needed in England to prevent orders being sent abroad, a course that has already been too largely adopted in several notable instances, as in the case of Liverpool, Dublin, and elsewhere. The difficulty of getting new tramway cars made in this country on short

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or on moderately long notice has for some time been felt by tramway companies and local authorities, and it is a source of satisfaction to find that our manufacturers are now making great efforts to cope with this difficulty. The delay which so often occurred when the operators of a tramway wished to increase the number of their cars, or to substitute new for old vehicles, may be said to have arisen primarily from lack of a general demand. That lack of demand in its turn can be traced back to the purchase clause of the Tramways Act of 1870, which for many years smothered all enterprise for the improvement of street locomotion. The result of all this was that those firms who built tramway cars turned the greater part of their attention to the construction of carriages and wagons for steam railways, and when an odd order did come for a few tramway cars, the firms naturally could not execute it so speedily as they might in other circumstances have been able to do. The partial removal of the incubus of the Tramways Act by local authorities exercising their power of purchase, and the passing of the Light Railways Act, which to a certain extent has made easier the construction of light railways and quasi-tramways, have, within the last two or three years, opened up the way in many districts for large and urgently needed tramway extensions Simultaneously, and partially arising from the above, has come the beginning of a development of mechanical traction in this country which speedily promises to assume vast dimensions, and it is on this account that we cordially wish the important enterprise as represented by the Electric Railway and Tramway Carriage Works every success.

The General Power Distributing Bill.—Mr. Dixon H. Davies forwards an interesting letter to the *Times* on the influence which led to the rejection of so many Electric Power Bills recently by the House of Commons. He traces the influence of the old guild feeling which was so disastrous to the trades of certain towns to the present municipalities, and holds that with the increase in municipal trading the prosperity of the towns will suffer. He also states that the influence of public servants in the growth of municipal trading is very great. "As," he puts it, "these gentlemen are debarred by the conditions of their office from engaging themselves in commercial pursuits, they find the only scope for their natural ambition and their only prospect of advancement in the constant expansion of the duties entrusted to their charge. These gentlemen are generally intellectually the superiors of the average town councillor, and they therefore have enormous influence with him in anything which does not directly affect the elections, but, beyond this local power, they are able through the Municipal Corporations Association to exploit the political influence of the various corporations all over the kingdom, and so can bring up a whip of members of such strength as to be most formidable to the chances of any private Bill which in their view encroaches upon the sacred domain of municipal bureaucracy." After speaking of the influence which can be brought to bear upon members of Parliament in this way, Mr. Davies goes on to say that "the Municipal Association have not hesitated to claim absolute monopoly for the corporation for any branch of trade upon which, for good reason or for bad, it may have embarked. If such pretensions are allowed to prevail, the result must be stagnation for this reason. A corporation represents, at the best, only the average opinion of the town. Advancement in any branch of commerce springs, not from the opinion of the average, but from the energy and initiative of one or two courageous and able men, who have probably devoted the concentrated study of a lifetime to that particular branch." Commenting on the backward state in this country in electrical matters, the writer adds: "It certainly is not pleasant to find that the machinery for the electrical railways in London, and also for the tramways of our large provincial towns, should be coming, as it is, mainly from abroad. This state of things, and also the rejection by Parliament of the schemes for power transmission—schemes which exist by the hundred in other civilised countries—may alike be traced to the insidious and malign influence of municipal trading. The appointment of the Joint Committee upon this subject is evidence that the Legislature is awakening to the cause of the mischief, and to the necessity of dealing with it."

U.S.A. Patents.—We recently had brought to our notice a paper read before an engineering society in the United States, in which the Patent Office practice of that country was extolled. The points in which the system was said to be much better than our own were said to be exceedingly numerous, but the following is perhaps the gist of the most serious claims in this respect: first, that the patents were only granted for real inventions, and after a careful search by experts; the second advantage was that the date of the patent was not coincident with the date of application as in England, but depended on the issue of the documents by the department. We have always contended that in both these respects a genuine inventor is apt to lose, and that the community at large is bound to suffer. A case of this description has just been brought to our notice in the columns of the *Electrical World and Electrical Engineer*. It seems that 10 years ago a gentleman who presumably wished to provide for his future patented the application of alternating currents to electric traction. In this patent there are 15 claims, which, stripped of technical verbiage, maintain as an invention the application of the alternating current in electric railway distribution and operation. Of course, the old-time combination claim appears, one reading as follows: "In an electric railway, the combination of an alternating generator, a vehicle or vehicles moving along a track, a motor or motors mounted upon said vehicle or vehicles, an inductional transformer or transformers interposed between the generator and the motors, and connections comprised wholly or in part of the rails for carrying the current from the tension-changing devices to the motors." The application for this patent was filed Oct. 21, 1889, at which time alternating-current distribution for electric lighting and the electric railway had both reached a stage of development practically that of to-day. Yet, after 10 years' consideration, the Patent Office endorses as descriptive of an invention the above and 14 similar claims of the patent. We hardly know which is the most inexplicable—the granting of the patent after 10 years, or the long delay in granting it. We should say, broadly, that a patent department run on English lines by ordinary clerks would be preferable to an office filled with experts as in America, if this kind of thing is to become general. It seems also that Mr. Hunter has a number of other general patents granted after years of delay, and could, if he were successful in upholding his patents in the law courts, control the entire electrical industry in America. Our contemporary adds that the wisdom is, therefore, apparent of the requirement that before a monopoly is assured to an invention, its right to such monopoly must, if challenged, be established in court by proof both of priority and invention. In spite of this, which is quite true, the Patent Office system in America is established with the idea that only valid patents shall be granted, and large sums of money are expended to this end, while in the long run the law courts, as in England are the only recognised arbitrators.

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THE ELECTRIC LIGHTING OF LYNTON AND LYNMOUTH.

BY J. H. FOOKS BALE, A.M.I.E.E.

In these competitive times one hears more and more every year about generating electricity by water power, and a few words will not be uninteresting which will show what has been done already in a small central station which has stood the test of time, as the works of the Lynton and Lynmouth Electric Light Company, Limited, was started as far back as the year 1889 and the current switched on in March, 1890 and continued therefrom.

MR. J. H. FOOKS BALE, A.M.I.E.E., MANAGING DIRECTOR AND ENGINEER TO THE LYNTON AND LYNMOUTH ELECTRIC LIGHT COMPANY, LIMITED.

Were it not for its small size and isolated position it would be the most important central station of its kind in the country, but though nothing is claimed for its importance, it is undoubtedly one of the most interesting stations in Great Britain for these reasons: (1) It has the largest water-power plant of any public electricity supply in England where water power only is used. (2) It is the only station using two distinct falls of widely different pressures where both pressures work in conjunction with each other. (3) Its main supply is derived from the only method that demands serious consideration in this country—that is, the natural descent of the river and a long pipe line. (4) Its dry-season auxiliary plant utilises the highest fall of any electric lighting station in the British Isles—viz., a fall of 760ft.; in fact, there are few stations in the world (and most of them in California) which use a higher pressure than at Lynmouth. (5) Both reaction turbines and high and low pressure jet wheels are used for driving generators.

Because of the foregoing, coupled with the fact that the station has now been in successful operation for nearly nine years, an account of the works cannot fail to be both interesting and useful to those who are considering the advisability of utilising water power for generating electricity. It is now what might be called an old station, and, like other old stations, has had its troubles as well as successes. From the successes some valuable information may be gained, and from the troubles some warnings, which may in future save much time and trouble. Now for a short description of the works, running machinery, etc., with a few remarks about the dry-season troubles. These can easily be imagined in a season-holiday resort like Lynmouth, where the load peak is highest from June till October.

Fig. 1 shows the station, which is situated on the south bank of the East Lyn River just outside Lynmouth. The building is a three-storey one, rather small, but well adapted for its purpose, and hewn out of the solid rock. The generators and water-motors cover the ground floor, as shown in plan in Fig. 2 and in elevation in Fig. 3. In Fig. 4 (a snapshot taken from the doorway) are seen the 75-kw. alternator, high-pressure countershaft, and compound belts to low-pressure jet wheels, with the Mordeys and turbine in the background. Office, drawing office, test-room, and workshops occupy the first floor, and cable and general stores on the top. A pump-house adjoins the main building, and contains a pump by W. H. Bailey and Co., and an icemaking machine by J. and E. Hall and Co., also a compound jet wheel for driving ice plant.

Sources of Water Supply.

Two distinct falls are utilised. The main supply or low-pressure system is obtained by extending a long pipe line of 30in. diameter, and an open canal up the East Lyn River, where a fall equal to 87·78ft. is obtained, giving a pressure of 38lb per square inch. The length of the pipes is 520 yards, and the canal extends another 400 yards to the headweir and intake. This is protected by a ½in. wrought-iron grating to keep out salmon and trout, which abound in the river. The auxiliary supply, or high-pressure system, might be called an artificial one. A reservoir capable of holding 200,000 gallons of water was hewn out of the solid rock at the top of Summerhouse Hill, immediately behind the station, where it rises to nearly 800ft. above the sea level. The outlet is 762ft.

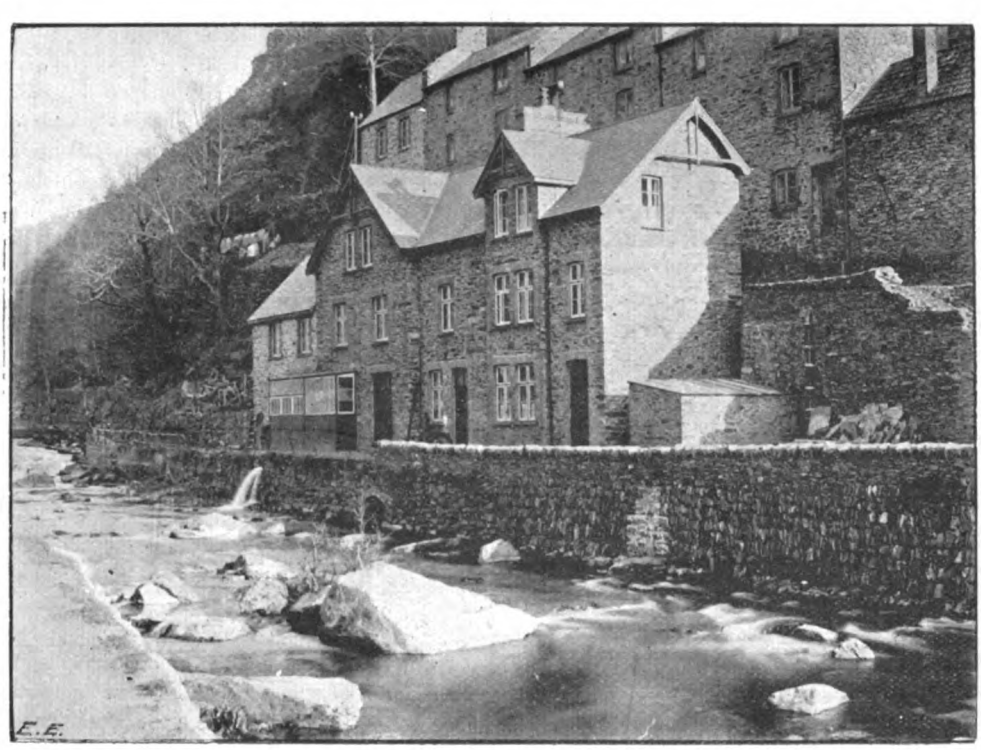

FIG. 1.—The Electricity Works at Lynmouth.

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above the station, and gives a pressure of 330lb. per square inch. The water is forced up there in the daytime by one of Bailey's three-throw equal-angle ram pumps, capable of dealing with 675 cubic feet of water per hour at 45 revolutions per minute, against the full head of 762ft., through a pipe line 1,200ft. long and 6in. diameter. This pump is driven by belt from the centre countershaft, the big alternator being disconnected at the coupling.

Generating Plant.

The original plant was two 37-kw. Mordey alternators coupled direct to a Little Giant turbine of 150 h.p., with

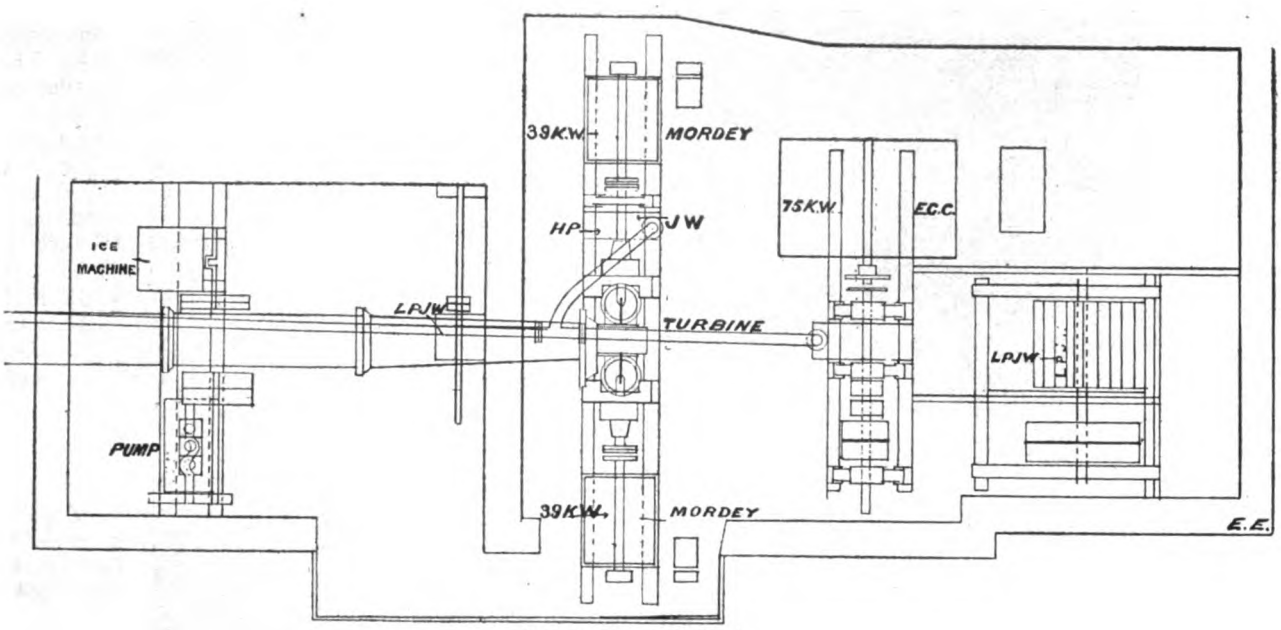

Fig. 2.—Plan of the Works.

spare pulley for driving a third alternator, which has now been removed for a high-pressure jet wheel built in its place. The load has so much increased that recently a 75-kw. E.C.C. alternator has been installed, driven with belt and countershaft by two 48in. jet wheels with 24 buckets of 6in. by 3in. from the low-pressure system. Four nozzles drive one wheel and three the other, and are fitted with spur gears for regulating the water supply after the main sluice has been fully opened. The high-pressure plant consists of a countershaft, upon which are built the high-pressure wheels, and connected by flexible coupling to the

drive their own exciters either by belt or ropes. Field resistances are used for keeping up the most efficient speed of the jet wheels when the water pressure varies. In the pump-house is another small compound jet wheel, which gives 8 h.p. off the low-pressure system for driving the ice machine and the workshop tools, drills, lathes, etc.

High-Tension Mains.

These are all run underground, and were originally of the Callender type laid in wood casing tarred. This has been replaced with iron and earthenware pipes and Callender and Silvertown cables drawn in, the usual size being $^{7}/_{14}$'s. The main feeder runs along the river bank through Lynmouth to the Bath Hotel, where it branches off to Lynton and the quay sub-station.

Sub-Stations and Distribution.

There are at present 10 sub-stations for dealing with the distribution to small consumers. Large consumers have their own transformers. The sub-stations are equipped with Mordey, Lowrie Hall, Hedgehog, and Ferranti transformers, the first three transforming from 2,000 to 100 volts and the last-named from 2,000 to 85 volts. The

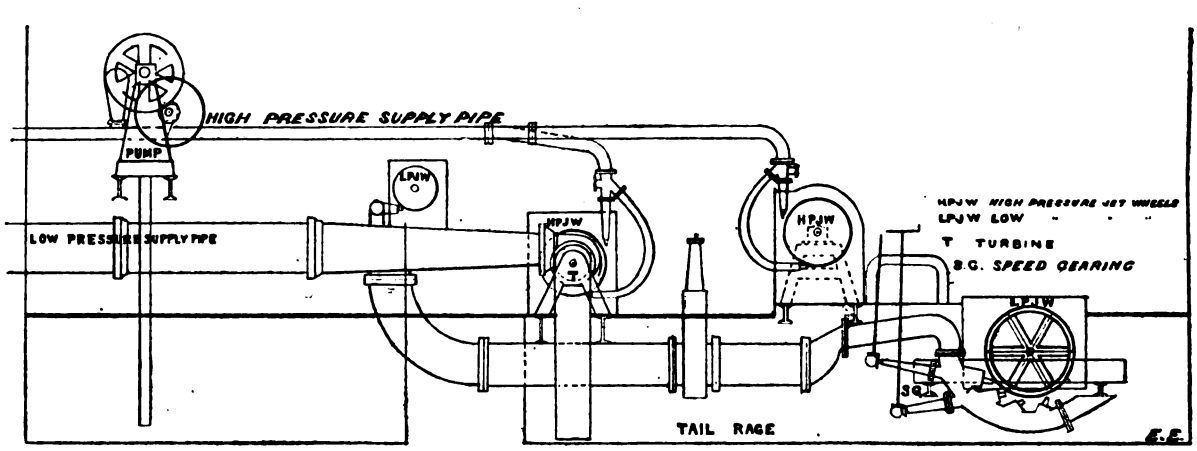

Fig. 3.—Elevation of the Electricity Works.

75 kw. alternator, and by belt to the low-pressure wheels. The power of the high-pressure wheels is varied from time to time by different sized nozzles, as required by the variation of the low-pressure system, the idea being to use only those nozzles which can be kept fully loaded. The high-pressure jet wheel on the centre countershaft is 36in. diameter, and has 24 buckets, 2½in. by 1½in., fed by two nozzles, each with separate valves, for a speed of 480 revolutions per minute. The high-pressure jet wheel on Mordey shaft is 30in. diameter, and has 30 buckets, 2½in by 1½in., for a speed of 640 revolutions per minute. All alternators

wires for street-lighting are bare, stretched on insulators, and the network includes nearly every street and road in the place.

Street-Lighting.

The public lighting consists of 59 32-c.p. incandescent lamps, and one Brush arc (12½ amperes) on the old Rhinish tower at the quay head. This will soon be extended to the new railway station, and when this is done every street and road will be lighted solely by electricity. Iron poles are used in the main roads, and wooden ones in the side streets and cliff walks.

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Charges and Supply.

The basis of charging for current to private consumers is 20s. per annum for a 16-c.p. lamp, but 60s. is charged for the 32-c.p. street lamps, the company erecting and maintaining same within the area of the district. The supply is commenced 30 minutes before sunset and continued until midnight, and in December and January from 6.30 to 9 a.m.

General Remarks.

There are generally two men on each shift. While the low-pressure system is working alone one man can do all the work in the machine-room, while the others are kept busy in the test-room, drawing office, or workshops. When both systems are working, which is required when the river is low in summer, two men are kept in the machine-room, one to look after the low-pressure system and the switchboard, and the other the high-pressure supply and alternators; and considerable practice is necessary to keep the voltmeters constant while turning in the high-pressure system and again turning it out when the load peak is on the decline. That the maintenance cost of water-power plant is considerably less than steam plant has been proved in this station, although it is not all honey in times of flood. The turbine was fixed in 1889, and has been working on an average six hours a day for 10 months of the year and has never needed repairs. The main screw that actuates the sluice has only just been renewed after nearly nine years.

It has long been a point of argument which are the best and most efficient under certain conditions—turbines or jet wheels. The experiences of the Lynmouth engineers leave them decidedly in favour of jet wheels. If a turbine could be kept fully loaded all the time it might be and probably is the most efficient, but this ideal state of things is seldom found in duplicated plant in an electric central station. With the turbine the only means of regulating is by a main sluice, and this not only reduces the quantity of water passing, but also the pressure on the vanes. With the jet wheels the main sluice is turned full open and the quantity regulated by closing the nozzles with spear gears, as required by the reducing load, thus keeping the pressure constant on the buckets. The above, of course, would not hold good for very low falls, in which cases the jet wheel would be impracticable.

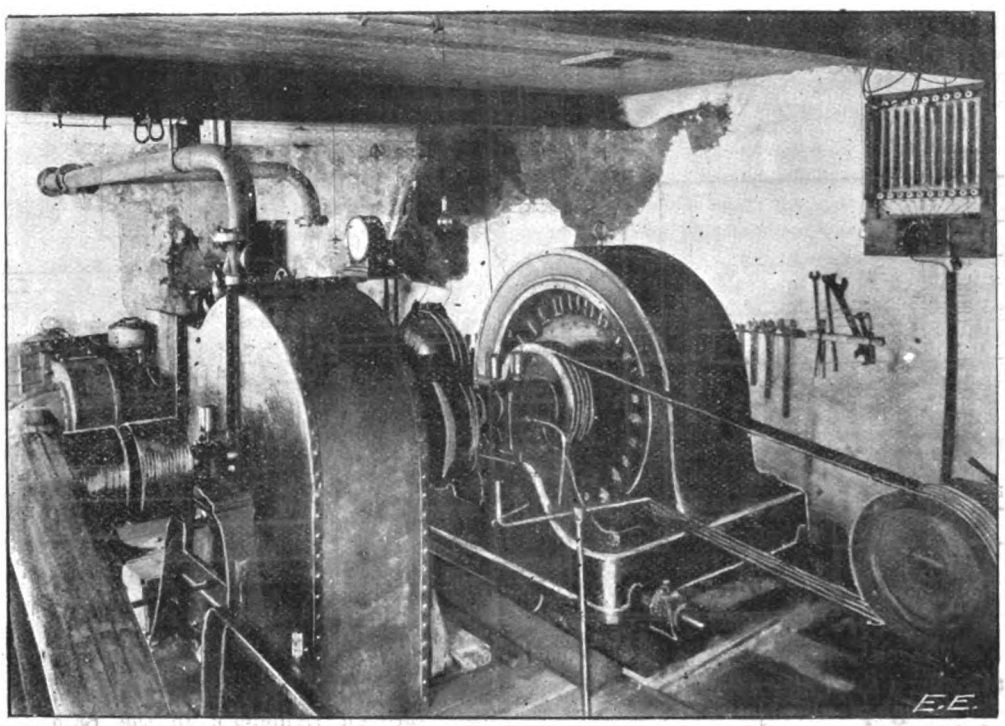

Fig. 4.—View of the Interior of the Generator-Room of the Lynton and Lynmouth Electric Light Company, Limited.

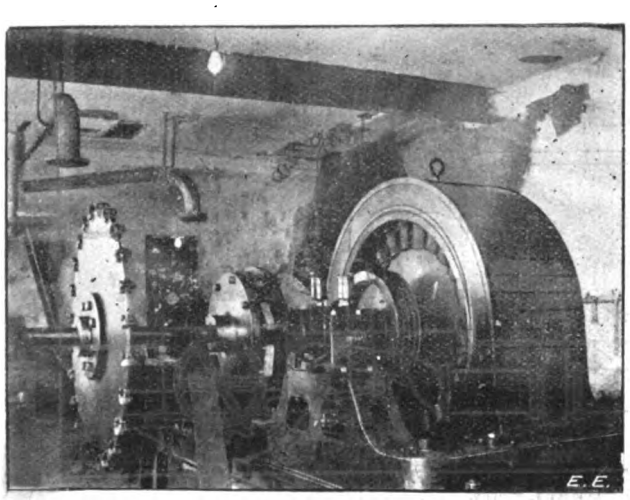

Fig. 5.—The E.C.C. Alternator and Jet Water-Wheel.

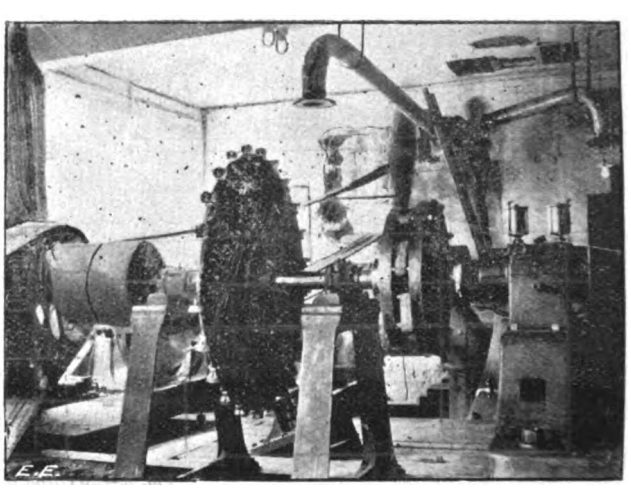

Fig 6.—View of the High-Pressure Plant when in course of Construction. The pump is driven by belts running through the hole in the wall.

Dry-Season Troubles.

In comparison to its size, it may safely be said that the Lynmouth station has passed through more trouble from dry seasons than any other, and the experiences of the chief engineer during his 6½ years' residence there would substantiate this statement. The dry-season bill has cost the company hundreds of pounds, and its expenses are not yet ended. Nor are the promoters of the concern to blame

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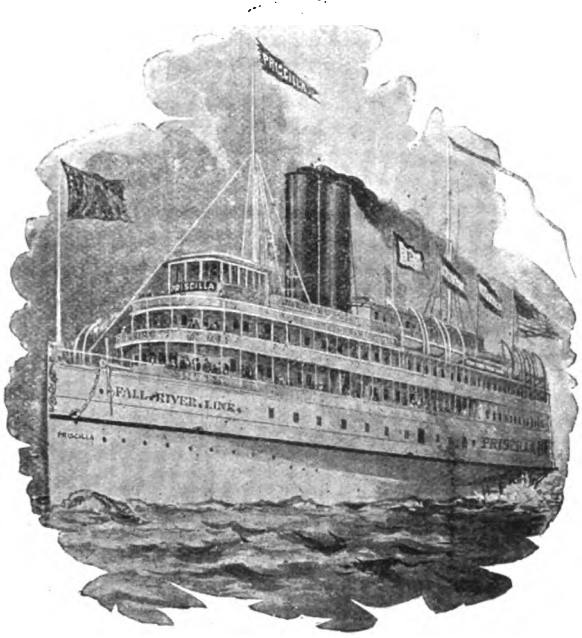
for this. In July, 1889, the oldest inhabitant could not remember the river at a lower level than that which would give anything up to 200 h.p. But since 1892 the river has, from no apparent cause, been getting beautifully less every year, until in 1898, at the end of August, not more than 20 h.p. was available. The Summerhouse Hill reservoir was



SS. "PRISCILLA."

built in 1896 at a great expense, and successfully helped the summer load for a time, but owing to the crankshaft being weak there was a general wrecking of the pump. A new pump was supplied early in 1898, strong enough to stand the worst of work, but there was not enough water available to drive it only half speed, or, rather, 20 revolutions instead of 45 revolutions, and the summer, although successfully got through, was only done by reducing

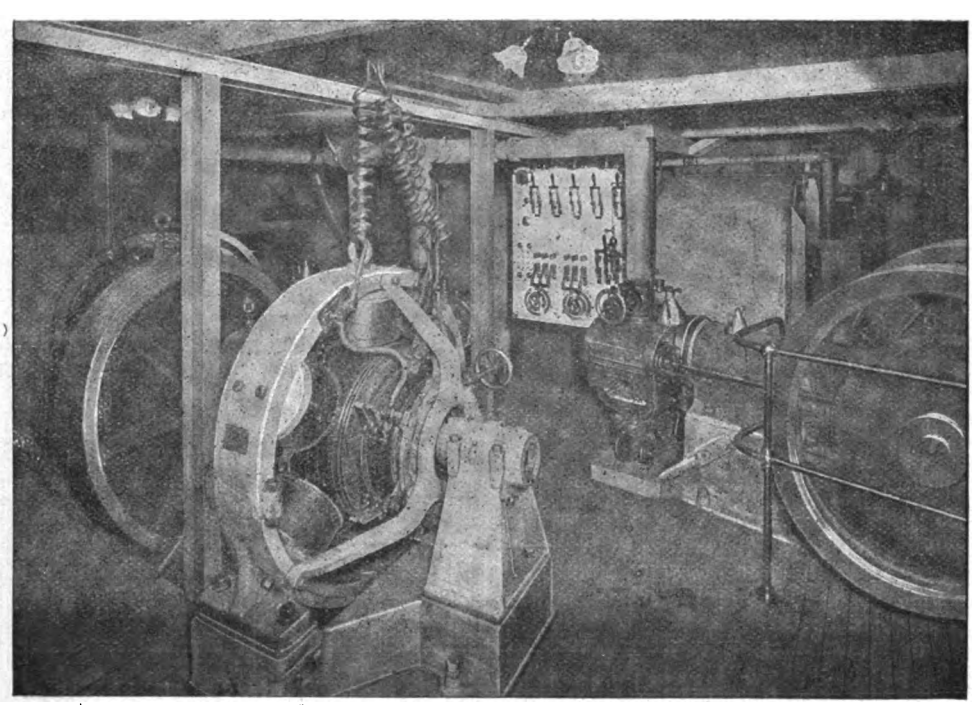


FIG. 1.—The Electric Lighting Engine-Room—ss. "Priscilla."

customers' lamps, and finally a drop of 5 per cent. in the voltage for the last two weeks of the dry season. This trouble, however, is not to be feared again, as the directors, regarding the river as one that can no longer be relied upon, are putting down a steam plant, to be ready for next summer, when the heaviest load can be handled in conjunction with the high-pressure system without any assistance, if necessary, from the river.

ELECTRICITY ON AMERICAN VESSELS.

BY J. MCGHIE.

The utilisation of electricity on board the steamers of the merchant marine of the United States has kept pace with its extensive adaptation on land, and, as on land, its use is not only utilitarian but also decorative. The elec-

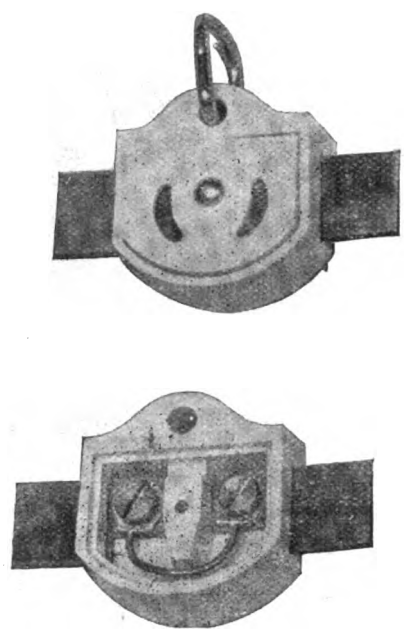


FIG. 2.—The Fuse Carriers.

trical equipment of the modern American steamer is the latest expression of electrical marine practice on the other side of the Atlantic, while the electric lighting effects sought and obtained are usually highly artistic. Up to the present, outside the vessels of Uncle Sam's navy, electricity is used chiefly for lighting purposes, but the success which has attended the installation of electric ammunition and shot hoists, electric turret-turning apparatus, electric hoists and winches on board the war vessels, is turning the attention of the builders of merchantmen to the use of electricity for power purposes, and it is probable that all new vessels will be equipped with electric power as well as lighting apparatus.

The electrical equipment of the "Priscilla," the latest addition to the fleet of fine passenger and freight steamers plying between New York and Fall River along the Long

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Island Sound, exemplifies a high degree of perfection in the adaptation of electricity to shipboard use. The "Priscilla" is a characteristic American steamer, in which the passenger consideration predominates. She is a huge five-decked craft, rising three storeys from the main deck. In general appearance she rather resembles a huge white hotel than what the Englishman associates with the name of a steamer.

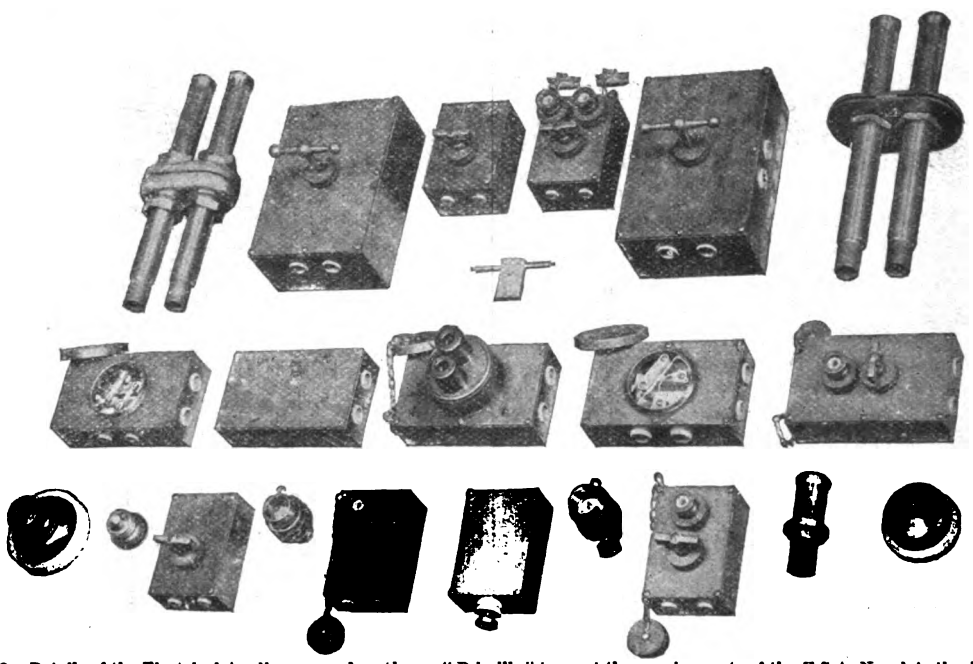

FIG. 3.—Details of the Electrical Appliances used on the ss. "Priscilla" to meet the requirements of the U.S.A. Naval Authorities.

Her length over all is 440ft. 6in.; length on water-line, 423ft. 6in.; breadth over guards, 96ft.; breadth of hull, 52ft. 6in.; depth of hull, 23ft. 6in.; registered tonnage, 5,398 tons. The hull is of steel, built on the double-hull longitudinal cellular system, with double bottom 340ft. long, having 52 watertight compartments. Unlike the American steamer of this class, the "Priscilla" is not driven by the vertical engine, but by a double inclined compound 8,500-h.p. engine. She has 347 staterooms, 14 parlour-rooms, 35 officers' rooms, 308 berths, first and second class, and 155 berths for the crew.

The electrical station (Fig. 1) is placed in the hold forward by the boiler-room. In a space 12ft. by 25ft. are set three horizontal engines directly connected to three multipolar dynamos. The engines are fitted with outboard bearings, and operate both condensing and non-condensing. Each unit is bolted to heavy yellow pine frames fastened to the double steel hull. The dynamos are set on the same bed-plate as the engine. Each dynamo is a six-pole 50-kw. 275-revolution machine, with a capacity of 400 amperes at 125 volts. The armatures of the dynamos are of what is known in America as the iron-clad type—*i.e.*, the armature winding consists of copper bars, thoroughly insulated, each winding being embedded in slots cut lengthwise into the periphery of the armature core. There are six sets of brushes, all capable of simultaneous movement by means of a handwheel and worm gear. The armature shaft runs in babbitted self-oiling bearings. The vessel is wired throughout on the two-wire system. Rising from each dynamo are the insulated cables, which pass along the ceiling to the switchboard. This is of white marble, and is equipped with fireproof field regulators, three dynamo switches, two voltmeter switches, and five main switches. Two illuminated dial voltmeters and three 450-ampere ammeters complete the equipment of the board. From the switchboard five feeders rise to the main deck, where they are connected at four points to risers running up through the vessel to the upper decks. These are connected to circulating mains, one of which is on each deck, through four centres of

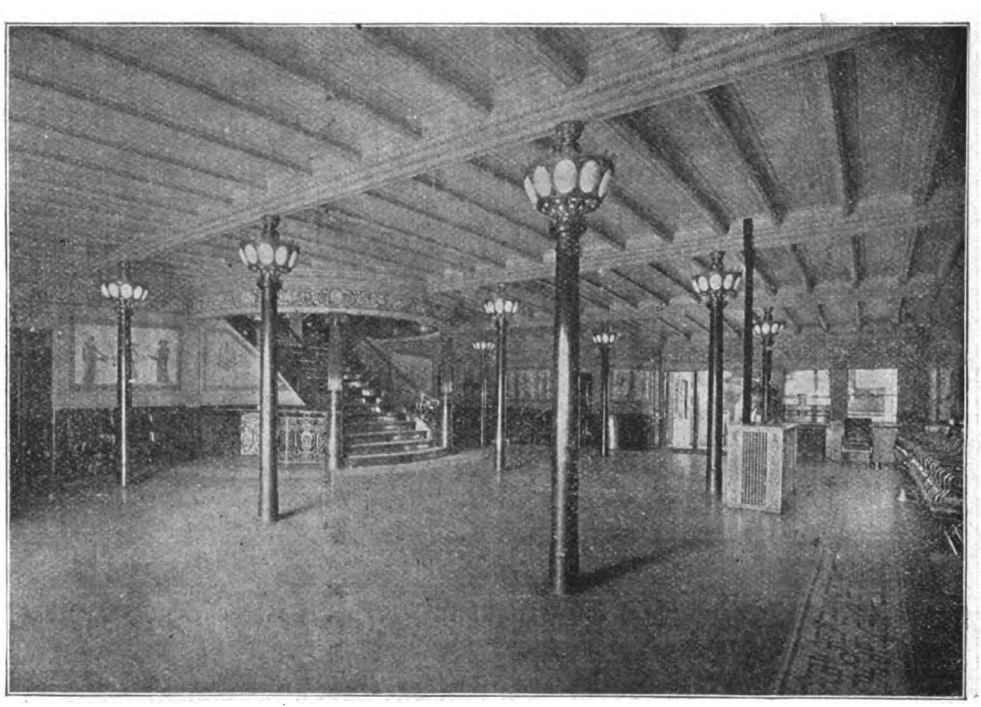

FIG. 4.—The Quarter Deck—ss. "Priscilla."

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distribution safety fuse-holders to each main. At six points in each main branch wires are taken to the state-rooms, saloons, dining-rooms, etc., from marble cut-out panels. These latter are of special design, involving a novel

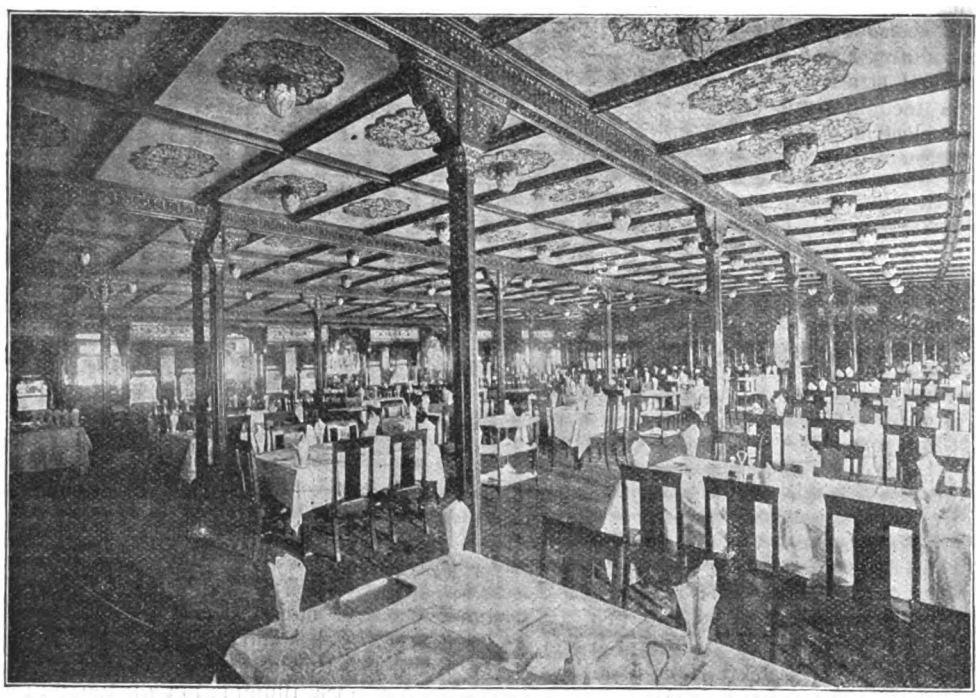

FIG. 5.—The Dining Room—ss. "Priscilla.

device. Each panel has two knife-blade switches, which bring the current to two pairs of flat copper strips, provided with small clips, between which are set fuse carriers of porcelain. Each circuit running from the panel board is connected behind to a snap switch on the front. The fuse carrier (Fig. 2) is a porcelain box, with a cover of the same material. The design of this can be gathered from the illustration. There are 25 of these panels. On the saloon and gallery decks these are set in the door transoms of the side passages; in the dining-room, under the sideboards; in the engine-room, facing the engines. The two largest are in the engine-room and the gallery deck, each controlling 24 circuits. The wiring is so arranged that 10 lamps on each circuit is the limit of the load on that circuit.

The "Priscilla" was equipped electrically by the General Electric Company, which, to secure Government contracts, was compelled to devise wiring appliances (Fig. 3) to meet the stringent requirements of the navy. These appliances are used on the "Priscilla." All junction boxes, switches, cut-out boxes, etc., used on the deck and other exposed places are absolutely watertight. The metal parts are of bronze, the insulation of vitrified porcelain, and the wires enter the boxes through soft rubber bushings. All the wiring appliances are finished in dull black. In all parts of the vessel where the wiring is exposed to moisture the wiring is lead-covered, and all larger than No. 6 Brown and Sharp gauge is stranded. Forty-five miles of wire in all is used, and the return circuits are of wire also. The wire is insulated with three layers of rubber. The decorative lighting effects are confined to the quarterdeck, dining-room, and saloon. The quarterdeck (Fig. 4) is the entrance hall of the ship. The floor is of purple-grey Venetian conglomerate, the walls of a delicate cream tint. The lighting is effected from the capitals of eight steel pillars, which support part of the saloon deck above. Each capital is a tulip-shaped fixture of polished brass with

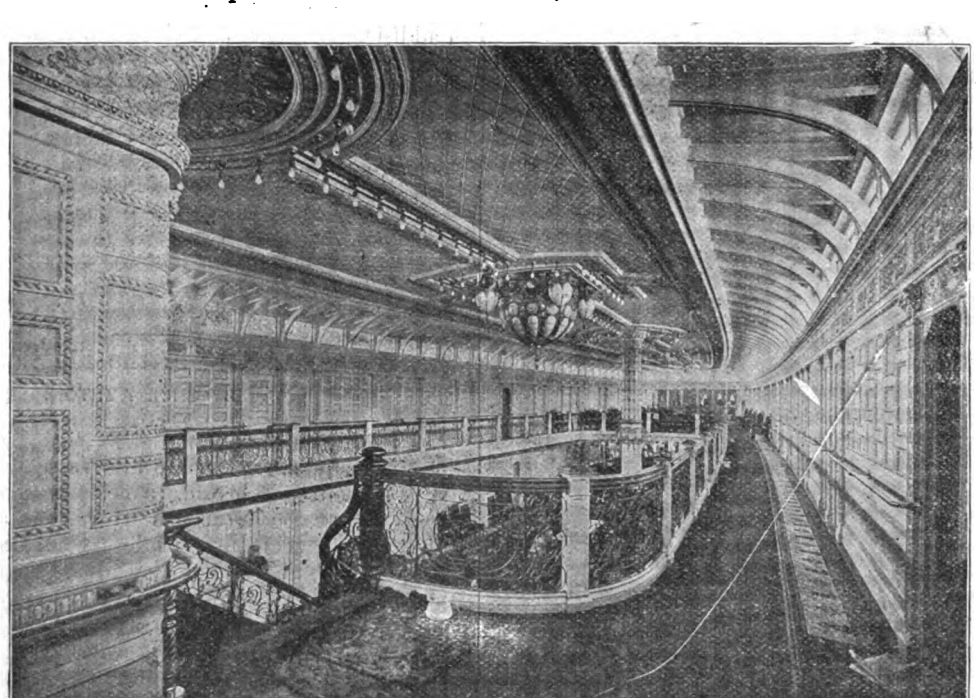

FIG. 6.—The Gallery and Saloon of the ss. "Priscilla," showing the Dome Lighting.

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opalescent glasses, and inside are 12 incandescent lamps arranged like the stamens of a flower.

The dining-room (Fig. 5), with a seating capacity of 250 persons, leads directly from the quarterdeck. It is a spacious room running aft, with broad windows looking on the water. Over each is a box with stained-glass front and sides. Each box contains 10 16-c.p. lamps. The ceiling is finished in beams and straps of mahogany, and panelled. Each panel has a medallion in the centre, and each alternate panel an electric pendant—an elliptical bowl of opalescent glass held in a rope net of brass, and containing two 16-c.p. lamps. At the after end of the dining-room are two private dining-rooms, each lighted from five elliptical bowls—a large one in the centre and four small ones at each corner. In the lighting of the dining-room 350 16-c.p. lamps are used. A broad flight of stairs leads to the saloon—the drawing-room of the vessel—divided into two parts by the engine-room. A wide elliptical opening aft of the engine-room causes the ceiling of the dome to be in part that of the saloon. The lighting other than from the dome is effected by eight-light chandeliers and two-light brackets. The mast passing up through the saloon carries an elaborate chandelier with flaring downward branching arms, each arm carrying a frosted incandescent lamp in an opalescent globe At the forward end of the saloon is an ornamental stairway leading to the gallery deck (Fig. 6). The dome light is both beautiful and effective. The principal feature is an inverted dome of brass-work, in which are framed panels of opalescent glass. This dome descends from the ceiling half way between the bulk-head of the engine-room and the mast. It contains 48 incandescent lamps, and occupies the centre of a square medallion, at each corner of which is a smaller inverted opalescent glass dome. Further aft is another inverted dome, and still further aft another. Running along the centre of the ceiling is a row of frosted incandescent lamps, which encircle the decorative fixtures just mentioned. The wiring arrangements of the dome are shown in Fig. 7. The forward saloon is lighted from ornamental electric chandeliers. In each stateroom and cabin is a single incandescent lamp. All the fixtures throughout the vessel with the exception of the lanterns outside, which are black, are in polished brass. All the lanterns are protected by cages, and wherever moisture can reach them are provided with watertight globes and sockets.

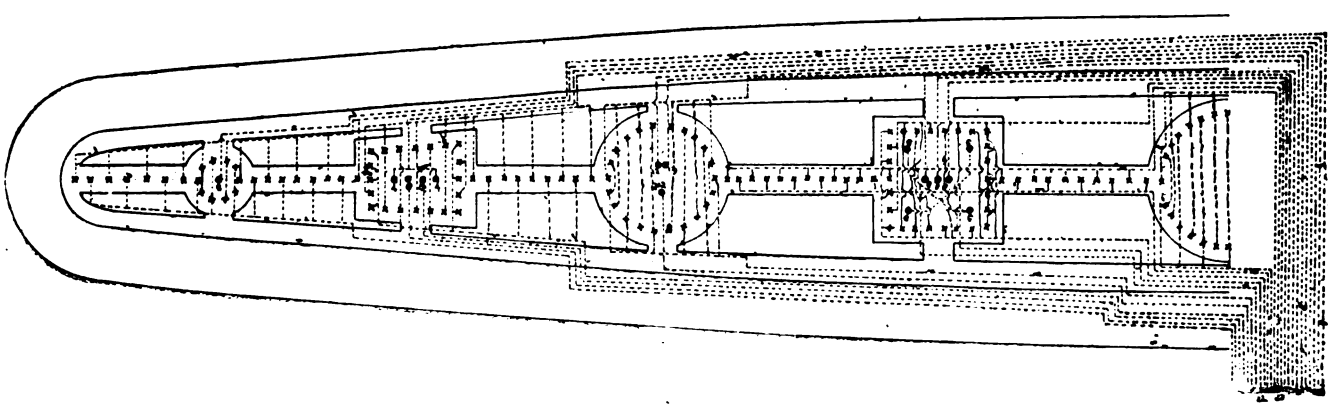

FIG. 7.—Plan of Dome Wiring—ss. "Priscilla."

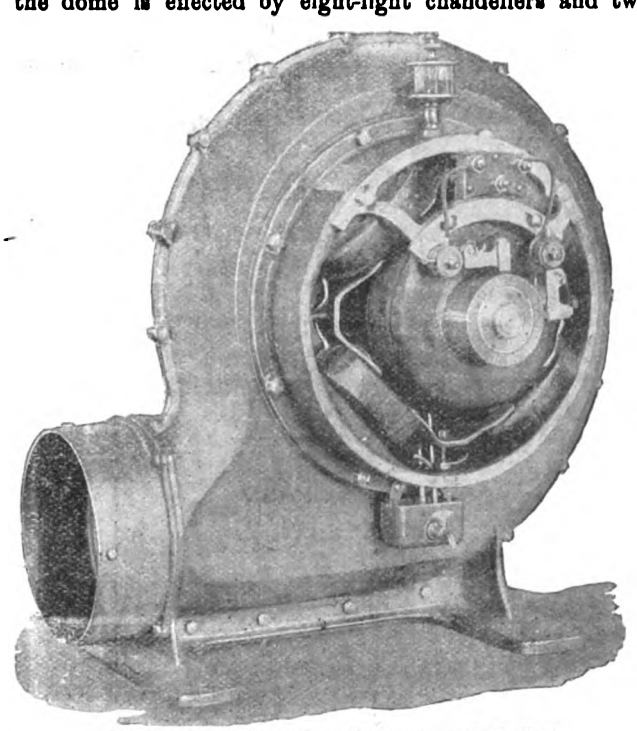

FIG. 8.—Electric Exhauster and Blower—ss. "Priscilla."

Some idea can be gained of the intricate wiring necessary to the proper illumination of the "Priscilla" from the following figures, which give the distribution of the lighting:

Dome deck	9 points	.....	55 lights.
Gallery deck.....	68 ,,	.....	596 ,,
Saloon deck	44 ,,	.....	360 ,,
Main deck.....	78 ,,	.....	748 ,,
Lower deck	12 ,,	.....	92 ,,
Hold	18	.....	136 ,,
Total	229		1,987

In addition, there are 364 electric bell calls and 610 automatic fire alarms. The electric power applications on the "Priscilla" are limited to a number of small propeller fans of $\frac{1}{8}$ h.p. each, and two electric blowers and exhausters (Fig. 8). In these the electric motor is mounted on the blower to become part of the blower itself. The motor has a capacity of 2 h.p.

(To be continued.)

INSTITUTION OF ELECTRICAL ENGINEERS.

The Hissing of the Electric Arc.

BY MRS. AYRTON.

(*Concluded from page 403.*)

Again, why does the arc always hiss when it is first struck? Is it not because a certain amount of air must always cling to both carbons when they are cold, so that when the crater is first made its surface must combine with this air? The cloud that draws in round the crater when hissing begins would be a dulness caused by the air cooling the part of the crater with which it first came into contact, the bright spots being at the part where the crater and air were actually burning together. In fact, everything seemed to point to the direct contact of crater and air as being the cause, perhaps not of the hissing sound, but of the diminution in the potential difference between the two carbons, which is the important part of the hissing phenomenon. One easy and obvious method of testing this theory immediately presented itself. If air were the cause of the hissing phenomena, exclude the air and there would be no sudden diminution of the potential difference between the carbons, however great a current might be used. Accordingly I tried maintaining arcs of different lengths in an enclosed vessel, and increasing the current up to some 40 amperes. No sudden diminution of

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the potential difference could be observed with any of the currents or lengths of arc employed, although when the same carbons were used to produce open arcs, the sudden diminution of 10 volts in the potential difference between the carbons occurred with a current as low as 14 amperes for a 1mm. arc. Indeed, so far from there being any sudden diminution in the potential difference when the current through an enclosed arc is raised to higher and higher values, the potential difference appears to slightly increase for large currents.

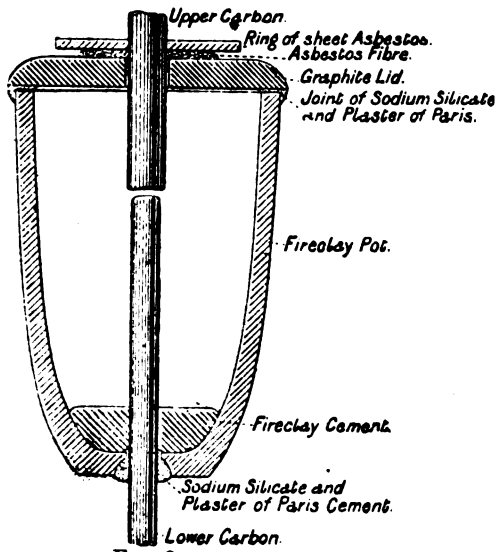

FIG. 8.

It was, of course, impossible in these experiments to avail myself of an ordinary enclosed arc lamp, since a current of only some five or eight amperes is all that is used with such a lamp, whereas to test my theory it was necessary to employ currents up to 40 amperes, although my carbons were of smaller diameter than those fitted in ordinary commercial enclosed arc lamps. Accordingly, I constructed little electric furnaces, some made out of fireclay crucibles with lids of graphite sealed on, as in Fig. 8; some moulded out of fireclay with mica windows inserted, so that the image of the arc could be projected on to a screen and its length kept constant; some constructed of iron lined with asbestos. Some had tubes inserted in them through which the air could be admitted when required, etc. It was found that when the vessel was entirely enclosed, the pressure in it was so great, on the arc being first started, that occasionally the lid was blown off. Consequently the space between the positive carbon and the asbestos ring was left open till the arc was well started, and then was tightly closed. This sudden increase of pressure probably took place when the carbons were first brought into contact, for Mr. Seaton, while conducting some experiments for Messrs. De la Rue and Müller in 1879, observed that when the arc was completely enclosed the increase of pressure when the carbons were first brought into contact was far greater than could be accounted for by the rise of temperature of the gas in the vessel, and that the pressure fell, the moment the carbons were separated, almost to what it had been before contact was made. This fact was confirmed by some experiments made by Stenger in 1885. This first great rise of pressure may, of course, be partly caused by the gases occluded in the carbons being expelled on the current being started, but a complete investigation of this phenomenon has not, as far as I am aware, yet been made.

Some curves connecting the potential difference between the carbons with the current when the arc was completely enclosed in the crucible (Fig. 8) are given in Fig. 9. The carbons were solid, the positive being 11mm. and the negative 9mm. in diameter, similar to those used with the open arc experiments (Fig. 2). As this crucible—the first one made—had no window, the length of the arc could not be kept quite constant, but the distance by which the carbons were separated was noted at the beginning of the experiment, and they were then allowed to burn away without being moved till the end, when the distance the positive carbon had to be moved in order to bring it tightly against the negative was noted. Measured in this way, the length of the arc was 1·5mm. at the beginning and 2mm. at the end of the experiment. The current was started at six amperes, and gradually increased to 39 amperes; then as gradually diminished to six amperes again, increased to 36 amperes, and diminished to five amperes, when the arc was extinguished. The potential difference between the carbons for a given current seems to have increased as the length of time during which the arc had been burning increased. This was undoubtedly partly due to the lengthening of the arc, but was probably also partly due to the whole of the air in the crucible having been gradually burnt up or driven out through the slag wool and the asbestos ring by the pressure of the carbon vapour. Many other sets of curves were obtained, but all with the same result—viz., that when once the crucible had been freed from air no sudden diminution in the potential difference could be observed on increasing the current far beyond the value at which this diminution occurred on lifting up the lid and allowing the air to have access to the arc.

The next thing to do was to try if an open arc could be made to hiss and the potential difference to suddenly diminish by blowing air at the crater when the current was so small that the crater remained well at the end of the positive carbon—in fact, to bring the air in contact with the crater artificially when a much smaller current was flowing than would usually produce hissing. I first tried inserting a carbon tube in the arc and blowing through it, but this almost invariably blew the arc out. Then Mr. Phillips, one of Prof. Ayrton's assistants at the Central Technical College, suggested using a tubular positive carbon and blowing the air down it. This plan answered admirably, for when a current of 10 amperes was flowing with an arc of about 3mm., so that the arc was quite silent, each puff of air blown down through the positive carbon was followed by a hiss and the characteristic diminution of the potential difference between the carbons. With a current of six amperes, however, I could get no hiss, but simply blew the arc out each time, probably because, with such a small current, the arc was cooled sufficiently to be extinguished before the action could take place. Oxygen was next tried, still with the open arc, and again each puff produced a hiss and diminution of the potential difference, the latter being exactly the same in amount as when air was used—namely, about 10 volts. As my idea was that the

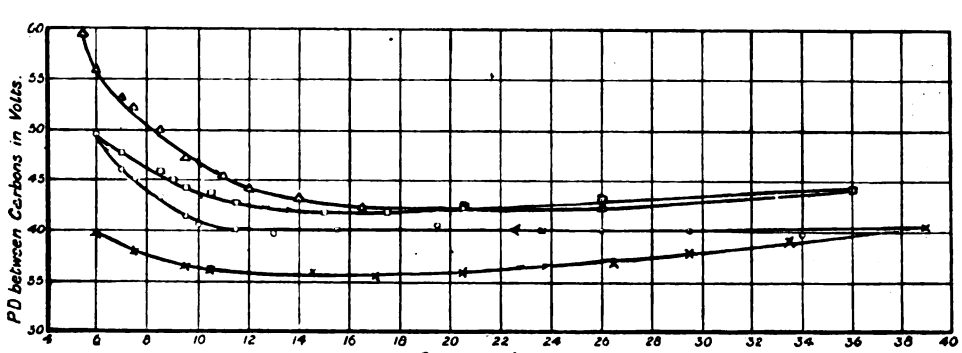

FIG. 9.—Arc Enclosed in Crucible. Curves connecting P. D. and Current for nearly Constant Length of Arc of 1·5 mm. to 2 mm. The Arrow show the Direction in which the Current was varied. Carbons: Positive, 11 mm. Solid; Negative, 9 mm. Solid.

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diminution of the potential difference was due to the chemical combination of air with carbon at the temperature of the crater, the fact of oxygen producing the same diminution of the potential difference as air seemed to show that nitrogen would produce no effect, and that all the effect produced by air was due to the oxygen in it. Accordingly I tried blowing nitrogen down the positive carbon of an open arc, and found that no change in the potential difference followed if the nitrogen was blown through gently, but that, beyond a certain pressure, the arc was blown to one side, and thus lengthened, so that the potential difference rose, and, if the pressure continued, the arc went out. This experiment proved two things—firstly, that it is the oxygen in the air that causes the diminution in the potential difference with hissing; secondly, that this diminution in the potential difference is not due to cooling, for nitrogen would cool the arc as effectually as oxygen or air. To make assurance doubly sure on this point, carbon dioxide was blown down the tubular positive carbon, with the same result as when nitrogen was used—viz., no change was produced in the potential difference between the carbons unless the pressure of the gaseous stream was large enough to blow the arc on one side, and then an increase and not a diminution in the potential difference was observed. If, however, the current was very near the value that made an open arc of the particular length used start hissing, blowing either nitrogen or carbon dioxide through the positive carbon sometimes started hissing; but this was due, not to any direct action of the stream of gas on the carbon, but to the arc being deflected by the gaseous stream and burning obliquely up the side of the carbon, and thus allowing the air to come into contact with the crater. The proof of this was that this diminution in the potential difference had the same value as if air had been employed, and that the hissing phenomena did not disappear on stopping the stream of nitrogen or of carbon dioxide. This was not the case with hydrogen, however. When that gas was blown down the positive carbon in the open air, the arc would start hissing if the current were large enough, and stop hissing the moment the hydrogen was shut off. Not only this, but the diminution in the potential difference had a different value from that produced by air, being only about 6·5 volts instead of 10 volts. Table IV. gives the current and the potential difference between the carbons just before the hydrogen was turned on, just after it was turned on, just before it was turned off, and just after it was turned off.

TABLE IV.—Effect of Blowing Hydrogen down a Tubular Positive Carbon. Carbons: Positive, 11mm. Tubed; Negative, 9mm. Solid; Length of Arc, about 3mm.

P.D. between carbons in volts				Current in amperes.
Before H. was turned on.	After H. was turned on.	Before H. was turned off.	After H. was turned off.	
52	46	46	53	14
52	45	47	52	12
52	45	45	52·2	12
52·5	46	46	53	12
52	45	46	52	9

Thus, the mean diminution of potential difference accompanying the hissing caused by hydrogen being sent down the positive carbon of an arc burning in the air was about 6·6 volts, or about 3½ volts lower than when the hissing was caused by air alone.

In order to exclude all possibility of doubt as to the effect of the various gases, I repeated the experiments with the arc entirely enclosed, so that the only gases that could reach it were those blown down the tubular positive carbon. The current was distinctly below the hissing point, being only 10 or 11 amperes, and the arc was from 2mm. to 3mm. long. When air was blown down the positive carbon, each puff lowered the potential difference by about 10 volts, and the moment the puff ceased the potential difference rose again. Next, oxygen was tried, with the same result. Thirdly, nitrogen, with no result, or with the result that the arc was blown out if the pressure was too great. Carbon dioxide had the same effect as nitrogen, and lastly hydrogen was tried. This gas, however, gave a totally different result with the enclosed arc from that already obtained with the open arc. For whereas, as has been previously stated, hydrogen produced a distinct hissing of its own when blown down the positive carbon in the open air, it produced none when used in the same way with the enclosed arc. To prove that, in order to produce the sudden diminution of potential difference under discussion it was necessary for the active gas to actually touch the crater, a tubular negative carbon was used, and each gas was blown up through it in turn, gently enough not to force the gas directly against the crater. In no case was there any sudden diminution of the potential difference, whatever was the gas blown through the negative carbon, and whether the arc was open or enclosed. On the contrary, there was generally a small increase, probably due to the lengthening of the arc by its being blown on one side. If oxygen or air were blown very hard up the negative carbon, they would either produce hissing or blow the arc out, or both; for in that case some of the gas got to the crater uncombined with the carbon vapour, and acted exactly as if it had been blown down the tubular positive carbon.

The case, then, stands thus: (1) when the arc begins to hiss in the ordinary way, the potential difference between the carbons diminishes by about 10 volts; (2) if the air is excluded from the arc this diminution of the potential difference does not take place, even when the current is nearly three times as great as would cause hissing in the air; (3) if, however, while the air is excluded puffs of air are sent against the crater, the diminution of the potential difference does occur, even with currents much smaller than would cause hissing in the air; (4) if, instead of air, oxygen is sent against the crater, the potential difference is diminished to exactly the same extent as when air is used; (5) if, on the other hand, nitrogen is sent against the crater, no diminution of the potential difference is observable; (6) if air or oxygen is gently blown through the negative carbon, so that it cannot get direct to the crater, no diminution of the potential difference follows.

Thus there can be no shadow of doubt that the sudden diminution of potential difference that accompanies the hissing of the open arc is due to the oxygen in the air getting directly at the crater and combining with the carbon at its surface. This explanation, like many another in science, solves certain difficulties, only to create others which may, perhaps, be yet harder to deal with. Directly we know exactly how the diminution of potential difference accompanying hissing is brought about, we ask, "How does this combination of gas and carbon, at the temperature of the crater, act in producing a diminution of potential difference so sudden, so certain, following such definite laws as those we have been considering? Why do certain gases produce it and not others? Why does hydrogen act in the presence of air, but not when air is absent?" etc.

These are questions that have been occupying me for some time past, and which will, I hope, be completely answered by the series of experiments on which I am still engaged. These latter experiments, although suggested by the investigation on the hissing of the electric arc, have already opened up a different field of enquiry, and the further results may therefore with advantage be reserved for a future communication. It only remains for me to express my high sense of the honour done me by the Institution of Electrical Engineers in asking me to read this paper, and to thank the many people to whom I am indebted for very kind assistance. My most sincere thanks are due to Prof. Ayrton for much criticism, for advice as to the methods of conducting the experiments, and for invaluable help in the literary portion of the work; to Mr. Solomon for constructing with much ingenuity the first enclosing crucible, and for making the earlier experiments with it; to Mr. Phillips for assisting in the experiments and for drawing most of the diagrams, especially the admirably executed coloured drawings of the hissing and silent arcs; to Mr. Carter for supervising, and to Messrs. Manuel and Pletts for very carefully constructing the apparatus for the experiments of this evening; and, lastly, to Messrs. Arundel and Spencer for helping with most of the experiments for the paper, and for conducting many of them alone, with great skill and patience, as well as for carrying out all those that have been shown to you this evening.

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OPENING OF THE BLACKBURN TRAMWAYS.

The formal ceremony of opening these tramways, a description of which appeared in our issue of 17th ult., took place last Wednesday week, and was in every way successful.

At 11.45 a.m. his Worship the Mayor (Alderman Eli Heyworth), the members and officials of the Town Council, and representatives of the engineers and the contractors, including Messrs. Alex. Siemens, Lacey, Clirehugh, Sillar, Crawford, Milnes, Kingston, and Russell, together with numerous visitors, assembled at the town hall. Opposite the front entrance there was drawn up several gaily-decorated cars, which were quickly boarded by a good-tempered and privileged party. The procession then wended its way *viâ* Preston New-road to Billings End, and returning, traversed the Witton route. The tour was accomplished without a hitch. The contractors have had a by no means easy task in dealing with the Witton line; the numerous very sharp curves and alternate routes have rendered necessary a somewhat elaborate system of overhead line and cross-overs. A casual glance would lead one to suppose that Messrs. Siemens were endeavouring to make the running of the trolley as difficult as possible in order to prove its capabilities; but, of course, that would result from a casual glance, and would presuppose a want of knowledge of Messrs. Siemens. However, the overhead line on this Witton section is a difficult one to traverse, and the trolley answered admirably.

On returning to the town hall the party sat down to an excellent luncheon, which was followed by the usual toasts and speeches. In the absence of Mr. Alderman Thompson (chairman of the Tramways Committee) through illness, Councillor Crossley (vice-chairman) gave the toast of "Success to the Blackburn Corporation Tramways," which was heartily received. Mr. Alex. Siemens followed, and set at rest the idea which has got abroad that he is an opponent of municipalisation. He declared that, though there were certain things, in his opinion, better left undone by a corporation, better left to individual than collective enterprise, tramways did not come within that category; tramways should be municipalised. He also dwelt upon the fact that, with the exception of the car bogies, the whole of the work was British. His remarks bearing upon the delay in completion due to the engineering strike, and also as to the results of the said strike, were listened to attentively even by those present who evidently did not entirely agree. Compliments passed between their worships of Blackburn and Darwen as to municipal matters in general, and tramways in particular, brought a highly successful gathering to a close.

ELECTRIC LIGHTING BILLS FOR LONDON.

The County of London and Brush Provincial Electric Lighting Bill.

(*Continued from page 407.*)

The Select Committee of the House of Commons presided over by Sir W. Coddington on March 27 resumed the consideration of the Bill promoted by the County of London and Brush Provincial Electric Lighting Company, Limited, for the erection of a new generating station, the enlargement of the existing stations at St. Luke's and Wandsworth, and the acquisition of numerous way-leaves.

Mr. LITTLER, Q.C., on behalf of the Whitechapel Board of Works, declared that the broad objection of his clients to the Bill was that it embodied an order which, if granted, would do them a great deal of harm and could not possibly do them any good. Whitechapel lay between St. Luke's, where one of the company's generating stations was situated, and several of their other districts in the East of London. Unless there was some almost imperative reason for passing through Whitechapel or any other district which could not be benefited, no such parliamentary power as that sought should be granted. It would inflict upon the petitioners considerable burden and responsibility, as their streets were honeycombed with underground mains, sewers, wires, etc., and were largely covered with wood pavement, which could not be interfered with without loss to the road authority. Another objection to the proposal of the Bill was that, if the promoters were once allowed to pass through Whitechapel, they might in some future session do something in the way of competition with the Board of Works, who were themselves supplying electricity. He held that there was something else behind the Bill—that the promoters contemplated something which the committee knew nothing about. If measures of this kind were allowed to pass they would soon have London riddled and honeycombed worse than it was at present with wires, and that not for the public advantage, but for the benefit of this private company. He submitted that the proper course for the company to adopt would be to go to some site on the banks of the Thames where there was no population and where land was comparatively cheap. Let them do as the Chartered Gas Company had done when they removed their works from the Blackfriars end of the Thames embankment to Beckton marshes.

Mr. GEORGE WHITEHEAD PRESTON, clerk to the Vestry of St. Luke's, said the effect of the proposed works would be to deprive them of rates to the amount of £1,227. In cross-examination, witness admitted that the Vestry lost nothing in the matter of rates in connection with the present generating works of the company.

Mr. WHEELER, Q.C., then addressed the committee for the Vestry of St. Matthew's, Bethnal Green. He submitted that the essence of the report of the committee of last year, on which Mr. Pember had relied, was that if the electricity-generating company could not find a generating station in its own district, it might go into another district to find it. Then as to Clause 15, which dealt with accounts, however simple the Bill might be in appearance, this clause alone would justify the strenuous opposition which was offered to it. If the clause, which was to relieve the company from the necessity of furnishing separate accounts of each of its undertakings, were passed, it would put an end to all existing contracts as to purchase at the end of 42 years. It was only on the condition that they should keep separate accounts, and that the local authority was to have power to buy, that the promoters had been allowed to go into those areas. With regard to the special case of Bethnal Green, he protested against giving the promoters a roving commission to go where they liked, no streets being indicated as those through which they wished their mains to run.

Mr. STATHAM (for the Vestry of St. Mary, Islington) called

Mr. W. F. DEWEY, vestry clerk of Islington, who said his parish had already spent £200,000 on electric supply and proposed to spend another £100,000. They supplied electricity for electric lighting at 3½d. per unit, for power during the daytime at 3½d., and for private lighting at 7d. for the first hour and 4d. for every subsequent hour. As an electric lighting authority they had a strong desire to reserve to themselves the streets down which the promoters were seeking powers to go. One of his great objections was that the Bill, as drawn in the clause dealing with accounts, would render it impossible to acquire the company's undertaking in Islington. He knew it was said that the Bill did not enable the company to supply electricity in Islington, but the moment they had laid a main down a street there was nothing to prevent them from spreading wires transversely in order to supply private consumers. He maintained that Islington was not between St. Luke's, where the company's generating station was situated, and Hackney, which the company wished to supply with electricity. At present the streets of Islington were congested with electrical mains.

In cross-examination, WITNESS said that the company were seeking to evade the possibility of Islington purchasing any part of their undertaking which might be in the parish. The powers contained in the orders already obtained did not apply to this Bill. Under the Bill private consumers might be supplied. So far as that point was concerned, his objection no doubt would be met by the insertion in the Bill of a clause declaring that electricity should not be supplied to private consumers in the parish of Islington.

Mr. PEMBER, Q.C., said the committee desired to have details as to the districts affected by the Bill. The facts were these. Battersea had obtained an electric lighting order in 1896 and Fulham in 1897, and no work had been carried out, though it had been commenced, and the same thing applied to Whitechapel, which had obtained its order in 1892, and Stoke Newington, which had obtained its order in 1893. Hackney and Poplar had obtained orders in 1893, but nothing had been done. Lambeth had got an order in 1892, but had transferred it to a company in 1897. Islington and Shoreditch had got orders in 1893 and 1892 respectively, and were carrying out the work. Bermondsey and Rotherhithe were applying for an order, and the company sought to supply them. In the case of Greenwich an order had been granted to the company for a part of the district, and the company were asking for an order in that district. In the Lee district an order had been granted to a company to supply a part, and the present promoters were seeking to supply the district. The Bethnal Green Vestry were applying for an order, and so were the company. Camberwell was the company's district, and in Lewisham powers were being sought both by the authority and the company.—The committee then adjourned until after the holidays.—*The Times.*

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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THE EASTBOURNE TRANSFER.

This week the agreement by which the undertaking of the Eastbourne Electric Light Company, Limited, will be transferred to the Corporation on the first day of the next century has been signed and sealed. By this another electric lighting company resigns its obligations and powers for a handsome consideration, but we do not grudge the shareholders of the Eastbourne Company the bonus they will receive from the sale. The purchase price is computed on the ordinary shareholder receiving twenty pounds for every ten pound share held, and as these shares received 10 per cent. dividend last year and 12½ per cent. this year, the Corporation would seem to have bought the undertaking at a very reasonable figure. The Eastbourne Company has a record extending back into the early eighties, as it was in 1882 that arc lamps supplied by the Anglo-American Brush Electric Light Company were first used to light the promenade. A company was formed to take over this lighting contract, which, we believe, was taken at the low rate of twenty pounds per arc lamp, the lamps being turned out at midnight. The new company then laid down one of the first alternate-current distributing systems in the kingdom, and charged one shilling per unit for the electric energy so supplied. As can only be expected, the company has had to bear a lot of pioneering experience, and the up-hill fight into a dividend-earning stage was a great tax on those responsible for its management. At the same time the works served a good purpose in the early days as an exhibition of what could be done by electric lighting, and for some years they were regularly visited by deputations from other towns. Naturally a great many modifications of plant and arrangements have had to be made, and yet in last year's balance-sheet the capital expended only averaged a little over one hundred pounds per kilowatt installed. In the old days the company and the Corporation had many disputes over the price to be paid for arc lamps, and it was of light from these at Eastbourne that Mr. Willoughby Smith in 1888 quoted the lines:

> "It shed a restless waving gleam
> Through the Gothic window pane;
> And now it vanished for a space,
> And now it came again.
> He stood, and thought it wondrous strange
> That such a scene should be."

When the company obtained a provisional order in 1890, it succeeded in maintaining its charge at tenpence per unit, and until recent years it kept the price of current up. In fact, in spite of the arc lighting, the average price obtained per unit in the year 1897-1898 was 7·44d. From this it will be seen that although a fairly large and paying load has been obtained, the supply of electricity in Eastbourne cannot yet be said to have had a fair chance. It may be urged by some that the equivalent of, say, twenty thousand eight-candle-power lamps in a population of some forty-four thousand is not bad, but we contend that this does not represent even a quarter of what is to be obtained in a town like Eastbourne. The price of gas in the

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town is three shillings per thousand cubic feet, and the Corporation should reduce their charges with the new year to compete with this figure. We trust that the Corporation will be well advised in this matter, as in this way they will both increase largely the value of the undertaking they have purchased, and secure a good and cheap illuminant for the townsfolk without in any way hampering the rates.

FORTHCOMING EVENTS.

TUESDAY, APRIL 11.

Institution of Civil Engineers.—At 8 p.m., "Alloys of Iron and Nickel," by Mr. Robert Abbott Hadfield, M.I.C.E.; resumed discussion.

Self-Propelled Traffic Association—Royal Institution, Liverpool, at 8 p.m., annual general meeting.

WEDNESDAY, APRIL 12.

Society of Arts.—At 8 p.m., "Telephones," by Mr. John Gavey, assistant engineer-in-chief and electrician to the General Post Office.

THURSDAY, APRIL 13.

Institution of Electrical Engineers.—At 8 p.m., "The Hissing of the Electric Arc," by Mrs. Ayrton; conclusion of discussion. "Experiments on Alternate-Current Arcs by Aid of Oscillographs," by Messrs. W. Duddell, A.I.E.E., and E. W. Marchant, A.I.E.E.

Royal Institution.—At 3 p.m., "The Atmosphere," by Prof. Dewar, M.A., LL.D., F.R.S., M.R.I.

FRIDAY, APRIL 14.

Royal Institution.—At 9 p.m., "Earth Currents and Electric Traction," by Prof. A. W. Rücker, M.A., D.Sc., Sec.R.S., M.R.I.

Institution of Junior Engineers.—At 8 p.m., "Piles and Pile-Driving," by Mr. H. C. Reid, M.I.J.E.

SATURDAY, APRIL 15.

Institution of Junior Engineers.—At 3 p.m., visit to the works of the new Vauxhall Bridge.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE TELEPHONE CRISIS.

SIR,—Although your views, as expressed in leading articles, appear to be despondent as to the success of the result of the Government Telephone Bill, I trust you will not close your pages to the consideration of remarks from an advocate of the localisation of all of the industry, which should not obviously be nationalised.

The points to which I wish to draw your attention are perhaps more suitable for the readers of a technical journal than to the general public. I refer, amongst other things, to what is known to telegraphists as "divided maintenance," and its effect on the upkeep of the conductors, and on the switchroom working and discipline of a telephone exchange system.

Except for the technical evidence before parliamentary committees, there is no information available as to the organisation and working of the telephone industry in these countries. The enquiring public would find it very difficult to get at the facts, and the few who are technically qualified to collate the information find it not easy to do so from the material being scattered through many documents in a way to make it intelligible to those who have only a little knowledge on the subject, and whose little knowledge makes them timid in face of what appears to be a radically new departure in the national policy as regards the telephone.

Let us admit that there is no going back on the legal decision of 1881, which constituted the telephone to be a telegraph, and that there is nothing to object to in the advantage then secured being used as a means of imposing a tax for the benefit of the national revenue. But that is quite a different thing from the admission that the use of the telephone is in close alliance with that of the telegraph, or that the telephone is a foster sister of the telegraph because the latter is a handmaid of the postal service.

In a letter from me in the *Times* of March 29, 1899, I pointed out: "A means which delivers a written communication by a slow process as in the post, or by a rapid one as with the telegraph, . . . is essentially different to one in which individuals are placed in communication for the purpose of conversation. In the first, the undertakers do the work of transmission in each of its stages from end to end, except the acts of writing and reading; in the second, they provide the machinery and stand on one side for their customers to use it."

Even amongst your electrical engineering readers, if I mistake not, there has in the past been a disposition to conclude that because the telegraph and the telephone each uses a conducting wire and an electrical instrument, therefore the industries are identical.

Pardon me if I digress a little as to one of the reasons for the condition of the public mind in this year of grace 1899 on the subject of wires both overhead and underground. It is traceable to the state of the law which vests the freehold of the soil and the air *usque ad cœlum* of all public rights of way in the owners of the frontages.

The old telegraph companies had to obtain Acts of Parliament to place wires over, along, and across the roads. The Post Office took over with the telegraphs in 1870 the rights under these Acts. The National Telephone Company in the early days (1881) declined to follow my advice to them to seek for similar powers, and took their chance. The public sees overhead wires along the highways—some belong to the Post Office, some to the National Company—and knows nothing about the distinction—namely, that the one has a legal right to be there, the other none whatever. It is probable that 99 out of 100 observers do not know also that the local authority over the roads has no statutory powers whatever to place wires over or under the highways, of which they have only the user for the purposes of maintenance as a public way.

All this means that local telephony as a local industry has never hitherto had a chance of coming into existence in these kingdoms, quite apart from the monopoly possessed by one company through its ownership of the master patents. I ask, is there anyone outside the Post Office and the National Company who alleges that, but for the condition of the law as regards the wires, and but for the patent monopoly, local telephone exchanges would not long ago have been in active work in town and country all over this realm? I venture to initiate a reply in the negative. If the local authorities had always had the power to grant wayleaves, and if the possession of the telephone master patents had not been riveted by repeated legal decisions, the industry would have started and have been developed following its natural course. Local exchanges at rates which, but for the monopoly—be it remembered—were quite as easily attainable in 1882 as now, would have been opened all over the country, and the inter-communication or trunk-line question would long ago have been settled by Parliament in the mutual interests of the local telephone industries and of the postal telegraph service. With a birth and during a growth of this kind, the questions affecting the size of switchrooms and the discipline of their working would have settled themselves in a natural way.

Now as to the difficulties of constructing and working switchrooms for, say, 10,000 subscribers. Telephone engineers do not question their existence; but they do not tell the non-experts where the real difficulties lie. There is no absolute engineering difficulty in the way of making provision by which any one of 10,000 subscribers may be "put through" to any other one of the same number. In any case, the junction portion of the switching machinery to do this costs so much per subscriber, and that cost is directly in proportion to the facility afforded—*i.e.*, so much per subscriber in an exchange with 1,000 connections, and so much more per subscriber if there are 10,000. In other words, there is an initial cost for each connection, which is the same, say, for each of the first 500. The junction wires for connecting each of the first 500 are an additional cost on all, and so on. Also, there is a *time* factor, which coincides with the incidence of these additional costs. Thus, the cost in question may provide connecting wires, or station junction connectors, in sufficient number to allow of limited or unlimited cross switching. If unlimited, it

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means that each one of the first 500 can be at the same moment put through to each one of the second 500. If limited, it means, perhaps, that only 50 of each group can be connected at the same time. If a few more than 50 wish to be connected, they must wait. The time occupied (1) in "putting through" (I use telegraphic terms in preference), or connecting one to another of the first 500, is the minimum time required for the manipulation of a switchboard for 500 connections; (2) it is the extra time occupied in connecting one of the first 500 to one of the second 500; and (3) it is the time one of the latter may have to wait while all the other 50 junction connections are in use.

These remarks indicate that facilities, within each exchange, have two main characteristics. One is subject to the number of subscribers connected to the same section of the exchange; the other, to the provision of junction wires between the sections of the exchange. These considerations apply similarly to a group of local exchanges, in which the 10,000 subscribers, instead of being connected with one exchange under one roof, are connected with, say, five exchanges of 2,000 each, all of which intercommunicate by means of junction wires, as if they were under one roof.

It is of interest at this stage to observe the essential difference between the circumstances I have described and those of telegraphy. In that industry the State provides that everyone may telegraph to everyone else. But telegraphing and talking are two very different things. In telegraphy, considerations of the time factor, by the sender or receiver, unless the delay is excessive, is practically eliminated, so far as the public is concerned. They are quite ignorant of the details of the operation, or time occupied, of each stage of transmission. In telephony, the efficiency and patience of the user is only secondary to that of the plant and the switchroom operators.

To go one step further. Here, as a preliminary, it may be claimed that the suggestion of the nationalisation of the whole telephone industry means that which is possible of accomplishment *only*, if classification of facilities is the foundation of all the Government proposals, to a degree that the Department as a public one could never venture to put in operation, and which would be contrary to all its postal and telegraphic traditions and procedure in the past.

It means giving equal facility of inter-communication to every subscriber over the whole country. Practically, one exchange system with, say, 400,000 subscribers! It is what Mr. Preece foreshadowed without qualification in his presidential address to the Civil Engineers. Either he had not studied the subject, or he knew that Post Office policy intended to limit the facility to the users of postal "call offices."

I have mentioned "classification." It is the soul of the successful popularisation of telephony. The National Telephone Company rejected its use from the beginning, obviously because they could not afford to await local development, and began with systems which met the wants of subscribers willing to pay a high uniform rate for the maximum service, and therefore widely scattered. To their policy in this respect can be easily traced much of the unpopularity and limited character of their telephone service.

As I have stated, the wires known as "trunk" wires—actually larger junction wires—will always be worked by the postal telegraph service, whether the local telephones are so or not. This is an accomplished fact, but only when they have provided Greater London with a popular local telephone service at fair rates of subscription, and placed the trunk-wire system on an efficient footing, will they have saved from almost ridicule Mr. Preece's claim to infallibility—namely, that "it is the function of the Postmaster-General to work for the public every system of inter-communication of thought which affects the interests of the whole nation." His claim, however, may be partially vindicated even if the Post Office in the course of a few years established 50,000 call offices throughout the land with complete and serviceable means of conversational inter-communication. The claim to be the only purveyor of means of local conversation is, when soberly contemplated, almost preposterous.

In classification, it is believed, lies the solution of most of the difficulties which the Government Bill, it is said, will produce. These are being daily held up *in terrorem* to the readers of newspapers.

In a paper I read in 1882 before the Society of Arts I advocated classification—namely, by regions, sometimes called "regional telephony." That is, that connected with the same exchange there may be subscribers who, according to the amount of their subscription, are entitled to a different service, and distinguished on the switchboard by different colours. In 1882 I had a London service on my mind, and described how there might be three rates within the London area.

Now, I believe that two classes (London being eliminated from consideration) will suffice—namely, first, those who will be entitled to be "put through" on the trunk lines—for this service, which will be also accessible to all at the "call" offices, a rate corresponding to the value of the service (the value of which, parenthetically, I may say has never been properly assessed) will be charged; second, subscribers who have a right to communicate with everyone inside their own telephone area, and who will be asked to subscribe the lowest rate compatible with the facilities afforded.

The Post Office rules for standard patterns of instruments and wires should be complied with before any subscriber is admitted to Class I. with the privilege of the use of the trunk wires from his own house or premises; the Post Office lists to contain the names and addresses of such subscribers only. As to all second-class subscribers (Class II.) throughout the kingdom, the Post Office will have no cognisance whatever. These, of course, as time go on, will form the immense majority.

A little consideration will allow the reader to understand the effect of legislation which would permit of this classification. For instance, to the present subscriber of the National Telephone Company it presents no change in his existing service except for the better. The whole attention of the company can be directed to increasing the efficiency of its local service. The company will be able to offer each of its present subscribers the opportunity if they care to join a second class—namely, a regional service at a reduced rate of subscription. By degrees those who wish to have the right to be connected with the trunk wires at their exchange, and who care to pay a subscription compatible with the great value of such a convenience, will be sifted out, and the general body of subscribers will be content to resort to the "call" offices for their occasional necessities. The universal access of subscribers to the use of the trunk wires by casual users, which is the chief cause of delay and trouble, will gradually disappear, and the demand will be brought nearer the capacity of the supply of lines, at present often wholly inadequate, or, on the other hand, even sometimes idle, simply on account of the unpopularity their use hitherto has acquired.

The relief to the Post Office will be immense. It is only by anticipating what the magnitude of local telephony may be in the future that anyone can measure the value of a policy which will not render it obligatory on the Post Office to undertake it. A policy leading straight to universal nationalisation of the telephone would mean either the maintenance of the present "drag" on the wheel of progress, or the provision for a future which no one of the present generation of officials is justified in imposing on his successors. For instance, imagine the shelf of volumes containing the indexes of the addresses of, say, half a million subscribers which would have to be installed, if not at the side of every subscriber's instrument, at any rate at every "call" office. If that shelf of volumes is not at hand for each subscriber, then where is the use of nationalisation, which is bound to reject classification because it would stultify its offers; and if it adopts classification why burthen a public department with the supply and working of a means of conversation, 95 per cent. at least of which is for purely local or regional purposes?

Again, I claim, besides emancipation from a great future difficulty, that the public revenue will not deteriorate within the boundaries of its present trading operations which Parliament has legalised, although I do not for one moment suggest that, even if it did so, the Treasury would be guided in its policy by that one consideration.

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There is no doubt some leeway in connection with the use of the trunk lines for the Post Office to pull up, due to what may be called the speculative nature of the past policy of the National Telephone Company. Neither the Post Office nor the company have in their practice recognised the great *value* this means of being able to talk at a distance is to the wealthy commercial community. Each, looking at the question from different points of view, has attempted to give these facilities for too little, and the absence of classification by rates of the persons entitled to the facility has hampered the whole business.

The whole of the *policy* connected with the use of the trunk wires should at once, before more mischief is done, be *reconsidered* with the view to getting the *maximum continuous good service* out of their capacity. In the same sense, the Post Office policy for the London service should be *regional* and *classified*. The fresh stratum of demand which it is proposed to tap must not be approached with visionary promises, arising out of an ill-considered and casual policy.

There is no pressure on the Government to water capital for the benefit of pioneers, or to pay quick dividends.

A good Post Office policy in London can only achieve future permanent success by proceeding quite independently of the existence of the National Company's system. In time, inter-communication between the subscribers to the Post Office system and to the company's system may be established, but there should be no haste about it, and, above all, there should be no sacrifice of a sound *far-seeing policy* to satisfy any popular cry.

Lastly, the Bill now before Parliament should go out to the country with no uncertain sound—namely, that *local telephony*, whether in competition within areas where the National Telephone Company has its exchanges, or in areas where they have not yet been licensed, is to be freed from all existing restrictions to the *bonâ fide* establishment of the local industry.

My attack on another bugbear connected with an alleged difficulty in obtaining satisfactory intercommunication, because local exchanges would be locally managed, and the trunk wires under Government management, which has been let loose, I must ask you to let me postpone to your next issue.—Yours, etc., C. E. WEBBER.

April 5, 1899.

ELECTRIC TRACTION AND ITS APPLICATION TO SUBURBAN AND METROPOLITAN RAILWAYS.*

BY PHILIP DAWSON.

There is no longer room for doubt that electricity is the one pre-eminently successful motive power for tramways. This is proved by the rapid growth of electric traction. The words "experimental line" have fallen out of use, yet it is only a few years ago that those who ventured to foretell that the trolley system would be generally introduced into this country were ridiculed. There is no country in which electric traction is advancing more rapidly, and in which finer plants are being installed, than in Great Britain. The day is not far off when horses and steam will have disappeared from the streets as far as tramways are concerned, and when the horse 'bus as a competitor will be no longer known.

The problem of greatest importance, however, in which electric traction will be a principal factor, is the rapid transportation of large crowds from and to their business in our cities. The object of this paper is to investigate in a general way the special requirements of this service, and to demonstrate the special adaptability of electric traction to it. It is evident that the only solution of rapid transit lies in railways which must be either overhead or underground, and of both London possesses a greater mileage than any other town in the world. The fact of initial expenditure must restrict the number of tracks available for the up and down traffic. The stopping places on such lines must of necessity not be far apart, and to diminish the crowds on the platforms and to increase the number of passengers the trains must follow each other with the greatest possible frequency. Consequently, the average speed of the trains must be increased as much as possible without unduly diminishing the distance between two consecutive trains, which would be dangerous.

Steam locomotives have probably reached their approximate maximum development, and the results so far obtained with them for the class of traffic in question are far from satisfactory. They do not get up speed rapidly owing chiefly to the torque on the driving axles constantly varying in consequence of the reciprocating motion of the pistons. They are not economical, as their fuel consumption is practically the same whether they are exerting their fullest power, coasting or standing still, and their maintenance is very costly.

There is a commercial limit as far as distance is concerned beyond which transmitting power electrically will not pay. But that limit varies with each case, and cannot be ascertained except by the most careful calculation after all the conditions that maintain have been minutely examined. England was the first country to introduce electric traction on railways, both underground and overhead, as instanced by the City and South London and Liverpool Overhead Electric Railways. But to prove commercially that very much heavier traffic could be handled, that much greater distances could be traversed, and to develop on a large scale the necessary machinery, was again left to America, and hence the necessity of being practically confined to American experience and examples in this paper.

There are practically three methods of handling electrically the traffic on a railway—namely: (1) by locomotives or motorcars hauling a train of trailer cars; (2) by independent motorcars; (3) by a set of independent motorcars formed into a train and handled from the front car, or from a so-called controller car. Each car, however, can be separated from the train, and then becomes an independent motorcar.

As regards the supply of the necessary current for the motors, there are three distinct methods: (1) by accumulators or storage batteries, which may be carried either on the motorcar or locomotive, or on a tender; (2) by having a car containing a stationary engine, dynamo, and boiler, which supplies the necessary current to the motors on the cars comprising the train of which it is part, and as proposed by M. Heilmann; (3) by continuous or multiphase current supplied directly from a generating station or from a substation which, in its turn, gets its supply of energy from the main station, the current being distributed either in the form of direct or polyphase to conductors running along the lines, and from which the power is supplied, through sliding contacts on the cars to the motors.

The two former methods, as far as this paper is concerned, will not be discussed, as sufficient data are not available to justify their being considered. The system of transmission of energy to the motors by means of conductors laid along the track will, therefore, alone be considered. This method allows of several variations as far as the generation and distribution of power is concerned, amongst which the chief may be set down as follows: (*a*) One continuous-current generating station supplying current direct to contact rail. Where drop in pressure owing to distance becomes excessive a negative "booster" may be used; it serves, so to speak, to pump back the current to the station, and is self-regulating, not taking at any period more power than is actually required to pump the current back. Should there be one or two lines too long to enable them to be worked this way, polyphase high-tension generators should supply the power to one or more sub-stations along the line, as may be found necessary, in which rotary converters are located, which transform the current back into continuous. The polyphase generators to be driven by continuous-current motors in the generating station. As an example of such a station, the new Dublin tramway power-house may be taken. (*b*) One central station generating continuous current, with substations in which accumulators are located along the road, and which are charged by means of a booster and special cables. As an example of this system, the Leeds tramways may be taken as designed by, and carried out by, the late lamented Dr. John Hopkinson. (*c*) A series of stations, as described under (*a*) and (*b*), situated at various distances

* Paper read before the Society of Arts, March 22.

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and connected together one with the other. As an example of this, the tramways and light railways in and round Boston, Mass., may be taken, owned by the Boston Elevated Railway Company, which has absorbed the well-known West End Company.

Data of Boston Elevated Railway.

Track miles operated	305
Number of cars	2,648
Car miles run during 1898	29,787,000
Passengers carried during 1898	172,764,300
Number of power stations	5
Total capacity of power stations in kilowatts	16,100
Total rated indicated horse-power of engines	24,000

(*d*) A power station generating polyphase currents, which, by means of static step-up transformers, are transmitted at tensions which run from 2,500 to 40,000 volts to sub-stations where static step-down transformers reduce them to pressures of 300 to 350 volts; the current at this pressure enters rotary transformers, which deliver direct current at 500 to 550 volts to the line. As an example of this latter system, the Central London Railway, which is now under construction, may be mentioned. (*e*) A three-wire system with continuous current, the rails or return forming the neutral wire. This has been tried and found wanting, and the engineers of the Central London Railway most carefully investigated its possibility and decided in favour of polyphase transmission and rotary converters, and rightly so.

From careful calculations, and the investigation of what has been done both in Europe and America, there is no getting behind the fact that for any power station which will exceed 4,000 kw. in capacity, the polyphase system is nearly certain to prove commercially the only admissible one. This statement is upheld by such an authority as Mr. H. F. Parshall, M.I.C.E. It is evident that in the particular cases at present under consideration (suburban and metropolitan communication), more than 4,000 kw. will be under consideration, and therefore nothing, as far as the power station and transmission is concerned, but polyphase currents will be considered.

There are two distinct varieties of service to be catered for. One, that on a system like the Metropolitan and District, where the stops are frequent and the runs short. The other, the case of long-distance lines with few stops. In the present paper it is only proposed to consider the first variety. In this case the use of polyphase motors need not be considered, as for work entailing frequent stopping and starting they have not up to date proved satisfactory.

A short examination of the importance of rapid acceleration on lines having stopping places at short intervals is interesting. Practical experience with electrically-driven motorcars or locomotives on the experimental track of the General Electric Company at Schenectady, has proved that it is perfectly feasible to attain a speed of 30 miles an hour 10 seconds after starting from a standstill. Assuming a level track, and that during 65 seconds the current is cut off, and the train allowed to coast, that the brakes are then put on, the train will be brought to a standstill 15 seconds later, and the total time from start to stop will be 90 seconds. Under these conditions it will be found that the average speed will have been 23·16 miles an hour, and that the total distance run will be about ·55 of a mile. Assuming that, instead of attaining the 30 miles an hour in 10 seconds, it took 30 seconds, and that this full speed of 30 miles an hour was kept up for 40 seconds longer, and the brakes then put on, the train would be brought to a standstill in 90 seconds, and the average speed would work out as 21·66 miles an hour, or an average speed of about 10 per cent. less than in the previous case, the consumption of power, however, being much greater.

It is evident that the most important point is to attain a high average speed, and to keep the maximum speed attained as low as possible, as by so doing less power is required in braking the train, and also less power is required to run the train. The time between the moment when the maximum speed is attained and when the brakes are put on should be at least from four to six times that required for stopping the train, so as to allow for errors in judgment on the part of the driver, and also to enable him to make up lost time. On the Manhattan Elevated Railway in New York, the trains which are drawn by steam locomotives take 20 seconds to attain a speed of 14 miles an hour, or less than half the speed in double the time as compared with electric traction just mentioned.

A much larger current will be required to attain a rapid acceleration than to attain a slow one, but the current will be required during a much shorter time, and the total energy supplied will be less in the case of rapid than of slow acceleration. This fact must not be lost sight of when calculating the feeders for such a system, and the train service should be arranged in such a way that as few trains as possible start together. Furthermore, the more rapid the acceleration required the larger will the motors have to be, and, therefore, there will be a limit above which it will not be advantageous to push the rapidity of acceleration. In new tunnel lines, such as are now being constructed all over London, it will be evident that it is an advantage to have the stations built with a down grade for the trains to start, so as to help the motors and reduce the current at starting, and that similarly it will be an advantage to have an up grade when nearing a station, so as to reduce the amount of power required in braking. By properly choosing these gradients, it is found that a total economy of from 40 to 50 per cent. in the total power required by a train may be made. According to Mr. Potter's tests, it was found that during acceleration an average power of 32 amperes per ton of weight of train was required.

With a complete train composed of one motorcar and two passenger cars, weighing complete 148,000lb., a maximum horizontal effort of 9,750lb. was required in acceleration, the maximum current was 780 amperes at 500 volts, the maximum speed attained was 32 miles an hour, and the time taken to attain the speed was 34 seconds, the motor-car being equipped with two 200-h.p. motors.

METROPOLITAN ELEVATED, CHICAGO.

Number of cars in train.	Average speed (not including stops) in miles per hour.	Average current (not including stops) in amperes.	Board of Trade units delivered at switchboard per ton-mile.
4	14·4	148·7	·050
4	14	153·2	·053
4	14·5	151·8	·050
3	14·7	137·4	·063
3	15·1	135·6	·058
2	15·3	90·1	·058
2	16·8	106·6	·059
4	12 2	101·1	·042

Railway company.	Number of cars.	Weight of trains in pounds.	Tractive effort per ton. Maximum for given time.		Tractive effort per ton. Average for total time.		Maximum speed in miles per hour.	Distance run.
			sec.	lbs.	sec.	lbs.		feet.
Metropolitan Elevated, Chicago ...	2	88,000	10	177	40	107	34·8	1,020
Lake-street Elevated, Chicago ...	2	88,000	10	135	40	84	27·6	870
Alley Elevated, Chicago	3	144,000	10	135	40	98	28 6	840
Illinois Central, Chicago	4	300,000	10	95	40	79	25·60	750
Manhattan Elevated, New York.	4	190,000	10	88	40	67	21·00	615

In another case, with a train composed of one motorcar, equipped with two 125-h.p. motors and one trailer car, total weight of train being 103,000lb., a maximum speed of 31 miles an hour was attained in 37 seconds, the maximum current being 500 amperes, and the maximum horizontal effort required to attain acceleration 5,640lb. In a series of tests made on the Nantasket Beach line it was found that with a heavy motorcar, 51ft. in length over all, carrying 100 passengers, weighing 31 tons, on an average distance of 2,980ft. between stations, a maximum speed of 40 miles an hour was attained, the average speed being 18 miles per hour, and the power required was 0·098 Board of Trade units per ton-mile. In an experi-

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ment with a train composed of one motorcar and one trailer car, weighing 57 tons, with an average distance between stations of 4,280ft., a maximum speed of 37 miles was attained, the average speed being 17 miles an hour, the power required being 0 067 Board of Trade units per ton-mile.

DISTANCE 2 000FT., TO BE RUN OVER IN 75 SECONDS, OR AT AN APPROXIMATE AVERAGE SPEED OF 16 MILES PER HOUR.

Time during which power applied in seconds.	Maximum speed attained in miles per hour.	Time during which brakes applied.	Average power consumption, per ton, in B.T.U.
7·5	25 75	10·0	0·035
12·5	26 00	10·5	0·036
16·5	26 25	11·5	0·038
24·5	27·15	12·5	0 0475
31·0	28·25	14·0	0·0480
39·0	30·50	17·0	0·0575
53·0	36 50	22·0	0·0850

Distance to be run 2,000ft.

Tractive effort per ton in pounds.	Maximum speed in miles per hour.	Time in seconds during which brakes applied.	Time in which 2,000ft. run.	Average speed in miles per hour.	Board of Trade units per ton-mile.
	62·5	41 0	41·0	33	0 300
300	53 0	34·0	52 0	26	0·196
150	46·0	26·0	58 0	23	0·160
100	40·0	24·5	67·5	20	0·130
65	34·0	22·0	82·0	17	0·100
45	27 5	15 0	98·0	13½	0·075
35·6	23·0	12·0	127·0	10½	0·057
27·6	17·5	11·0	160·0	8	0·045

From a comparison of the actual results obtained on the elevated electric railways of Chicago and on the Metropolitan and District line in London, we see that whereas the maximum speed of 25 miles an hour is obtained in 10 seconds with electric traction, it takes 33 seconds to do it with steam locomotives—and that whilst the electrically-propelled train could do the distance of 1,880ft. in 66 seconds, with steam it would take 93 seconds, or nearly half as much time again. If in the case of electric traction the power is cut off the moment the maximum speed of 25 miles an hour is obtained, and the train allowed to coast before the brakes are put on, the distance considered would be done in 76 seconds, and the steam-driven train even then would take more than 25 per cent. more time to do the same distance.

Having tried to show the advantages which electric traction possesses as regards the possibility of increasing the frequency of the trains without decreasing the factor of safety—namely, the distance between two trains—it may be advantageous to see how, from an economical standpoint of generating power, electricity is a cheaper method of operation than steam locomotives. An electrically-driven train only requires one man instead of two to drive it, and when the train is not running no power is consumed and no coal or water wasted. Steam locomotives, it is well known, use but very little less coal and water when they are standing still than when they are running, and are much less economical, consuming, as they do in America, from 5lb. to 6lb. of coal per indicated horse-power. On main-line English roads it is stated that 3lb. to 4lb. are consumed, and taking an average power of 400 h.p. per locomotive, and a train plus engine weighing 250 tons at a speed of 40 miles an hour, we get at the most economical rate about 0·65lb. of coal per ton-mile, or, compared to the electric power required by electric traction, 13lb. of coal per Board of Trade unit required, which is enormous—under favourable conditions it would not take much over 3lb. of coal to give one Board of Trade unit at the switchboard. A properly-designed electric station with large units would probably never consume more than 2lb. of coal per indicated horse-power hour, or 2·65lb. per kilowatt-hour at the switchboard, and engines of the size of 4,000 h.p. to 6,000 h.p. would be guaranteed to consume not more than 12lb. of steam per indicated horse-power hour. A large station would fully justify a comparatively large initial expense in coal-handling and stoking machinery, and the location of the station could be chosen so as to be most advantageously situated as regards both coal and water, the coal without being handled being taken from either the ship's hold or the railway truck, conveyed automatically to the coal stores, and thence automatically to the fires, the ashes being conveyed away automatically as well. In such a station but very few men would be required, and the cost of power could be reduced below ½d. per Board of Trade unit, including expenses of every kind.

Comparing again the coal consumption per train mile on large English main-line railways, which varies from 35lb. to 58lb. of coal per train mile, we get a coal consumption of from 0·146lb. to 2·32lb. per ton-mile, corresponding to 28·12lb. to 46·4lb. per Board of Trade unit, required to be generated at the power-house. The following results actually obtained with slow-speed Corliss type engines and standard American railway generators may be of interest: Total coal consumed, Brooklyn City Railway Company, per Board of Trade unit, 3lb. Total cost, everything included, of Board of Trade unit at switchboard, 00·5195 cents (about ½d.). Cost of coal per unit, 0·2307 cent (about 0·166d.); Union Traction Company, Philadelphia. Poorest coal, 3½lb. consumed per Board of Trade unit at switchboard. In another case cost of coal, 0·272 cent per Board of Trade unit at switchboard (about 0·186d.). Total cost of unit, all included, 0·591 cent (about 0·296d.). Coal consumption in another case with Corliss engine, average for one year per indicated horse-power hour, 1·65lb. to 1 76lb. What good slow-speed Corliss engines, properly designed for railway work, compared to other engines, mean is shown by the fact that by such a change in a large American station the coal consumption was reduced from an average of 8·3lb. to 4·9lb. of coal per car mile. From a series of figures obtained from the various Chicago electric overhead lines, from 1·16 to 2·35 Board of Trade units are required at the switchboard to drive the trains, the average speed of the trains being 13½ miles an hour, and the maximum speed obtained varying from 28 to 35 miles an hour.

The coal and water consumption per Board of Trade unit must necessarily be very low, the losses in the step-up and step-down transformers and in the transmission and rotary converters would not be very great, and it would be perfectly feasible to attain an efficiency of 60 per cent. at the motor terminals and of 50 per cent. on the power applied to the car axles. Large engines and large generators and converters are designed so as to take an overload of 25 per cent. for any period of time, and be capable of overloading 50 per cent. for a short time without injury; and by a selection of proper units a very large economy could be attained.

Metropolitan Elevated, Chicago.

Length of street	36½ miles.
Average distance between stations	1,600ft.
Time interval between consecutive trains	2½ minutes.
Average speed in miles per hour	13 miles.
Maximum speed	28 miles.
Total rated power of generating station	5,000 kw.

South Side Elevated, Chicago.

Length of street	18½ miles.
Average distance between stations	1,720ft.
Time interval between consecutive trains	1½ minutes.
Average speed in miles per hour	14 miles.
Maximum speed in miles per hour	26 miles.
Total rated power (4 units 800 kw. each) of generating station	3,200 kw.

Lake Street Elevated, Chicago.

Length of line	15 miles.
Power of station	3,000 kw.

North-Western Elevated, Chicago.

Length of line	15 miles.
Rated power of station	3—1,500 kw. / 1 800 kw... — 5,300 kw.

Loop, Chicago.

Length	4 miles.
Rated capacity of station	4 units ... / 1 500 kw. ... — 6,000 kw.
Number of trains passing over line in 24 hours	3,000 trains.
Total rated power of Chicago elevated lines, approximately	22,500 kw.

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Nantasket Beach.

Length of line	20 miles.
Rated power of station	1,800 kw.
Average distance between stations	4,280ft.
Maximum speed per hour	43 miles.
Average speed	25 miles.
Board of Trade units per ton-mile at switchboard	0·0808.
Weight of two-car train	55 tons.

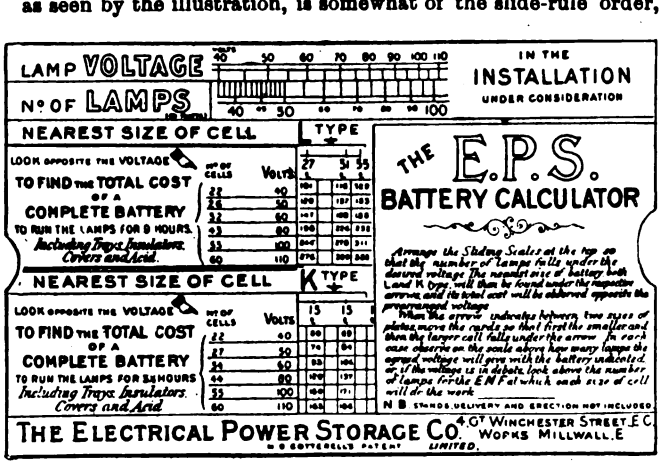
The elevated railroads of New York and Brooklyn have been losing business during the last few years so rapidly that the financial condition of the Brooklyn system is serious, and the return on investment of the New York system much reduced, and is still declining. The elevated railroads of Chicago have never been able to earn a satisfactory dividend The general introduction of electricity in the Chicago system has greatly improved the Chicago situation, in spite of the competition of the surface trolley lines, which parallel the elevated lines in most cases. The elevated railroad problem is resolved into a discussion of speeds, station frequencies, and relative costs of service. Any railroad of this class which aims to maintain a high schedule must choose a motive power in which the possibilities of rapid acceleration are a maximum, and, all other conditions being equal, should choose that particular motive power which will bring about the quickest acceleration consistent with due economy.

The Manhattan system is a comparatively simple one, with four main through lines, without branches of importance, while the Brooklyn and Chicago systems are composed of trunk lines with branches, involving more or less complicated switching arrangements. Until about a year ago, the three Chicago companies—the Lake-street, the South Side, and the Metropolitan—had independent termini in the business heart of the city. Now, however, the newly-constructed "loop," encircling the business district, is used as a terminus for all three lines and for a fourth—the North-Western—now under construction, and all the elevated trains of the city pass round this loop on each trip. The Brooklyn elevated system has lately secured a new terminus on the Manhattan Island side of the Brooklyn Bridge, and experiments are being made with a view to converting the entire Brooklyn system to electricity in the near future. The entire New York system, however, is at present operated by steam locomotives.

(To be continued.)

ELECTRICAL POWER STORAGE COMPANY.

We have received from the Electrical Power Storage Company, Limited, of 4, Great Winchester-street, E.C., what they call their "automatic price-list for storage batteries." This, as seen by the illustration, is somewhat of the slide-rule order,


LAMP VOLTAGE
Nº OF LAMPS
IN THE INSTALLATION UNDER CONSIDERATION
NEAREST SIZE OF CELL
TYPE
TO FIND THE TOTAL COST OF A COMPLETE BATTERY TO RUN THE LAMPS FOR 8 HOURS
Including Trays Insulators Covers and Acid
NEAREST SIZE OF CELL
K TYPE
THE E.P.S. BATTERY CALCULATOR
THE ELECTRICAL POWER STORAGE Co.
4 GT WINCHESTER STREET E.C.
WORKS MILLWALL E
LIMITED.

although there is nothing of the logarithmic order in the gradation of the scales. The list gives quickly the price complete of sets of accumulators from 15 lamps at 40 volts to 30 kw. at 220 volts. The list is figured on both sides. One side gives the prices of the L and the K types of accumulators, while on the reverse, information concerning both the K W S and the K L P types will be found. The prices given include everything required except the stands. We do not think that a more convenient arrangement of a price-list could be obtained in a small space, but we fancy the makers would find it to their advantage to put rather better workmanship into it.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

155. Describe in detail how you would carry out an evaporation test on a boiler in an electric light station fitted with feed-water heater.—T. R. H.

156. When a dynamo (shunt-wound) is to be rewound to give double its former voltage, how could the rewinding of the field magnets be dispensed with? Discuss the dangers of separate excitation in this case.—C. M. M.

ANSWERS.

Question No. 149.—How can the dryness of steam be ascertained? Also, how would you tell if a boiler was passing water into the steam-pipes?

Best Answer to No. 149 (*awarded* 10*s.*).—Prof. J. A. Ewing, in his valuable work on "The Steam-Engine and other Heat Engines," gives three methods for ascertaining the dryness of steam formed in a boiler. The "dryness fraction"—*i.e.*, the proportion of saturated steam, by weight, in the steam and water mixture coming from the boiler—is denoted by q. The first method described is that known as the "barrel" calorimeter test. In this steam is blown from the boiler into a barrel containing water whose initial weight and temperature are known. After steam has passed for some time the supply is stopped, and the weight and temperature are again taken. Assume the initial weight of water to be W_1 and the final weight W_2. The increase in weight—*i.e.*, the weight of steam mixture passed in—is evidently $W_2 - W_1$. The heat given up by the steam mixture is equal to the increased heat in the water, provided that radiation and the thermal capacity of the barrel are small or negligible. Further, let t_1 and t_2 be the initial and final temperatures of the water, and t the temperature of the steam, which may be obtained from a table showing the relation of pressure and temperature. The heat given up by the condensing steam per pound is $q\,L + h - h_2$, where h is the heat required to raise a pound of water from 32° F. to $t°$, and h_2 is a similar quantity for $t_2°$. For all practical purposes, $h - h_2$ may be taken equal to $t - t_2$. The heat absorbed by 1lb. of water in raising from $t_1°$ to $t_2°$ is similarly $h_2 - h_1$. There are W_1 pounds of water and $W_2 - W_1$ of steam, and hence

$$(W_2 - W_1)\,(q\,L + h - h_2) = W_1\,(h_2 - h_1),$$

an equation in which q is the only unknown. This method is liable to error by reason of the difficulty in accounting for radiation losses and the thermal capacity of the barrel, and, further, because of the difficulty in weighing the quantities exactly.

The second method described is the Barrus calorimeter method, which gives more accurate results, as the steam does not mix with the condensing water but circulates in a pipe contained in a vessel of water, forming practically a surface condenser. The water is kept circulating, and passes after being warmed by the steam condensing in the pipe. After a time the temperatures at the inlet and outlet stand constant at $t_1°$ and $t_2°$, say. The water formed by condensation also passes out through a stop-cock at a temperature $t_3°$, its initial temperature being as before $t°$. When a steady condition is obtained, the amount of water used for cooling in a given time is noted and weighed—say, W pounds—and also the amount of steam mixture condensed and cooled down is obtained, say w pounds. Then, as before,

$$W\,(h_2 - h_1) = w\,(q\,L + h - h_3),$$

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from which q is easily found. There is a small radiation correction to make in this case also, which may be determined experimentally.

The third and last method described by Prof. Ewing—a method which is also described in the *American Electrician*, vol. ix., 1897, pp. 230-231—is that which employs the "throttling" calorimeter. In this apparatus the principle relied on is that, when the pressure of the steam is lowered by expansion, heat is liberated, and this heat is sufficient to evaporate any moisture which may be present in the steam, and to slightly superheat the dry steam thus produced. The wet steam is passed through an adjustable throttle valve into a large chamber, the inside walls of which are coated with non-conducting material. Its pressure and temperature in this chamber are measured by a thermometer inserted through the wall of the chamber, and a steam-gauge also attached. The steam passes away through another stop valve. These two valves are adjusted until the steam in the chamber is seen to be a little superheated, which will be shown when the temperature—say t_1'—of the steam in the chamber is a little above the temperature—say t_1—which would correspond to the pressure, p, of the steam if it were saturated only.

If L be the latent heat at $t°$, the temperature of the steam mixture entering the chamber, and h, the heat required to raise 1lb. of water from 32° to $t°$, and if L_1 and h_1 be similar quantities for $t_1°$, then, remembering that if no heat be lost to the walls of the chamber, the "total heat" (this being the heat which would be given out by steam condensed and cooled down to 32°) per pound is the same for steam entering the chamber as for steam expanded in the chamber, we get the relation

$$q\,L + h = L_1 + h_1 + k\,(t_1' - t_1),$$

where k is the specific heat of steam superheated under constant pressure, the value of k being about 8·48. From this q is found. The applicability of this method is limited, because it is only possible to superheat the steam if it has less than a certain quantity of water initially present. Ewing gives this as 4 per cent. for steam at 100lb., a quantity which may be increased to 6 per cent. by passing the steam to a condenser. But the *American Electrician* places the limit at 2·5 per cent.

The second method is apparently the most accurate for general purposes. For further information reference should be made to Ewing's book, from which the above methods are taken.

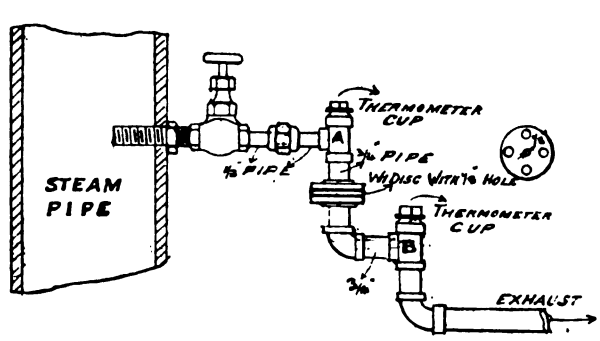
As regards the second part of the question, which refers to the passing of water from the boiler to the steam-pipes, no definite rules can be laid down, but in each separate plant it is possible to ascertain generally the normal amount of water carried over by the steam and produced by condensation in the pipes, etc., simply by observing the quantity given off by the drain-cocks and the steam-trap, and, further, by comparing the expansion curve of the engine indicator diagram with the theoretical expansion curve for dry saturated steam. If this difference becomes abnormally large, or if an abnormally large quantity of water is passed by the drain-cocks and steam-trap, or if the relief valves on the cylinders start a continuous clicking, it may be taken for granted that the water in the boiler is being "lifted by the steam.

Sometimes a test is made by putting salt into the water in the boiler. If the steam is dry on leaving the boiler it will carry no salt, but if it contains water there will be salt in solution with the water, and the condensed water if evaporated will leave a solid residue of salt. This, however, is not very reliable, as in cases the dry steam may carry over small quantities of salt. But it is useful in cases where the "lifting" is serious. Generally, however, the indications enumerated above will be sufficient to show whether water is coming in quantities with the steam.

The cause of the defect known as "lifting" is generally traceable to dirty water in the boiler or to working the boiler with the water at too high a level, or to making sudden demands for steam by rapidly varying the engine load. The remedy is to have clean water, to feed regularly at a moderate level, and to run the engine as regularly as possible. If the water be not clean, the defect is incurable. In one particular case, with a locomotive type of boiler where there was very bad "lifting," a perforated plate was actually inserted between the pipes about 1in. above water-level without having the slightest effect. In this case the water was very dirty. The knowledge, then, of the state of the steam as regards wetness can only be obtained by experience in each particular case.—T. C.

Answer to No. 149 (*awarded* 5*s.*).—The quality of steam generated in a boiler is generally ascertained by means of some form of calorimeter. Formerly the standard apparatus for this test was the barrel calorimeter, which consisted essentially of a barrel or other good non-conducting vessel placed upon a scale. Into this was led a pipe from the boiler to be tested, and also a thermometer. Then by measuring the increase in weight of the barrel and the increase in temperature of the water, it is possible to arrive at the quality of the steam generated. By this experiment, carefully carried out, and certain precautions taken, a fair estimate of the dryness of the steam may be obtained, but if much greater accuracy is required, a simpler and more reliable method is by means of the "throttling calorimeter."

The principle upon which this instrument works is that dry steam, when expanded from a higher to a lower pressure without doing external work, becomes superheated, the amount of superheat depending upon the two pressures. If any moisture be present, this, of course, must be evaporated before superheating commences. The sketch below shows the form of the instrument in general



use. Steam is taken from a ½in. pipe which is led into the steam-pipe, projecting into the latter some few inches; it then passes through two ¾ tees, A and B, situated on opposite sides of a ¾in. flange union; between the flanges of this union is inserted a piece of sheet wrought iron having in its centre an ⅛in. orifice. In each of the tees mentioned above is screwed a thermometer cup, and after passing the second one the steam is finally led away by means of a pipe of sufficient area to prevent any back pressure. The whole instrument is wrapped up in hair felt or some other non-conducting substance. Then, presuming that there is no back pressure in the exhaust, and no appreciable loss from radiation in passing through the instrument, the total heat in the mixture of steam and moisture before throttling and the amount in the superheated steam subsequently should be equal, and will be expressed by the equation:

$$H - \frac{x\,L}{100} = 1{,}146{\cdot}6 + {\cdot}48\,(t - 212);$$

or

$$x = \frac{H - 1{,}146{\cdot}6 - {\cdot}48\,(t - 212)}{L} \times 100;$$

in which H = the total heat above 32° in the steam at boiler pressure;
x = percentage of moisture;
L = the latent heat in the steam at boiler pressure;
1,146·6 = total heat of steam at atmospheric pressure;
t = temperature of lower thermometer;
212° = temperature of any steam at atmospheric pressure.

The boiler pressure is indicated by the reading of the upper thermometer, but if the instrument is not well lagged, as mentioned above, this reading will be too low, and it should be checked by means of the steam-gauge on the boiler.

It should be mentioned here that there is a limit to the range of this instrument, which is reached when the amount of moisture in the steam is greater than that taken up in

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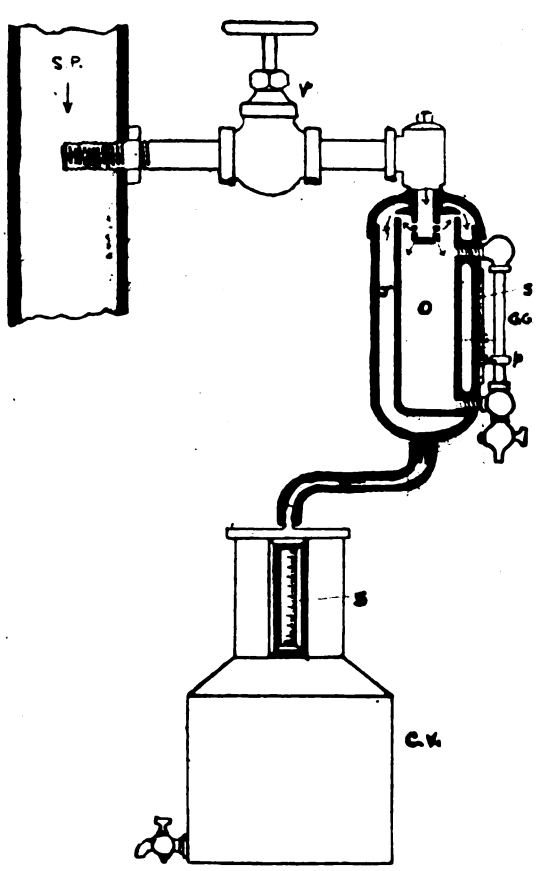
superheating; if this happens, then a steam-pocket must be inserted, into which the condensed steam falls; the amount in this must be weighed, and its percentage of the total steam passing the pocket must be added to the result obtained from the calorimeter test.

Finally, extreme care must be taken that the instrument is thoroughly heated up before commencing the test, that the thermometer read absolutely correctly, that all the joints are perfectly tight; in other words, great precautions must be taken on every hand to obtain accurate results.—H. F. E. B.

Answer to No. 149 (*awarded* 5*s.*).—The best method of ascertaining the dryness of steam is by means of a calorimeter. There are various forms of this instrument on the market, that illustrated herewith being one of the *separating*



Carpenter's Calorimeter.

type, designed by Prof. Carpenter, of Cornell University. The calorimeter consists of a circular vessel about 12in. × 3in., and is shown in section. The steam whose quality is under test enters at the top of the calorimeter, and passes direct into the inner chamber, O. Here the moisture is precipitated and collected, the actual quantity being shown by gauge, G G, to which is fitted pointer, *p*, and scale, S. The dry steam passes into an outer chamber, which forms a jacket to the inner chamber, maintaining it at a constant temperature. From this outer chamber the steam is led by a pipe to the bottom of a condensing vessel, likewise fitted with a scale, the pointer of which is adjusted to zero by a certain quantity of cold water put into the vessel at the commencement of the test. The scale of the calorimeter is graduated to read in hundredths of a pound at a temperature corresponding to steam of ordinary working pressure. The scale on the condensing vessel is graduated to read in pounds and tenths at a mean temperature of 110deg. F.

Let us suppose now a test is made of sufficient duration to nearly fill calorimeter gauge—representing, say, W_1 pounds of moisture. The reading on gauge of condensing vessel will represent weight of dry steam, say W_2 pounds.

Then *per cent. of moisture* $= y = \dfrac{W_1}{W_1 + W_2} \times 100.$

The *per cent. of dry steam.*

$$= x = (100 - y) = 100 - \left[\frac{W_1}{W_1 + W_2} \times 100\right].$$

For example:

Calorimeter scale reading in actual experiment—

Initial	·005lb.
Final	·256lb.
Water in calorimeter	·251lb.
Condensing vessel readings—	
Initial	·01lb.
Final	15·42lb.
Weight of dry steam	15·41lb.

$$\therefore \text{Percentage of moisture} = \frac{·251}{·251 + 15·41} \times 100.$$

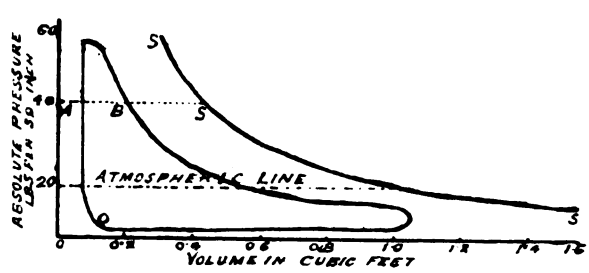
$$y = 1·605 \text{ per cent.}$$

Quality of steam $= x = 100 - 1·605 = 98·395$ per cent.

In carrying out a test, the sample should be taken from a vertical pipe, and the calorimeter erected as close to it as convenient. The connecting pipe to the calorimeter should, of course, be well lagged. Steam should be allowed to blow through till the whole is thoroughly heated, and the two scales either adjusted to zero or read carefully before starting the test.

To tell if a boiler was passing water into the steam-pipes might be possible in extreme cases from general observations. Thus excessive priming could be detected by abnormal discharge from drain-pipes, separators, etc. The amount of feed water used might be compared with the rated evaporative efficiency of the boilers, and should bear a reasonable comparison with the estimated consumption per indicated horse-power of the engines. The presence of moisture in the engine cylinder can, of course, be determined with fair accuracy from the indicator diagram. Initial condensation and expansion account for this, no doubt, in ordinary cases, but an excessive quantity would lead one to suspect other causes—priming, for example.

The accompanying diagram represents that of a small marine engine tested by Prof. Ewing. S S is the saturation curve. If through any point B on the expansion curve



A B S be drawn to intersect the expansion curve at B, A B is the actual volume which the expanding mixture filled at this pressure, while A S is the volume it would have filled if dry and saturated. B S is thus the volume lost by wetness. Hence the proportion of water in the mixture is sensibly $\frac{B\,S}{A\,S}$, and dryness fraction $q = \frac{A\,B}{A\,S}$.—A. M. O.

Question No. 150.—Describe what you consider to be the best two methods of securing steam-tight joints on high-pressure steam-pipes.

Best Answer to No. 150 (*awarded* 10*s.*)—The joints of a steam ring or main are always a source of trouble, more especially where steam of high pressure is used. The best method of making a joint depends to a great extent on the position of the steam-pipe, whether it can be got at easily or not. Sometimes it is not possible to separate the different sections more than an inch or so in order to make a joint, and in this case I have always found the metallic ring spread with putty the most reliable and lasting. Suppose now in a steam ring or main a joint blows, the best way to proceed is as follows: If the sections are heavy, they will require shoring, or they will drop when the bolts are taken out. Having done so, slack back all nuts and remove bolts. Next drive in three wedges at different points round the joint until it is open sufficiently to scrape it. The joint clean, a metallic ring is now spread with two parts red lead and one part white lead, mixed up together with a little boiled oil as thick as

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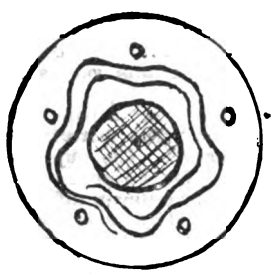
common glaziers' putty. Some engineers use a cement, but, in my opinion, it is not so good as the above compound, as it sets too hard and entails much labour and time to scrape off when a joint is remade. Now replace three bolts (on which, of course, the nuts have been made to run easily) in the bottom holes of flange and drop the ring carefully in, which should just clear the inside of the bolts all round. Of course, the wedges will require shifting in order to do this. Replace, now, the whole of the bolts and knock out the wedges. Screw up the joint equally all round and the job is done. When jointing copper pipes undue pressure on the bolts should be avoided, as sometimes the



outside edges of the flange are drawn in over the ring, causing it to become hollow, and the joint will blow worse than before. I knew a case where a joint blew three times in succession, and in the end the flanges had to be refaced.

The next best method of making a joint where the pipe may be taken down is by scraping the joint clean and spreading with the same compound as above, and then laying on about two turns of thin lead wire inside the bolt-holes, as shown. This makes an excellent joint when screwed up, and I have made many this way which have remained perfectly tight under steam pressure at 175lb. per square inch. Asbestos is not suitable for steam-ring joints. The contraction and expansion of the pipes cause leakage, and they need following up with the spanner several times after making.—F. BRUTON.

Answer to No. 150 *(awarded* 5*s.).*—One method of connecting and making tight joints of pipes for high-pressure steam is by using Taylor's corrugated metallic discs (see Fig. 1), made in different sizes to suit different diameters

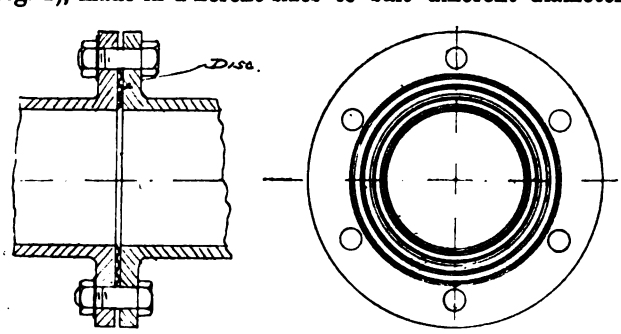


FIG. 1.

of pipes. This disc makes a good joint with very little trouble, just requiring each side coating with red-lead paint, centering between the flanges and screwing up. One great advantage of this method is that, in remaking a joint, it is not necessary to spring the flanges very far apart, as in the

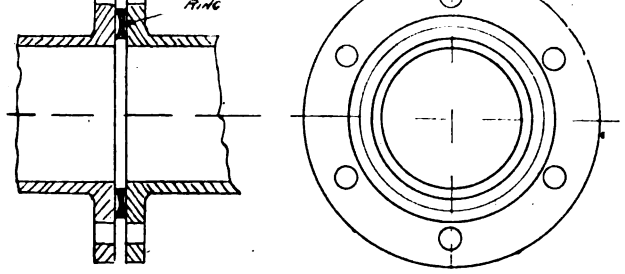


FIG. 2.

case of many other methods, neither is there any red lead or other sticking compound to chip off before the flange faces are ready again. Fine copper-gauze rings are sometimes used in conjunction with these discs. Another method is to use the soft copper joint rings (see Fig. 2). These rings, like the discs, are made to suit different diameters. They are placed in position between the flanges, and when the bolts are screwed up the sharp copper edges give to the shape of the flange face and make a tight joint.—E. M. H.

ELECTRIC LIGHTING OF MAIDENHEAD.

The following is the full text of the report of Messrs. Burstall and Monkhouse, the consulting engineers to the Maidenhead Council, on the electric lighting question. The report, which has been referred to the Electric Lighting Committee, together with the maps and plans referred to, is dated March 17, and reads as follows:

Dear Sir,—In accordance with the instructions of the Electric Lighting Committee, and in reference to your letters of Feb. 18 and 28, we have worked out the capital cost of the initial installation of a capacity to supply the demand likely to arise in the streets mentioned in yours of Feb. 18, and which are given in the schedule below and shown on the maps sent with this, together with 35 arc lamps and also the sewage pumping station. We give our estimates in the appendix marked as Scheme D. This scheme includes about 8,200 yards of distributing main, as against about 1,500 yards included under Scheme B.

Public Lighting.—The proposed positions of the arc lamps are shown on the map, but these positions can be varied between somewhat wide limits without affecting the estimates. We have assumed, for our estimates of costs and income, that the arc lamps will be lit from dusk to 12 o'clock all the year round (about 2,200 hours per year). At 12 o'clock the arc lamps would be switched off and replaced each by two 16-c.p. incandescent lamps, which would run until daylight (about 2,200 hours per year). These lights would not, of course, give any great amount of light in the streets, but, we think, would be quite sufficient for the purpose. If the Electric Light Committee charge the Corporation the absolute cost price for current, carbons, renewals, etc., this would be about £16 per lamp per year, but we think the figure given in our first report—viz., £18. 10s.—should still be taken in the estimates, so as to allow for interest and sinking fund.

Private Lighting.—We have provided distributing mains in the streets marked on the map in blue lines, and have taken the number of lamps which might be expected to be connected to the mains at the end of the first year's working as 2,700 for the whole district shown, and this, we think, is putting the number low. We have allowed for each lamp using 18 units per year, a figure which has been exceeded in several towns, especially in the first year of working. In this connection, we would point out that in the first year a number of lamps are put on circuit which, like those in shop-windows, are run for long hours, and it is not until later that lamps which are only occasionally used are connected. It is also to be expected that consumers will not be so economical during the first year as afterwards. The price taken for private lighting is an average of 7d. per unit, which, if some sliding scale were adopted, would about correspond to charging at the rate of 8d. per unit for the first hour's burning per day and 4d. per unit after that.

Fisheries Estate.—The capital cost of laying mains in this district would be about £800, and would, we consider, be a good investment, as the number of lamps to be expected in this district would be fairly large in comparison to the cost.

Sewage Pumping.—We have allowed for power for this, and have assumed the same income as in our first report.

Launch Charging.—We have taken the income expected to be derived from this as £150, as estimated by Mr. Pearce.

Provisions for Extension.—We have allowed in our estimate of capital cost for spare ways, for new feeders, and for distributing mains of sufficient size, so that it would not be necessary to lift the roads in any of the streets covered in this scheme for future extensions, at any rate for some years to come.

Power Provided.—We have provided for machinery at the central generating station of sufficient power to run the 35 arc lamps, the sewage pumping plant, and about 2,650 lamps each of 8 c.p. on at once, still leaving sufficient spare plant. This would allow of about 3,800 lamps being connected to the mains without extension being required at the station. We do not recommend that smaller plant than this should be installed, even at first. We have also provided a battery of somewhat large capacity in comparison with the size of the station, so that the incandescent street lights, the sewage pumping plant, and such lights in private consumers' premises as may be on during the night can be run from 12 o'clock midnight until seven or eight o'clock the next morning, thus saving one shift of men. If no complete spare plant were provided the capital cost would be reduced by about £1,000, and the interest and sinking fund would be reduced by £51. 5s. per year. If this saving is con-

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sidered advisable it might be possible to do without complete spare plant for the first winter, using the battery as a stand-by.

The prices of machinery, cables, etc., have risen considerably since our last report, and we have allowed for this in the estimates given with this report.

It will be seen, from the estimates, that with this scheme the installation might be expected just to pay its way or make a small deficit on the first complete year's working; this will, of course, depend entirely upon how the consumers come on, and must be taken as an estimate only. We have not allowed for any extra labour for trimming and cleaning the public lamps, as we believe we have allowed sufficient for this in the labour item; at any rate, for the first year.

(Signed) BURSTALL AND MONKHOUSE.

TABLE OF ESTIMATED COST, INCOME, AND ANNUAL EXPENDITURE.

SCHEME D.

1. *Capital Cost.*	£	s.	d.
Plant at generating station	7,780	0	0
Cables and mains	3,310	0	0
Roadwork	2,205	0	0
Arc light mains, lamps, and lamp-posts	1,250	0	0
House services and meters	900	0	0
Contingencies	1,000	0	0
Buildings	4,000	0	0
Professional charges	1,022	0	0
	£21,467	0	0

2. *Estimated Income.*	£	s.	d.
Private lighting, 2,700 lamps, each consuming 18 units per year at 7d. per unit	1,417	10	0
Public lamps, 35 at £18. 10s.	647	0	0
Sewage pumping	290	0	0
Launch charging	150	0	0
Meter rents	100	0	0
	£2,604	10	0

3. *Estimated Annual Expenditure.*	£	s.	d.
Coal	325	0	0
Wages	862	0	0
Engine-room stores, etc.	100	0	0
Carbons for arc lamps	40	0	0
Lamp renewals	9	0	0
Repairs and maintenance	200	0	0
	1,536	0	0
Interest and sinking fund, 5⅛ per cent. on £21,500	1,102	0	0
Deficit, £33. 10s.	£2,638	0	0

Schedule of Streets in which Distributing Mains are Proposed to be Laid (Scheme D).—King-street, one side; Queen-street, one side; High-street, from Marlow-road to bridge, both sides; Bridge-street and Bridge-road, one side; Ray Park-avenue (part), one side; Ray Mead-road to Thames Hotel, one side; Market-street, one side; Cookham-road to Norfolk Arms, one side; Marlow-road to Craufurd-rise, one side; Castle-hill, one side; The Terrace, Castle-hill, one side; Bath-road to All Saints'-avenue, one side; Fisheries Estate. Total length about 8,200 yards.

PHYSICAL SOCIETY.

At the ordinary meeting on March 24, 1899, Prof. Oliver Lodge, F.R.S., president, in the chair, **Mr. W. R. Cooper** read a paper by **Mr. A. P. Trotter** on "**The Minor Variations of the Clark Cell.**" The author describes a series of experiments, in which he compared the E.M.F.'s of certain standard cells at frequent intervals from July, 1896, to February, 1897, at Cape Town, where the temperature of the double box containing the cells varied between the limits 13deg. C. and 28deg. C. One cell was selected for comparison with all the others. No special precautions seem to have been taken to keep the temperature of this selected cell constant. The observed differences between the E.M.F.'s of the respective cells rarely exceeded 0·001, corresponding to about ¼in. on the slide wire of the potentiometer. Details as to the area of the slider contact are not stated; the readings were generally taken to the fourth decimal—*i.e.*, to one-tenth of a millivolt, and occasionally to one-fourth of this. Temperature was read to 0·1deg. C. on a mercury thermometer placed through a hole in the double box containing the cells, not in the cells themselves.

Mr. R. H. Griffiths said that the paper appeared to have value only in so far as it showed that Clark cells at Cape Town behaved in a manner that agreed with common knowledge and general experience everywhere else. Their variations depended upon shifts of temperature, and the consequent changes in the degree of saturation of the liquid. From his own experiments during seven years upon 42 Clark cells, he had shown that if temperature was kept constant to within 0·01deg. C., the steadiness and uniformity of all the E.M.F.'s was most remarkable. They started with discrepancies, but at the end of the time it was impossible to detect any differences. It was of little use to put a thermometer anywhere but within the cells; very slight changes of temperature caused serious changes in the degree of saturation of the liquid. The existence of the capricious lag of E.M.F. behind temperature precluded the possibility of formulating a temperature correction for Clark cells. In the case of Callendar cells there was no lag; their E.M.F. varied slightly with temperature, by a definite amount, which could be corrected by a coefficient.

Mr. W. R. Cooper said the method of comparison used by the author was unsuitable, because to arrive at the differences of E.M.F. necessitated the measurement of the E M.F. of each cell. The variations only amounted to a few ten-thousandths of a volt. The length of potentiometer wire corresponding to a thousandth of a volt was only ¼in.; under such conditions it would be difficult to ensure accuracy. A method of opposition would have been preferable. Mr. Cooper had found that Board of Trade cells only vary about one ten-thousandth of a volt between themselves from day to day. Cells of the H form vary about one-fifth of that amount.

Prof. J. D. Everett then read a paper by **Dr. E. H. Barton** and **Mr. W. B. Morton** on "**The Criterion for the Oscillatory Discharge of a Condenser.**" The object of the paper is to enquire how the condition for the oscillatory discharge of a condenser is modified when the ordinary differential equation of the second degree is supplemented by the terms added by Maxwell to take account of the distribution of current in the (straight) wire. The coefficients of these terms are relatively small, so that the algebraic equation giving the periods is a quadratic with small terms of higher order added. The effect of these higher terms is, first, to introduce very rapid vibrations of small amplitude, and, next, to displace the roots of the unaltered quadratic. The nature of the discharge, oscillatory or non-oscillatory, may be taken to be determined by these principal roots, and the critical case is when they are equal. The condition for equality is obtained by the property of the derived function, as a series of powers of the small coefficients of the equation, which may be carried by successive approximation as far as is desired. The paper also treats the question by an alternative and more physical method, which consists in replacing the resistance, inductance, and capacity that occur in the ordinary formula by modified values. This gives the criterion correct to the third order in the small terms. It is shown that a condenser satisfying the critical condition on the simple formula would, when the added terms are taken into account, give an oscillatory discharge.

Prof. Lodge said that the result naturally to be expected of "throttling"—viz., the increase of resistance and decrease of self-induction, due to the current keeping to the outside of the conductor—would tend rather to damp out the oscillations than to favour them.

Prof. Everett observed that the equation was no longer a quadratic, and that the quadratic criterion as to whether the discharge was oscillatory or non-oscillatory did not hold. The paper appeared to be consistent with itself, and he considered that the authors had satisfactorily proved, in their discussion of the equation of current, that the effect of "throttling" was to *increase* the tendency towards the oscillatory mode of discharge.

Prof Lodge admitted that the quadratic criterion did not hold; he thought it most likely that the authors, who evidently had gone into the matter with care, were right. At the same time, he wished to call attention to the singular and unexpected character of their conclusion. If it turned out that it was correct—*i.e.*, that there was no slip in sign—it was a result upon which he would desire to congratulate them.

The **President** proposed votes of thanks, and the meeting adjourned until April 21.

COMPANIES' MEETINGS AND REPORTS.

WILLANS AND ROBINSON, LIMITED.

The ordinary general meeting of this Company was held last week at the Cannon-street Hotel, E.C.

Mr. Mark Robinson, who presided, said that after writing off £5 013 for depreciation, and paying interest on debenture stock, the balance to the credit of the profit and loss account was £25,069. Out of this it was proposed to pay dividends of 6 per cent. per annum on the preference shares, and 10 per cent. per annum on the ordinary shares, altogether amounting to £12,000. The amount payable to the original directors was £3,863, leaving a balance of £9,206. From this the directors proposed to carry £2,000 to the debenture redemption sinking fund, and £3,500 to the reserve fund, leaving a balance of £3,706. 4s. 1d. to be carried forward. He pointed out that the sums reserved out of profits in the five years—viz., £25,146. 9s. 11d. in the reserve fund, £10,000 in the debenture redemption fund, and the balance of £3,706. 4s. 1d. now carried forward—amounted together to £38 852. 14s., and this sum exceeded the amount paid for the goodwill of the business. The last year, and more particularly the last half year, had been marked by a great increase in the demand for the special class of machinery which they manufactured. There had also been a rapid increase in the size of the engines the Company was called upon to supply. Twelve months ago it had been announced that an engine was on order to develop as much as 1,500 h.p.—a notable advance upon the sizes previously made by the Company. Six months ago the directors were able to state that the number of such engines on order had

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increased to four. The number then on order was 16, and there was reason to expect that much larger sizes would be called for. The directors believed that the increased demand for engines would be permanent, and that it would continue to increase to an extent far exceeding their present producing powers. The directors, therefore, recommended that the plant should be increased, and that larger and more powerful tools should be provided. The directors also considered that the manufacture of the Niclausse boiler should be taken up upon a larger scale than had hitherto been contemplated, or than was possible at Rugby. Under these circumstances the directors proposed to make the existing boiler shop at Rugby into an additional machine shop, and also to double the size of the foundry. They proposed to erect separate boiler works upon a site which had been secured near Chester, on the Dee, which had the advantages of cheap sea carriage for materials and easy railway communication with Rugby and other centres. This had had the very careful consideration of the directors, who were satisfied as to its necessity. It would render necessary an increase of capital, and the meeting would be asked to authorise the creation of 40,000 new shares of £5 each to provide for the necessary new buildings and plant, and to supply additional working capital.

The retiring directors (Sir Gilbert Augustus Clayton-East, Bart., and Mr. Thomas Orger Lazenby) were then re-elected.

At an extraordinary general meeting held afterwards, the proposal to issue the new stock was agreed to.

LIVERPOOL AND DISTRICT LIGHTING COMPANY.

The annual meeting of the Liverpool and District Lighting Company was held last week at the Company's offices, Hackinshey, Mr. A. Hill Holme presiding.

The **Chairman**, in moving the adoption of the report and accounts, said they had made a small profit on the year's working after paying all expenses. They had done a good deal of contracting work, which, they believed, would increase. During the greater part of the year they had only a loss to record, but the last three months not only made up this loss but showed a profit. In January, 1898, they supplied at Waterloo 508 lights, which had increased to 2,253 lights by January, 1899, and at the present time they supplied 2,760 lights, a figure that was being added to every day. In the Gateacre district they had 1,098 lights, and proposed to largely increase that number. The directors had decided to reduce the price to 6d. per unit, and the same price would be charged in the Gateacre district after July 1. They had ordered two large engines for the Waterloo district, which were of the most modern type, and the same as those used by the Liverpool Corporation. These engines would be ready in July. The new engines at Gateacre were working satisfactorily. At Waterloo they had adopted the principle of free wiring for customers who paid 1d. extra. They were making a call which would bring in £9,500, for while they had enough money to do all the work in hand, yet they would require to pay their contractors for laying mains, while the new engines would be delivered in July, and they would require money to pay for them. In January last their expenses at Waterloo were £52. 10s.. and their receipts £124. 4s., leaving a balance of £71. 14s. In February they had a balance of £65. 11s. 9d. This was with 2,000 lights, and when they had 3,000 lights the expenses would not be materially increased, while the income would be largely augmented. Therefore instead of a profit of £150, they would have something like £1,200 or £1,500 next year.

The report was adopted, and Mr. A. H. Holme and Mr. John Naylor were re-elected directors. Mr. W. L. Jackson was reappointed auditor.

A vote of thanks to the chairman terminated the proceedings.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Salford.—The Electric Light Committee are prepared to receive tenders for the various stores.

Bristol.—The Electrical Committee require tenders for high-tension switchboards, instruments, etc. Tenders by April 10.

Wimbledon.—The Urban District Council are about to call for tenders for wiring the electric lighting station.

Tynemouth.—The Corporation are prepared to receive tenders for the various electrical plant. Tenders by noon on April 15.

Reigate.—The Town Council are prepared to receive tenders for the supply and erection of various electric plant. Tenders by May 1.

Edinburgh.—The Corporation invite tenders for installing the electric light at the City Chambers (extension buildings). Tenders by April 10.

Peterborough.—The Corporation are prepared to receive tenders for the supply and erection of the plant for the municipal electricity works. Tenders by April 20.

Bradford.—The Corporation invite tenders for the supply of a complete battery and switchboard for the electric light station, Bolton-road. Tenders by April 12.

Dublin.—The Directors of the Great Northern Railway Company (Ireland) invite tenders for the various works in connection with their line between Sutton and Howth, near Dublin. Tenders by April 20.

Epsom.—The Urban District Council are prepared to receive tenders for the supply and erection of various electric plant. Tenders by 12 o'clock noon on May 8.

Buxton.—The Urban District Council invite tenders for the following works in connection with their electric light station in Buxton: (Contract No. 7) arc lamps; (8) arc lamp posts. Tenders by April 17.

Hull.—The School Board invite tenders for an adequate installation of the electric light at their central higher-grade school and school of science in Brunswick-avenue, Beverley-road. Tenders by 25th inst.

Poplar.—The Board of Works invite tenders for engine and pump room equipment and all electrical plant in the works except the battery, boiler-house equipment, battery and battery stands, and public street lighting. Tenders by 10 a.m. on April 25.

St. Pancras.—The Vestry invite tenders for the following additional plant at the Regent's Park station, at an estimated cost of £19,000: two 750-h.p. engines with dynamos, condensing plant, air pumps, steam and exhaust pipes, etc., two boilers, fixed, including foundations and seatings complete.

Leeds.—The Markets Committee of the Leeds City Council invite tenders for electric lighting required at the new dead-meat market and abattoir, now in course of erection in New York-street, Leeds. Particulars may be obtained upon application at the offices of Messrs. Walter Hanstock and Son, architects, Branch-road, Batley. Tenders by April 8.

St. Helens (Lancs.).—The Electric Supply and Tramways Company invite tenders for the construction of about six miles of tramways in sections Specifications, etc., may be obtained from Mr. Geo. J. C. Broom, M.I.C.E., borough engineer, on payment of £2. 2s., which amount will be returned on receipt of a bona fide tender. Tenders by 12 noon on 19th inst.

Edinburgh.—The Lord Provost, Magistrates, and Council invite tenders for installing the electric light at the City Chambers (extension buildings). Specifications, etc., can be obtained at the office of the Resident Electrical Engineer, 5, Dewar-place, Edinburgh, on deposit of £2. 2s., which deposit will be returned on receipt of a bona fide tender. Tenders by April 10.

South Shields.—The Corporation invite tenders for the supply and erection of steam and water pipes and valves, and a 15-ton hand-power overhead travelling crane. Specification, etc., may be obtained from the Borough Electrical Engineer, West Holborn, South Shields, on payment of £1. 1s., which sum will be returned on receipt of a bona fide tender. Tenders by noon on April 20.

Derby.—The Corporation invite tenders for the works in excavations, foundations, engine-bed and retaining wall in connection with extensions to the electric lighting station, Derby. Specifications, etc., may be obtained on payment of £2. 2s. (to be returned if a bona fide tender be made) on application to the office of Mr. Arthur Eaton, architect, 6, St. James's-street, Derby. Tenders by 12 noon on April 10.

West Ham.—The County Borough Council invite tenders for two 1,500-i.h.p. engines, two 800 kw. alternators and exciters, or two 800-kw. 1,500-i.h.p. steam alternators and exciters. Specification, etc., may be obtained from the Borough Electrical Engineer, Abbey Mills, West Ham, on the deposit of a £5 Bank of England note, which will be returned on receipt of a bona fide tender. Tenders by 4 p.m. on April 25.

Hampstead.—The Vestry invite tenders for the supply, delivery, and erection of electrical plant, including steam alternators and engines, switchboard panels, boilers, feed-water heaters, vertical steam feed pumps, exciter, water-softening plant, air pump and condenser, Green's economiser, and overhead travelling crane. Particulars may be had of Mr A. P. Johnson, vestry clerk, to whom tenders must be sent by 12 noon on May 18.

Belfast.—The Electric Committee invite tenders for the supply and erection of the following: (Section C, 8) mechanical stokers; (C, 9) economisers; (C, 10) pipe work; (C, 11) condensing plant. Specifications, etc., may be obtained on application to Mr. Victor A. H. M'Cowen, city electrical engineer, on payment of £1. 1s. per copy, which sum will be refunded on the return of the specification with a bona fide tender. Tenders by noon on 20th inst.

Dudley.—The British Electric Traction Company, Limited, invite tenders for the construction of about 2½ miles of tramway permanent way from Dudley to Cradley Heath, Staffordshire. Specification, etc., may be obtained from the Company's permanent-way engineer, Mr. W. Howard-Smith, A.M.I.C.E., Donington House, Norfolk-street, Strand, London, W.C., on payment of £2. 2s., to be refunded upon return of documents. Tenders by April 14.

Perth.—Applications will be received at the City Council Office from persons desirous of applying for a concession for the installation and working of a system of electric lighting for the municipal buildings and streets of the city of Perth, as well as house-to-house lighting. Conditions of contract and full particulars may be obtained on application to the Agents-General for Western Australia, 15, Victoria-street, Westminster, London, or Gordon and Gotch, St. Bride-street, Ludgate-circus, E.C. Tenders by May 2.

Rochdale.—The Guardians invite tenders for a complete electric light installation at the workhouse buildings and cottage homes. Specifications, etc., may be obtained from the consulting engineers, Messrs. Crews and Handford, Cross-street-chambers, Manchester, on payment of a deposit of £5 Bank of England note. Deposit will be refunded to each unsuccessful contractor as soon as the work is placed, providing a bona fide tender has been received

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within the stated time and is not withdrawn subsequently. Tenders by April 12.

Cape of Good Hope.—The Controller and Auditor-General of the Colony is prepared to receive at his office at Cape Town alternative tenders for the construction of a light or ordinary railway, with or without permanent-way materials and bridge-work, from Sir Lowry Pass Station to Caledon, about 53 miles in length. Further particulars, as soon as they shall have been received from the Colony, will be obtainable by intending contractors upon application at the office of the Agent-General for the Cape of Good Hope, 112, Victoria-street, Westminster, S.W. Tenders by noon on April 17.

Moscow.—Electric railways are to be provided for Moscow. The tenders must be submitted by October 1. We draw the attention of those wishing to tender to the fact that applications will only be received from such firms who have intimated their willingness to tender to the municipal authorities of that town by the 12th inst. A sum of 750 roubles has to accompany the letter as a deposit. Applicants will receive specifications, designs, etc., of similar lines laid down in the town during the last five years. These will be accompanied by the specifications, etc., for the intended line, translated into English, and by estimates indicating the prices between which the contracts will probably fluctuate.

RESULTS OF TENDERS.

Wolverhampton.—The tender of Mr. Henry Gough, Dudley-road, Wolverhampton, has been accepted for extending the engine-house and boiler-house of the Corporation's electric lighting station in Commercial road, at a cost of £1,424.

Gloucester.—The following tenders have been accepted: Messrs. Blake and Knowles, two sets of condensing plant, £567; Stanton Ironworks, Limited, condensing water pipes, £400; Messrs. Ashton, Frost, and Co., steam, exhaust, and drain and feed pipes, £1,185.

Hereford.—The Electric Lighting Committee have accepted the tender of Messrs. W. P. Lewis and Co. for the erection and completion of the electricity station buildings, etc., at £2,752, and the tender of Messrs. Alexander and Duncan for the ironwork at £394. 17s. 6d.

Islington.—In consequence of an error being found by Messrs. Johnson and Phillips in their tender for electrical stores, the firm have declined to complete the contract in so far as it relates to the supply of carbons. Under the circumstances the tender of Mr. Oscar Scholzig, of 8, New Broad-street, E.C., for carbons (items Nos. 1, 2, and 3) for one year ending March 25, 1900, has been recommended for acceptance.

Fulham.—The Vestry have received the following tenders for supply of mains, machinery, etc.:

General Electric Company, Limited	£45,718	7	10
Brush Electrical Engineering Company	47,282	0	0
S. Z. de Ferranti, Limited	49,339	17	2
Johnson and Phillips	49,927	6	0
J. Fowler and Co.	50,815	2	6
British Insulated Wire Company	51.524	8	6

Shoreditch.—The Lighting Committee of the Vestry have accepted the tender of Messrs. Nalder Bros. and Thompson, at £197, for the supply and erection of a new battery switch panel. They have also accepted the following tenders for annual contracts: Messrs. Williamson and Joseph, switches, ceiling roses, and cut-outs; Edison and Swan Company, incandescent lamps and arc globes; Mr. G. Braulik, shades, flexible wires, and insulating materials; General Electric Company, rubber tapes; Messrs. Johnson and Phillips, fuse and lead wires; Messrs. Crompton and Co., carbons; Messrs. Thos. Tilley and Sons, street lamps, cradles, and gasfittings; Messrs. Pryke and Palmer, ironmongery and tools.

BUSINESS NOTES.

Wigan.—It appears that good progress is being made with the electric lighting installation.

Epsom.—The Council have resolved to advertise for tenders for the installation of electric lighting.

Dungiven.—The installation of the electric light into Messrs. Semple's mills has just been completed.

Hereford.—It is expected that the Corporation will be able to light the city by electricity early in October.

Dublin.—We hear of a successful trial with electric motors made along Abbey-street and Gardiner-street.

Colwyn Bay.—The Council intend to apply for a loan of £4,000 to carry out the proposed electric lighting scheme.

Removal.—Messrs. Meirowsky and Co. have removed from 10, Glasshouse-street, W., to 52, Queen Victoria-street, E.C.

Barton.—The Guardians have decided to apply for a loan of £3,355 for plant for lighting the workhouse by electricity.

Morecambe.—The proposal to join Morecambe with Knott End by means of an electric tramway is being discussed by the Lancaster Rural Council.

Colchester.—A proposal for additional plant to meet the expected demand for electric light of the next two years has been referred to the borough surveyor for report.

Sale.—Readers are referred to an advertisement in this issue giving particulars of a sale by tender, pursuant to a judgment in an action *re* the Elieson Lamina Accumulator Company, Limited, the Earl of Galloway *v.* the company.

Grimsby.—Colonel W. A. Ducat, Local Government Board inspector, has held an enquiry into the Council's application for a loan of £43,500 on an electric supply scheme.

Stretford.—The Council have decided to apply to the Board of Trade for the renewal for a period of two years of the provisional order of 1897 relating to the supply of electricity.

Maidenhead.—The consulting engineers (Messrs. Burstall and Monkhouse) have furnished a further report and amended estimates upon the proposed electric lighting of the borough.

Hetton-le-Hole.—At a special Town Council meeting, it was decided to support a scheme of electric traction for Houghton-le-Spring and district, including Hetton and Easington Lane.

Burnley.—The Town Council have asked the National Telephone Company, Limited, to defer the laying of underground wires in the borough in view of the Government's Bill now before Parliament.

Notting Hill.—The Notting Hill Electric Lighting Company are about to lay mains in Holland road and street, across Holland Villas-road, in and across Campden House-road, and in and across Addison-gardens.

Harrington.—We learn that Messrs Bain and Co. intend to introduce a system of electric lighting into their works at an early date, also that they are prepared to supply the District Council with the same for public lighting.

Personal.—We are informed that Mr. Douglas C. Bate, A.M.I.C.E., the manager of the Stewart Electrical Syndicate, Limited, Charing Cross-road, W.C., has been unanimously appointed managing director of the company.

Bude.—The Parish Council have decided to adopt electric lighting as soon as the Bude Electric Lighting Company are ready to supply it. The company have offered to supply current at 4d. per unit, or an estimate of £1. 5s. per lamp per annum.

Edinburgh.—Estimates to the extent of £5 003. 18s. 4d. for work at the Macdonald-road power station have been accepted. The Council have also sanctioned £8,827 for the formation of the subway from Macdonald-road station up Leith walk to Picardy-place.

Pontefract.—The Guardians on Saturday last passed a resolution that the Building Committee be instructed to take steps to light the workhouse buildings with electric light. A probable saving of £100 to £180 per annum is estimated to result from this step.

Littleborough (near Rochdale).—Mr. W. C. C. Hawtayne's appointment of consulting electrical engineer to report upon the proposal to light the district by electricity has been confirmed by the Council. The preceding appeared in an earlier issue under "Rochdale."

Guildford.—The Council have agreed to a proposal made by the Board of Trade with reference to an alteration in the proposed extension of the area of the supply of the Guildford Electric Light Supply Company, Limited. This extension will include the whole of Worplesdon.

Ross.—At the next meeting of the Urban District Council a letter will be discussed from Messrs. Burt and Evans giving notice that, on behalf of some clients of theirs, not named, they intended applying for a provisional order for supplying the urban and rural parishes with electric light.

Felixstowe.—At the meeting of the Felixstowe and Walton Urban District Council on Wednesday, when discussing the lighting question, it was suggested that if the matter were adjourned for a month an electric lighting company would be in operation, and they would doubtless gladly light up the roads.

Argentine Electric Traction Company, Limited.—This Company has been registered, with a capital of £500,000 in £5 shares, and the object is to adopt and carry into effect an agreement with the Anglo-Argentine Tramways Company, Limited, to construct and work tramways either by electric or other methods.

Presentation.—The employés of the Folkestone Electricity Supply Company recently held a smoking concert at the Guildhall Hotel for the purpose of meeting Mr. Bishop, who is leaving Folkestone. During the evening a presentation was made to Mr. Bishop of a fitted leather dressing and writing case.

St. Annes.—The electrical engineer has presented his report to the Town Council. He estimates the cost of the proposed installation at £23,000. As the report far exceeds the previous ideas of councillors, the consideration of the same has been deferred until it has been further reported on by the electrical engineer of Preston.

Barrow.—An application is to be made to the Local Government Board for power to borrow £15,000 for extending the electric lighting, as the applications received almost exhaust the present producing capacity. It is only intended to spend £4,500 at present in order to cope with the demand. About 6,000 lights have been applied for.

Durham.—It is reported with reference to the application for a provisional electric lighting order that the Board of Trade have refused to give the Council power to sell absolutely, or even to lease the proposed powers. The Council are now in communication with the Board of Trade with the object of getting them to reconsider their decision.

Auckland Electric Tramways Company, Limited.—This Company has been registered, with a capital of £150,000 in £10 shares, and the object is to construct, purchase, lease, or otherwise acquire any rail or tram ways in Australasia; be carriers of passengers and goods, electrical engineers and contractors, and to establish and maintain telegraph and telephone systems, etc.

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Anglesey.—The Visitors to the North Wales Lunatic Asylum have recommended to the County Council the lighting of the asylum by electricity, the cost of which they estimated at £4,442, exclusive of the engineer's charges. The consideration of the report has been deferred, and the proposal will probably be greatly modified, as the estimate is considered to be far too high.

Blackpool.—The Blackpool Corporation's Bill for widening the promenade provides for a double line of tramways on the front, with a raised tramway track and stopping stations. The overhead system will be used. The receipts of the Electric Trams Committee for the last financial year amounted to £18 196 In 1898 they were £15,376; in 1897, £13,223; and in 1896, £9,869.

Halifax.—After an inspection on behalf of the Board of Trade the new section of the Corporation electric tramways from Market-street to Booth Town was opened last week with a half-hour service. Since the inauguration of the overhead electric tramways in Halifax by the Corporation, nine months ago, the receipts have amounted to about £10,500, and the profits to nearly £2,000.

Rotherham.—Prof. Kennedy has advised the Corporation in connection with the proposed electric lighting scheme that (1) provision be made for taking in tramways at any time; (2) it is advisable to defer street-lighting, as possibly the present lamp columns might be utilised; (3) the site selected for the generating station was the best of the available sites he had seen on his inspection.

Grays.—The following sites have been suggested for an electric lighting station: Maidstone Lakes, £1,500; Stanley-road, £2,500; corner of Clarence and Bridge road, £1,500; Bridge-road and Cromwell-road. At the last meeting of the Urban District Council it was stated that a much better and cheaper site could be obtained, and the matter has been referred back to the Electric Lighting Committee.

Kingstown.—The Urban Council have been considering the proposal of the Municipal Industries Syndicate to undertake the electric lighting of Kingstown. It is believed that the Council will not entertain the proposal of the syndicate, as they think it would be more profitable to carry out the work themselves. The same syndicate have made a similar application to the Blackrock Urban Council.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to the New General Traction Company, Limited, 24,000 ordinary shares of £5 each fully paid, Nos. 10,001 to 34,000, and to appoint a special settling day in the Chelsea Electricity Supply Company, Limited, further issue of £40,000 4½ per cent. debenture stock.

Londonderry.—The Corporation's electrical engineer is preparing plans, specifications, and estimates for an installation for the supplying of private lighting and power by the laying of the necessary mains, etc., from the generating station to Shipquay-place, and from thence up Shipquay-street, The Diamond, Bishop-street to Bishop Gate, Ferryquay-street, Carlisle-road, John-street, and Foyle-street.

Cardiff.—As the Corporation will take over the tramways at the end of 1901, the Tramway Committee will soon have to decide whether they will have separate generating stations or make an arrangement to get power from the present electric stations. The chairman and the borough engineer have been instructed to visit certain towns and report upon what places it would be useful for the committee to visit.

Woking.—At a recent meeting of ratepayers of the Station and Maybury Ward the following resolution was passed: "That the chairman of the Urban District Council, or, if he declines, the vice-chairman, be respectfully requested to at once convene a meeting of the ratepayers of the parish to take into their serious consideration the advisability of negotiating for the purchase of the electric light undertaking."

Bristol.—On Easter Monday the tramways company ran 117 cars, including horse and electric, and carried 140,949 passengers. On the corresponding holiday last year 117 cars were run and 111,050 passengers were carried, showing an increase this year of 29,899 passengers. Of this increase the 38 motorcars run on the popular electric lines contributed no fewer than 10,913 passengers more than they carried last year.

Scarborough.—Another electric tramway company is asking the Council to agree to an application to Parliament for powers to establish a system of electric tramways in Scarborough. The special Electric Tramways Sub-Committee, which was appointed lately, is dealing with the matter. The Corporation proposes to go to Parliament for further powers next session, and it has been suggested that they might take up the subject of electric tramways themselves.

Derby.—The Town Council have authorised the conversion of gas lamps into incandescent lamps in all streets where the electric light mains are now laid, and also in Mill Hill-lane, St. Chad's-road, Breedon Hill-road, and Burton-road, when the mains are laid in those streets, on condition that the cost of conversion to be borne by the Highways Committee does not exceed £1 per lamp, and that the charge for electric light does not exceed the present cost of gas.

Islington.—At the meeting of the Vestry to-day the Electric Lighting Committee will recommend that the salary of Mr. C. H. Yeaman, assistant electrical engineer, be increased by two further increments of £25 each at Lady Day 1900 and 1901; and also that an offer be accepted from the Islington Board of Guardians to sell their freehold property, known as 36, Newington Green-road, for the sum of £250, as the property in question would be suitable for the purpose of a sub-transformer station.

Stockton.—At the last meeting of the Town Council a communication was read from Billingham Parish Council enclosing the following resolution passed at the annual parish meeting: "That we request the Parish Council to consider the advisability of seeking an extension of the electric tramway service from Norton to the Clarence Hotel, Billingham, for the purpose of transit and public lighting." The clerk was ordered to confer with the representatives of the tramway company on the question.

Gloucester.—At the last meeting of the Town Council a letter was read from the Local Government Board enclosing approval of the use of part of the Beanland Estate and adjoining property for the purposes of the Gloucester Corporation Electric Supply Order, 1896; and sanction to the borrowing of £43,450 for purposes of electric lighting, repayable, with interest, within 25 years from date of borrowing. The positions for the 36 arc lamps to be erected in the four principal streets have been decided upon.

London Gazette.—*Re* the estate of D. W. Paine, electrician, 84, Glo'ster-road, Brighton, the *Gazette* contains the following notices: "Receiving order, March 29, on debtor's petition; first meeting, April 11, 12 noon, at Official Receiver's Offices, 4, Pavilion-buildings, Brighton; public examination, April 20, 11 a.m., Court House, Church-street, Brighton." A receiving order has also been issued in the estate of J. E. Stott (trading as James E. Stott and Co), Huddersfield, on creditors' petition.

Chelmsford.—The Town Council have decided to apply to the Chelmsford Electric Lighting Company, Limited, to contribute £200 towards the sum expended by the Council in repairing the various footpaths and roads broken up by the company for the purpose of laying their new cables. The Lighting Committee have engaged Mr. Robert Hammond, of 64, Victoria-street, Westminster, to advise the Council as to the value of the undertaking, etc., offered by the Chelmsford Electric Lighting Company, Limited.

Southampton.—Mr. Manville's estimate for the new works is £4,346 for the public and private lighting of the roads at Shirley and the extension to the isolation hospital, and £12 813 for the necessary storage room and provision for tramway purposes—a total of £17,159. After having been discussed by the Town Council last week, it was referred back to the Electric Lighting Committee to bring up a complete report and plans for supplying electricity for lighting purposes and motor powers in the most economic manner.

Weston-super-Mare.—Major Philip Cardew, R.E., on the 28th ult. conducted an enquiry into the application of the Weston-super Mare and District Electric Lighting and Power Syndicate for a provisional order under the Electric Lighting Acts (1882 and 1888), to authorise them to supply electricity for all public and private purposes within the district of Weston-super-Mare; and also into the proposal by the undertakers under the Weston-super-Mare Electric Lighting Order, 1891, to transfer their powers, etc., under the order. The enquiry was concluded after a sitting which lasted 10 hours.

Todmorden.—The Town Council have resolved that their parliamentary representatives be requested to take the necessary steps to obtain the inclusion of all boroughs having a population of 20,000 or upwards in the provisions of the Government's Telephone Bill. The Council will not petition against the National Telephone Company's Bills, as the company have consented to include Todmorden in the list of boroughs to which the Acts will not apply. The parliamentary representatives were requested to offer all possible opposition to the County of London and Brush Provincial Electric Lighting Company's Bill in its remaining stages in Parliament.

Eastbourne.—The borough engineer has been instructed to prepare plans for tramways or light railways from the Archway Tavern along Seaside, Seaside-road, South-street to the town hall; from the town hall along Grove-road, Upperton-road and Willingdon-road, as far as Eldon-road; also from Upperton-road, along the Avenue, Lewes-road, and the proposed new road as far as the Decoy, with a connecting line from Seaside-road, along Cavendish-place to the Upper-avenue. The purchase of the undertaking of the Eastbourne Electric Light Company, Limited, by the Corporation has been completed. Shareholders receive £21 for every £10 share.

Sunderland.—An agreement has been signed between a sub-committee of the Sunderland Corporation and Sir E. T. Gourley and two other directors of the Sunderland Tramways Company, Limited, for the purchase of the rights and property of the tramways company by that Corporation. The price to be paid is £35,000, and the transfer is to be made on Jan. 1, 1900. The company also agree to assist the Corporation in securing the passage of the Bill now before Parliament to enable the Corporation to construct and work electric tramways. The Corporation propose to expend about a quarter of a million sterling in laying out an efficient electric service.

City of Birmingham Tramways Company.—At the ordinary general meeting of shareholders last week, the Chairman said he regretted that no further progress had been made in arriving at a settlement of their difficulties with the Corporation. He was quite sure that Birmingham, whose motto was "Forward," would not stand still and see other cities like Glasgow, Manchester, Liverpool, Sheffield, and Bristol, and all other great centres, adopting modern electric tramcars, giving a splendid service to the people, without doing the same thing. The directors were always ready and willing to meet the Corporation and discuss the question of the future equipment and other matters in a proper spirit.

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Luton.—At the last meeting of the Town Council the Electric Lighting Committee presented a report stating that the Board of Trade had approved of the system for the supply of electrical energy in connection with the Luton Corporation Electric Lighting Order, 1895. Mr. Albion T. Snell, C.E., had submitted his sketch plan and specifications for carrying out the electric lighting works. The plans, etc., were approved, and tenders were ordered to be invited for executing the works referred to therein. After a debate upon this report which lasted for three hours, further discussion was postponed for a month.

Fulham.—At the last meeting of the Electric Lighting Committee it was stated that the cost of the electrical works, including mains, would be £94,348, including £8,900 for the land. The 46 applications received for the post of clerk of works were referred to a sub committee. The accountant submitted a report as to the application to the County Council for a loan to carry out the works. The money required would be, he said: Horsfall contract, £16,760; building contract, £24,970; electrical equipment and artesian wells, £48,000; allowance 10 per cent. to cover cost of cranes, extras, commission contingencies, £8,973—total, £98,703. It was decided that a loan of £100,000 be applied for.

Appointments Vacant.—The Electric Lighting Committee of the Hull Corporation have vacancies for two junior electrical assistants as switchboard attendants at their electricity works, at a salary of £78 per annum, rising by annual increments of £13 to £104.—The Gas Committee of the Keighley Corporation require the services of an electrical engineer to prepare specifications and plans, superintend the erection of buildings and machinery for their proposed station, and of the laying of the street cables for lighting and tramways, etc., and to take charge of the works after completion.—The Gloucester Corporation require a clerk of works to overlook the erection of the electricity and library buildings, at a salary of £3 3s. a week. Particulars of these vacancies appear in another column.

Wolverhampton.—The present buildings of the electric light station are 43ft. high, and together 108ft. wide, and a tender has now been accepted to increase its size by more than a third. At present the boiler-house accommodates four boilers, and it is intended to put in two new ones in the new portion, leaving space for two more at some future time. There are at present two engines, and provision will be made for two more. Two new engines will also be provided, though neither these nor the boilers are included in the contract, which, however, comprises the setting of the boilers. The work of excavation has been commenced, and the contract will be completed by the middle of May. The erection of a battery-room has been deferred, as this would have raised the cost to £1,542.

Hull Telephones.—An agreement has been arrived at between the Works Committee of the Hull Corporation and the National Telephone Company in connection with the underground wire question. Under this, permission is granted to the company as licensees of the Postmaster-General to place their wires underground, the Corporation reserving certain rights. The company are to pay a rent of 5s. per annum for each subscriber in Hull, 10s. for large and 5s. for small junction boxes. The revenue thus likely to accrue to the Corporation will be between £200 and £300 a year. The scale of charges for telephone service at present applied to the Hull central telephone exchange is not to be increased, and such scale subject to any reduction, is to be equal in its application throughout the city.—*Yorkshire Post.*

Windsor.—With regard to the lighting of the town by electricity we learn the following particulars: Ten 2,000-c.p. lamps have been erected in Thames-street, High street, and Park-street, seven 500-c.p. lamps in Peascod street, and one at Windsor Bridge. The other streets of the town are lit with about 230 incandescent lights of 16 c.p. The company had not much time to instal the light, as its tender was only accepted about a month ago. The gas company had demanded 12s. 6d. more per lamp if electricity were introduced into the principal thoroughfares. This would have made the Corporation's bill greater than when they were responsible for the whole town, and the result is that they did not renew their contract with the gas company. Some of the roads where the electric lamps are not yet ready are lit with oil lamps.

Flather and Son.—We have received from this firm which has its manufactory in Leeds at the Park Electrical Works, an illustrated list of the continuous-current dynamos manufactured by them. We notice that for all sizes over 4 kw. multipolar designs are now being used by the firm, and that these machines are being wound for voltages varying from 65 volts up to 660. From the speeds given we presume that the larger sizes are meant to be direct-coupled to steam-engines, whereas the smaller machines are quite moderately speeded for rope or belt driving. The smaller two pole dynamos and motors made by this firm are listed. We also notice their new type of enclosed motors, which are also made for voltages from $\frac{1}{8}$ up to 500. The brake-horse power developed by these enclosed types varies from ¼ h.p. up to 25 h.p. These machines are likewise multipolar.

Cheltenham.—The electrical engineer reported at the last meeting of the Council that since the previous meeting applications had been received from intending customers which would necessitate extensions to the mains estimated to cost, including 5 per cent. for contingencies, about £670. With the 200-volt lamps usually used, the bills of the 200-volt customers were about 10 per cent. more than those of corresponding 100-volt customers, and he thought it would facilitate changing over to 200 volts by degrees throughout the system of mains if the committee decided to reduce the price to 5½d. per unit in the case of 200-volt customers from the end of the present financial year. It was resolved that the report be approved, and the recommendation therein contained adopted. The Local Government Board have sanctioned a loan of £17,200 for electric lighting purposes.

Newport.—Several of the suburban business parts of Newport are now taken over by the Corporation and lighted by electricity. Thus the number of arc lights added is 34; there were previously 42 lights. Each arc light displaces an average of three gaslights, which cost 50s. per light under the contract, so that the income of the electric light department will be increased to that extent. The department already pays its way, and no doubt at the end of next half-year or next year will show a profit, which will go on increasing. The new engines ordered for the extension of the central station will, when fixed, treble the producing power. The new heavy iron castings for them are now being placed in position, and the new switchboard is rapidly assuming shape. On the new engines, the dynamo and flywheel will be combined; at present the power is communicated to the dynamo by ropes working off the flywheel.

Ediswan Fittings.—We have recently noticed a number of high-voltage electric fittings manufactured by the Edison and Swan United Electric Light Company, Limited, and have illustrated many of these in detail. We have now received from the firm a complete list in one binding of the whole of these high-voltage fittings and accessories. The list ranges from incandescent lamps to lampholders, switches, fuses, and switchboards. Of course, in it the ornamental electroliers for which this firm is noted are not included, as the adoption of them for high-voltage work is merely a matter of the wiring and end fittings. We notice on page 41 of the present list a very convenient floor socket and plug design for high-voltage work. The socket consists of a porcelain receptacle with polished brass face plate. This latter is provided with a lid which closes flush with the floor or wall when the plug is withdrawn. The plug itself is of ebonite, with laminated copper contacts. The high-voltage main switches made by this firm, whether of single or double pole type, are worthy of careful inspection when ordering such materials.

Crewe.—With reference to the Town Council's application for sanction to borrow £26,000 for electric lighting purposes, the Local Government Board have requested that trial pits might be sunk in suitable positions on the land to be purchased as the site of the generating station, and then to be furnished with information as to the nature of the ground as ascertained by such trial pits; also with an accurately surveyed plan on the $\frac{1}{1056}$ Ordnance scale of the land, and with a plan and section of the intended sanitary accommodation and drainage arrangements at the proposed generating station, showing the levels, sizes, and gradients of the drains, and also with an estimate showing the expected revenue from the supply of energy as ascertained by communication with intending consumers whose premises and requirements should be specified in the estimate. The Town Clerk reported to the last meeting of the Electric Lighting Committee that the estimate and plan had been supplied to the Local Government Board, and the nature of the ground as ascertained by the trial pits for the foundation in the site of the chimney of the electricity works had been reported upon by Mr. C. Hopkinson in a letter dated 7th ult., as consisting of alternate layers of sand and clay with a bed of tough clay at a considerable depth, and that there would be no difficulty in providing sound foundations without going to a great depth. It is stated that the result of a canvass made as to the likely revenue from consumers of the light has been satisfactory.

Southampton.—The Town Council have adopted the report of the Tramways Committee's deputation which visited Dover, London, Glasgow, Liverpool, and Bradford. The deputation are unanimously of opinion that the overhead system adopted by the Southampton Corporation is the cheapest and best, and the electric system throughout the various towns has proved to be economical and advantageous. The electrical engineer has also submitted a report, concerning which the deputation has made the following recommendations: (1) that double lines be used wherever possible; (2) that side poles and centre poles be used in all positions favourable, but span wires are not recommended; (3) that fixed stopping places be adopted throughout the entire system, and that such stopping places be denoted on the lamp columns, at a distance of about 220 yards apart; (4) that the Corporation adopt a type of car similar to car No. 450 in use by the Liverpool Corporation, and that Messrs. Kincaid, Waller, and Manville be instructed to prepare a specification with such modifications, including longitudinal seats, as may be necessary, and obtain tenders to be submitted to the Corporation; (5) that in view of the recommendation to immediately order the rolling stock, Messrs. Kincaid, Waller, and Manville be instructed to prepare plans and specifications for the necessary alterations to the Shirley depôt; (6) that time recorders be placed at each terminus, as at Dover. The deputation, in conclusion, desire to report that they are in possession of a vast amount of information respecting the salaries of the head officials, emoluments, hours of labour, uniforms, etc., of the other employés of the tramways department, and which will be submitted to the Tramways Committee at an early date.

Hull.—At the last meeting of the Electric Lighting Committee it was decided that mains be laid on one side of Great Thornton-street, at a cost of £188; both sides of Hessle-road, from the Boulevard to St. George's-road, at a cost of £540; and Park-avenue, at a cost of £145. It was also decided to increase the feeders in the Old Town system of mains at a cost of £450. The Chairman gave a brief review of the past year. He said loans had been sanctioned by the Local Government Board for the following amounts; Old works (completed some time ago), £45,800; new

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works (recently completed), £40,690; new extensions (now being carried out), £26,000. On the first of the above accounts (old works), a sum of £161. 13s., expended in providing connections to new customers, had been spent in excess of the loan sanctioned. Owing to the great and unexpected demand made upon them for current from districts that had not been contemplated when the estimates on which their application to the Local Government Board were based were drawn up, a sum of £5,339. 3s. 6d. in excess of the loan sanctioned for new works had been expended in extending the mains in streets not included in the original scheme. Further extensions of mains to other districts not included in any scheme for which loans had been sanctioned or applied for would probably be required; it therefore seemed advisable that application should be made at an early date for power to borrow, say, £10,000—£5 339. 3s. 6d. for the extension of mains already carried out, and the balance for similar extensions yet to be made. A sum of £5,534. 2s. had been expended on meters and charged to capital account. As, however, electricity meters were not calculated to last for so long a period as 25 years, it was advisable that this amount should be treated as a suspense account. The year had witnessed the completion and opening of the new works at Soulcoates-lane. The whole of these works were designed entirely by and were carried out under the sole superintendence of their electrical engineer, Mr. Barnard, and the committee were thus saved the heavy expense which the employment of a consulting engineer would have involved. In recognition of the time, energy, and ability Mr. Barnard had devoted to the work, and the expense he had saved, it was suggested to grant him an honorarium of 100 guineas. The report and suggestion of the chairman were adopted without dissent. The Corporation desire to erect a signal cabin at Paragon station gate for electric tramway purposes.

The Simplex Steel Conduit System.—We have received from the Simplex Steel Conduit System, Limited, of Coventry-street, Birmingham, their new list of conduits for house wiring. The list consists of a little book of over 100 pages, in which every information a contractor requires to know about the goods manufactured by the company is given. In the first few pages the works in which these tubes and their accessories are made are illustrated. The company advocates the use of these steel conduits instead of wooden casing wherever possible, and we quite endorse their claim that the protection so afforded to the insulated wires is much more permanent than anything that can be obtained with wood. When such tubes are used with a complete system of distribution boards and fuses, there is no need whatever to have any joints in the insulated wires. The tubes in question are as a rule simply rolled together, and not brazed. Again, where the tubes are joined into bends and sockets, no screwing is used, the accurate fit between the sockets and tubes being relied on. With these arrangements an absolute watertight system is not obtained, but the company claim that this is an advantage inasmuch as the water which usually accumulates in tubes, due to condensation, is able to get out, and hence the wires can be kept dry. Over and above the tube itself and the various bends, etc., the company have specialised the drawing-in box and switch and fuse connections for their system of pipes. We notice in this respect that in the present list the half normal bend of 135deg. has been added to the special parts previously listed, and that the inspection cross and Y pieces have been considerably improved. A detachable brass bellmouth is also now supplied for each size of tube to prevent the chafing when wire is being drawn in. The company also supplies a number of simple electric light fittings, such as would be used in the great majority of commercial installations. The draw-boxes on to which these are fixed are, of course, suitable for supporting any of the more ornamental electroliers and fittings which can be obtained in the open market. The representative of the company in London is Mr. E. Sheppard, who has his offices at Mansion House-chambers, E.C. This gentleman informs us that, wherever new buildings have to be wired, the Simplex steel conduit system works out quite as cheap as wood casing, and that in other places where surface work is allowed, the same claim can also be substantiated.

PROVISIONAL PATENTS, 1899

MARCH 24.

6395. Improvements in appliances for transmitting the current from a charged wire to an electrically propelled vehicle. William Richard Wynne, 42, Palace-mansions, Addison Bridge, London.

6396. Improvements in and relating to electrical coin shoots for automatic coin-freed apparatus. Max Heyder, 75, Chancery-lane, London. (Complete specification.)

6429. Improvements relating to electrical resistance boxes and like apparatus, and to switches therefor. Charles Thomas Gambrell and Thomas Edward Gambrell, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

6439. Improvements in combined telephonic jacks and call indicators. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske, Aktien Gesellschaft, Germany.) (Complete specification.)

6441. Improvements in electric cables. Théophile Carles, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

6443. An improved pocket galvanometer. Carl Beez, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

MARCH 25.

6473. Improvements in electrical apparatus for igniting gas burners from a distance. Carl Bollé, 57, Barton-arcade, Manchester. (Carl Fitzlaff, Germany.)

6478. Improvements in electric arc lamps. Robert Frederick Hall, 24, Temple-row, Birmingham. (Complete specification.)

6484. The fairy mountain, electrical switchback continuous railway, with enchanted reptiles, snakes, dragons, and other animals. Charles Ercole and Alexis Charpoulart, 22, Chaussée d'Antin, Paris.

6487. Improvements in electric switches. The British Thomson-Houston Company, Limited, and Frederick Samuelson, 83, Cannon-street, London.

6510. Differential hot-wire voltmeter. Alexander Melville Clark, 53, Chancery-lane, London. (The firm of Hartmann and Braun, Germany.) (Complete specification.)

MARCH 27.

6562. Improvements in or relating to current regulators for electric batteries. Manes Ephraim Fuld, 31, Southampton buildings, Chancery-lane, London. (Complete specification.)

6582. Electrical furnace with peripheral heating by means of electrical resistances. Denis Lance, Raphael Louis Emmanuel de Bourgade, and Leon Schmitz, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Aug. 29, 1898, being date of application in France.) (Complete specification.)

6593. Improved combination brake coupling for electrically connecting railway vehicles fitted with vacuum brake for communication or signalling purposes. Daniel Cunningham, 171, Queen Victoria-street, London.

6604. Improvements connected with motor road vehicles, and in electric igniting apparatus for explosion engines. Philip Middleton Justice, 55, Chancery-lane, London. (The Pope Manufacturing Company, United States.) (Complete specification.)

MARCH 28.

6624. An improved switch or "push" for use in connection with electrical intercommunication on railway trains. Alexander Shiels, 100, Wellington-street, Glasgow.

6631. Improvements in and relating to electric switches and the like. Llewellyn Burbank Codd and Percy Newton Chatterley, 7, St. Martin's road, Broad-street, Birmingham.

6647. Improvements in wall plugs for electric lighting and heating. Andreas Peter Lundberg and Gustaf Charles Lundberg, 18, Fulham-place, Paddington, London. (Complete specification.)

6684. Improvements in carbons for electric arc lamps. Daniel Bacon, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

6685. Improvements in voltaic cells. Richard Otto Albert Heinrich, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

6687. Improvements in porous diaphragms for electrolytic cells and methods of producing the same. Herbert Henry Dow, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

6690. Improvement in method of and means for varying the speed of direct-current motors. Benjamin Garver Lamme, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883 Sec. 103, Sept. 3, 1898, being date of application in United States.)

6691. Improvement in systems of electrical distribution and regulation. Benjamin Garver Lamme, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Sept. 28, 1898, being date of application in United States.)

6712. Lines circuits and apparatus for telephonic intercommunication. G. Aboilard et Cie., 24, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Aug. 30, 1898, being date of application in France.)

MARCH 29.

6801. An improved indicater for dynamometers. Walter John Murphy, 19, Holborn-viaduct, London.

6809. A method of and apparatus for the transformation of two-phase electric currents specially applicable to electric welding. Reginald John Wallis Jones and William Beedie Esson, Norfolk House, Norfolk-street, London.

6816. Improvements in electric cigar-lighters. William Frederick Kessler, 70, Chancery-lane, London. (Complete specification.)

6819. Improvements in electric switches. Walter Frederick Jones, 322, High Holborn, London.

6820. Improvements in or in connection with trolley or like current collectors for electric railways and tramways. Bonomo Magrini, 6, Lord-street, Liverpool. (Baldassare Villa, Italy.)

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6833. Improvements in step-by-step printing telegraph instruments. Louis Marina Casella, 1, Queen Victoria-street, London.

MARCH 30.

6847. A safety device for contact-rods of electric cars with overground line. Ludwig Huber, 33, Augustastrasse, Aix-la-Chapelle, Germany. (Complete specification.)

6873. Improvements in or relating to accumulators or secondary batteries. Percy Prestwich, 4, St. Ann's-square, Manchester.

6883. Improvements in apparatus for the production of electric discharges. Marius Otto, 46, Lincoln's-inn-fields, London. (Complete specification.)

6886. A new or improved system of wiring electrical installations. Frederick Bathurst, 73, St. Stephen's-road, Upton Park, London. (Complete specification.)

6894. Improvements in or relating to electrical measuring instruments. John Sealy Townsend, Harold Albert Wilson, and John Alexander McClelland, 111, Hatton-garden, London.

6947. Improved method of and apparatus for transforming continuous electric currents into continuous currents of different voltage. Alfred Wydts and Gustav Weissmann, 45, Southampton-buildings, Chancery-lane, London.

APRIL 1.

6960. Improvements in electric arc lamps. Herbert Godsal, 13, Bruton-street, Berkeley-square, London.

6963. Improvements in electric cut-outs. Henry Mostyn Darrah, 55, Market-street, Manchester.

6982. Improvements in apparatus employed in wireless telegraphy. Guglielmo Marconi and the Wireless Telegraph and Signal Company, Limited, 24, Southampton-buildings, Chancery-lane, London.

6992. Improvements in switching contrivances for two electric incandescent lamps connected up together. Wilhelm Schloesser and Hermann Moeres, Cologne, Germany.

7001. New or improved means for cutting down the current in incandescent electric lamps August Edward Segnitz, 128, Colmore-row, Birmingham.

7005. Improvements connected with electric storage batteries. Philip Middleton Justice, 55, Chancery-lane, London. (The Pope Manufacturing Company, United States.) (Complete specification.)

SPECIFICATIONS PUBLISHED.

1898.

735. Switches for use in electric light installations. Taffs and Hill.

5423. Automatic electric switch for hoists and cranes. Goddard.

5703. Electrodes for secondary batteries or accumulators. Pieper.

5704. Electrodes for secondary batteries or accumulators. Pieper.

6649. Dynamo-electric generators and motors. Atkinson and Johnson.

7583. Electrical switches. Jacoby and White, Jacoby and Co., Limited.

8222. Clutches and brakes for arc electric lamps. Byng and Angold.

8988. Electrodes for accumulators. Alker and Mennessier.

9178. Electromotors. Robson, Marsden, and Headland.

9394. Process for electric heating and furnace for realising same. Roufaut.

9482. Apparatus for turning on, lighting, and extinguishing gas at a distance by means of electricity. Guyenot.

9912. Chimney for incandescent gas, electric, and oil lights. Altman.

10291. Rheostats for electric circuits. Wirt.

10496. Maximum electric current self-recording instrument. Staunton.

16464. Construction of electrodes for secondary batteries. Henneton.

22603. Prepayment electricity meters. Long and Schattner.

26397. Acid-proof or non-conducting material for electrical and other purposes, and method of preparing the same. Jung, Brecher, and Kittel.

26476. Galvanic batteries. Burroughs.

1899.

287. Cooling appliances for alternating-current and rotary-phase current motors. Siemens Bros. and Co., Limited. (Siemens und Halske, Aktien Gesellschaft.)

2654. Electric switches. Joseph.

2745. Conduits for electric wires or cables. Callaway.

2825. Signals to indicate the approaching exhaustion of the carbons in electric arc lamps. Claremont and Royce.

2956. Apparatus for controlling electric motors. Siemens Bros. and Co., Limited, and Wilson.

3994. Electric arc lamps. Rzepka.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1899.	Corresponding week 1898.	Increase or decrease	Total receipts for half-year. 1899.	1898.
		£	£	£	£	£
Birmingham Tramway	April 1	4 301	3,508	+ 505	48,805	44 988
Blackpool and Fleetwood Tramroad	,, 1	433	—	—	2,520	—
Bradford City Trams	Feb. 5	145	—	—	6,733‡	—
Bristol Tramways and Carriage Co.	Mar. 31	2 745	2,339	+ 406	—	—
City and South London Railway	April 2	889	1,050	− 161	15 275	14,942
Dover Tramways	,, 1	200	118	+ 82	1,896	1,395
Dublin U.T., elec. cars	Mar. 31	1,006	686†	+ 320	11,306	9,061†
Dublin S.D. Electric Tramways	,, 31	721	352	+ 369	8,083	5,101
Halifax Corporation Tramways	,, 22	315	—	—	10,400*	—
Liverpool Overhead Railway	April 2	1,405	1.313	+ 92	18,316	18,316
South Staffordshire Tramways	Mar. 31	572	567	+ 5	7,664	7,472

* Since June 30, 1898. † Including horse cars. ‡ Since July, 1898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	24½-25½
Bournemouth and Poole Electric Supply, Limited, Ord.	10	13½-13⅝ xd
—— 4½ per cent. Cum. Pref.	10	10½-11½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	19½-20 xd
—— 6 p. c. Cm. Pf., 30,001-40,000 (all paid)	10	13½-14½
—— 5 per cent. Perpetual Debenture Stock	100	125-128 xd
Brush Electrical Engineering Limited, Ordinary	2	1⅞-2⅛
—— Non. Cum., 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	102-105
Callender's Cable Company, Debentures	100	114-117
—— Ordinary	5	12½-13½
Central London Railway, Ordinary	10	9⅞-10⅛
——	8	7⅞-8⅛
—— Pref. Half-Shares	8	3¾-4
—— ,, ,,	5	4⅛-4⅜
Charing Cross and Strand	5	11-12
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	7½-8½
—— 4½ per cent. Debentures	100	114-116
City of London, Ordinary	10	17-18
—— ,, 90,001-100,000	10	18-19
—— 6 per cent. Cumulative Pref.	10	15-16
—— 5 per cent. Debenture Stock	100	124-129
City and South London Railway, Consolidated Ordinary	100	68-70
—— Ordinary	8	4½-5½
—— 4 per cent. Debenture Stock	100	133-135
—— 5 per cent. Pref. Shares	10	14½-15½
—— ,, ,, '96	10	14-15
County of London and Brush Prov. Elec. Light Co., Ord.	10	11-12
—— ,, ,, No. 30,001-40,000	10	11-12
—— 6 per cent. Cum. Pref.	10	14-15 xd
Crompton and Co.	8	3½ 3⅝
—— 5 per cent. Debentures	—	98-101
Crystal Palace District, Ordinary 5 per cent. Stock	100	130 135
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	8	2-2½
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	97-99
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5½-5⅝
Electric Construction, Limited	2	2½ 2⅝
—— 7 per cent. Cumulative Pref	2	3-3½
—— 4 per cent. Perp. 1st Mort. Deb.	100	103-106
W. T. Henley's Telegraph Works, Ordinary	10	25½-26½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	113-115
House-to-House Company, Ordinary	5	8½-9½
—— 7 per cent. Preference	5	9-10
Imperial Tramways, Limited	6	24½-25½
India Rubber, Gutta Percha, and Telegraph Works	10	21½-22½
—— 4 per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	12½-13½
London Electric Supply, Ordinary	8	3½-4
—— 6 per cent. Pref.	5	6½-7
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	105-107
Metropolitan Electric Supply, Limited, Ord., No. 1-62,500	10	17-18 xd
—— ,, ,, No. 62,501-85,000	4	13-14 xd
—— 4½ per cent. First Mortgage Debenture Stock	100	117-120
National Telephone, Ordinary	5	4½-5
—— 6 per cent. Cum. First Pref.	10	11-13
—— 6 per cent. Cum. Second Pref.	10	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	4½-5½
—— 3½ per cent. Deb. Stock, Red.	100	99-101
Notting Hill Electric Lighting Company, Limited	10	16½-17½
Oriental, Limited, 1879	1	1½-1⅝
—— £5 Shares	5	7½-7⅞
—— £4½ Shares, New	4½	6½-6⅞
Oriental Telephone and Electric Company	1	⅞-1
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6¾-7
Royal Electrical Company of Montreal	1½	165-185 xd
—— 4½ per cent. First Shares Mortgage Debentures	100	105-107 xd
South London Electric Supply, Ordinary	8	3½-3⅝
St. James's and Pall Mall, Limited, Ordinary	5	17-18
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	37-41
—— 5 per cent. Bonds	100	106-108
Waterloo and City Railway, Ordinary	100	109-112
Westminster Electric Supply, Ordinary	5	15½-16½

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NOTES.

Fatal Accident.—At some electricity works in course of construction at Hogneck, on the Lake of Bienne, Switzerland, a dam, together with a caisson, was carried away by the River Aar. Of 12 workmen who were in the caisson at the time four were killed, while two were seriously and others slightly injured.

Dundee Institute of Engineers.—This organisation has recently issued its fourteenth annual report and financial statement, which shows that the institute continues in a satisfactory condition, both as regards membership and finance. A gratifying increase of activity on the part of the members has been shown throughout the year, and the excursions and lectures have on the whole been well attended.

Hoosac Tunnel.—This tunnel is shortly to be equipped with one of the largest ventilating fans in the world, its diameter being 16ft. and its width 8ft. The fan will be worked by an electric motor, will have a capacity of drawing 600,000 cubic feet of air per minute, and will thus make a speedy clearance of all accumulations of smoke, gas, and whatever other atmospheric impurities there may be, from the tunnel.

Obituary.—We regret to have to record the death, on the 6th inst., of Mr. F. L. Hutchins, who for the last 33 years has been closely connected with the legal side of the electrical industry. Mr. Hutchins has during that time acted as the legal adviser of the Silvertown Company, and this company, in common with his partners in the firm of Messrs. Murray, Hutchins, and Stirling, deplore the loss of an able colleague and a cherished friend.

Paris Exhibition. — A sub-committee has been appointed to look after the interests of the British electrical section of the 1900 exhibition at Paris. The committee as at present arranged include the following gentlemen, who may be said to well represent the electrical industries of England: Mr. W. H. Preece, C.B. (chairman); Sir Henry Mance, C.I.E.; Mr. Alexander Siemens; Mr. Henry Edmunds; Mr. J. J. Swan; Mr. H. Thomson Lyon (secretary).

Personal.—The Board of Trade, as rumoured some weeks ago, have appointed Mr. A. P. Trotter to be their electrical adviser in the place of Major Cardew, who has resigned to take up consulting work. It will be remembered that Mr. Trotter has been for the last two years acting as the Government engineer for Cape Colony, and we understand that he is now on his way home. We are sure that he will receive a warm welcome from the electrical profession. Mr. Trotter's technical abilities eminently qualify him for the position he is to hold.

Honour to Volta.—The telegraph operators of Italy are asking for funds to enable them to purchase a bronze crown to be placed at the foot of the statue of Volta. The monument of the great scientist is located in the city of Como, Italy. As announced in these columns some time ago, it is proposed to have a grand celebration in May, 1899, at Milan and Como, Italy, in honour of the hundredth anniversary of Volta's discovery of the voltaic cell. The bronze crown is to be paid for by subscriptions from the telegraph operators of the world.

The Mutual Telephone Company.—The New Mutual Telephone Company of Manchester is still waging its up-hill fight in favour of telephone competition against a company in that city. We understand, however, from a recent paragraph in the newspapers that a further attempt is being made to induce the Corporation to support a memorial to the Lords of the Treasury. Most of the members of Parliament for Manchester and Salford and the adjacent county divisions have signed the memorial, but we are afraid that in spite of this there is very little chance of the company mentioned gaining its hoped-for powers.

Vienna.—Although the Austrian Minister of Commerce has reserved his decision with regard to the projected electric railway along the shore of the Danube, it appears from the evidence produced at the recent conference between representatives of the various departments of State that the line will be built. The line is to run along the quay from the Petöfiplatz to the Franz Josef Platz on a viaduct. The arches of this viaduct will be used as storerooms, and provided with gates which will be opened in the case of floods. The building of the line is fully justified, as the inner part of the town is touched on one side only by the electric lines at present existing.

State Telephone Rates.—In view of the proposal of the Government to take up the supply of telephones in London, the following facts as to the rates which the State of New York are trying to make compulsory are of interest. By a Bill now before both the Senate and the Assembly, the following maximum rates are proposed: For cities with over 1,000,000 inhabitants, £25 per annum: in cities over 500,000 and under 1,000,000, £17; in those with from 100,000 to 500,000 inhabitants, £10; and so on until places with less than 20,000 inhabitants are only to be asked to pay £6 per instrument. Calls by non-subscribers are to be paid for at the rate of 5d. for the first five minutes, with an additional charge of 2½d. for every five minutes taken afterwards.

Prof. Dewar.—The Royal Institution announces that: "A gold medal has been conferred on Prof. James Dewar, F.R.S., of London, by the Smithsonian Institution, in recognition of his discovery of processes by which air may be liquefied. It is what is known as the Hodgkins medal. Mr. Hodgkins left 200,000dol. to the Smithsonian Institution, half of which was to be spent in aiding and rewarding the discoverers of new elements or properties of the air. The first call upon the fund was made some two years ago, when 10,000dol. was divided between the principal discoverers of the new element "argon," and four silver and eight bronze medals were conferred upon those whose efforts aided in the discovery. The gold medal given to Prof. Dewar is 3in. in diameter, and was made in the mint at Paris."

Imperial Telegraphy.—On Monday last Mr. Webster called the attention of the House of Commons to the general subject of our submarine telegraphs. He pointed out that nearly £100,000 were given annually in subsidies, and said he thought a time was now reached when a better service should be established without a subsidy. He proceeded to advocate all-British cables to connect up England to her Colonies, and referred to the great advantage which would accrue from a reduced cost in telegraphing to the Colonies. In the connection of the all-British Pacific cable it is interesting to note that the Canadian Government has just decided to join in the scheme, and in a few days will introduce a measure in Parliament to give them the necessary legislative authority to co-operate with Great Britain and the Australasian Colonies to put the work under contract so soon as the various Governments concerned see fit.

The Murphy Third-Rail System.—We understand that a very satisfactory trial was made at the end of last month at Manhattan Beach, Coney Island, on the sectional third-rail system invented by Captain J. Murphy. In this case the third rail is laid in between the other two, and it

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is split up into sections so arranged that only those under the car are made alive. We understand that the trial line was put to a very severe test by means of snow arranged over the track, but that the plough which collects the current had no difficulty in clearing away the obstructions. Nothing is said, however, as to how far the snow or the liquid mud, which was also used to try to obstruct the plough, conformed with what would be met with in actual practice. The line leakage was said to be under 7½ per cent.; but here, again, we do not quite know whether the leakage was 7½ per cent. of the mean power taken by the car or of the maximum power of the dynamo.

System of Charging.—We have come across a curious paper read by Mr. C. R. Maunsell before the first annual meeting of the Kansas Gas, Water, and Electric Lighting Association, on "Standard Charges for Electric Current." The paper in question would have been in place some 15 years ago, but it seems rather late in the day to urge the advantages of charging by meter over the flat-rate charge. Evidently, from the author's statements, the system of charging so much per lamp per annum is still in use in some parts of Kansas. He proceeds to explain the great advantages of charging consumers for the energy they actually use rather than a lump sum, independent of the same. He finally urges all the stations in that State still selling current on flat rates to abandon a system so unjust both to themselves and to their customers, and to adopt a meter system of charges based on the cost per kilowatt. We fancy by this Mr. Maunsell means kilowatt-hour, but throughout his paper he leaves out the important factor of time in estimating the quantity of energy used.

The Telephone Question.—Representatives of the Liverpool Corporation, the Mersey Docks and Harbour Board, the Chamber of Commerce, and the various trade associations of the city, recently met in conference at the town hall, on the invitation of the Lord Mayor of Liverpool, to consider the possibility of some joint action being taken to oppose Mr. Hanbury's scheme for dealing with the telephone system. The Lord Mayor and Sir Thomas Hughes, the chairman of the Parliamentary Committee of the Corporation, strongly advocated the nationalisation of the telephone system, and said that under the Government scheme London would get all the benefit, and nothing would be done for Liverpool and the other large provincial towns. Resolutions were adopted recording dissatisfaction with the Government scheme, and expressing the opinion that it is desirable, not only in the interests of trade and commerce, but of the whole community, that the telephone system of the country should be placed under the control of a Government department, so as to have it extended, developed, and cheapened with the least possible delay.

The U.S.A. Pacific Cable.—The Berlin correspondent of the *Standard* gives the following technical details of the proposed cable from the United States to Manila. The cable itself is to be 7,000 miles long, is to touch at Hawaii and the Carolines, and connect the Southern Ladrones, being thence extended to Manila. The weight of the deep-sea cable is to be 28 tons per mile. A sixteenth part of the actual distance of the necessary connection will be allowed in excess, in order to make up for the unevenness of the sea bed. The cost is reckoned at £200 per mile, and as soon as Congress has given its consent to the slight concessions still demanded, the company is ready to commence work. The starting point, according to the company's plans, will be Monterey in California, and the last point the town of Manila on the Island of Luzon. Two years will probably be spent on the completion and laying of the cable, but the survey of the route across the Pacific to Manila will probably be begun immediately. The longest section of the proposed cable would be that from San Francisco to Hawaii, amounting to 2,098 English miles. From Hawaii to Wake Island is 2,040 miles; from Wake Island to Guano, 1,290 miles; from Guano to Manila, 1,520 miles.

Telephone Licenses.—Last week those Scottish corporations which are desirous of applying for a municipal license, which the Department propose to grant under the new Government Telephone Bill, held a conference at Preston with the Right Hon. R. W. Hanbury, M.P. The Corporations represented were Glasgow, Aberdeen, and Paisley. Edinburgh, having decided not to apply for a municipal telephone license, sent no delegate. The measure purposes to give certain large municipalities power to establish telephone systems, the necessary funds being obtained on the security of the burgh rates. Under the Bill, however, these licenses were only to be granted to municipalities with a population of over 50,000. The Press was not admitted to the conference, but unofficial reports state that Mr. Hanbury indicated to the deputation that this proposed restriction would be struck out. The deputation, it is understood, were further assured that the Government Bill would be proceeded with this session. It could be inferred that there is every prospect of an amicable settlement between the Department which Mr. Hanbury represents and the municipalities interested regarding the question of wayleaves, and the safeguarding of the rights and interests of municipalities at the end of 1911.

Mica Mining in Bengal.—Mr. Amervyen Smith recently read a paper before the Institution of Mining and Metallurgy on the above subject. He has recently visited the principal mica districts in India, and he clearly describes in his paper the form in which payable mica is found. It seems that it is only within recent years that Europeans have taken up the mica industry, and that the mining as carried on by the natives is both wasteful and expensive. There are four kinds of mica recognised by the Indian dealers, the qualifications being as follows: hard and tough ruby mica; white transparent mica; the third division is discoloured and smoky mica; while the last class is called black mica, and in it are included the mica flakes obtained in trimming the other varieties. Mr. Smith estimates the total output per annum at about 17,000cwt., of which about half is exported. The growth of the export trade is clear from the following figures: In 1892 only 2,298cwt. of mica was exported from Bengal, whereas in 1896 the amount had risen to 8,835cwt. The author concludes that the supply of mica in India is practically inexhaustible, and that some of the veins are extremely rich. The present method of mining is, however, very wasteful, as practically nine-tenths of the mineral extracted is injured and rendered useless for export. This waste mica could, however, be used very largely in the manufacture of micanite, and the manufacture of this commodity, we think, should prove a remunerative adjunct to any company taking up mica mining on a large scale in India.

Electric Power in California.—In no district that we know of are there more openings for the use of electric power than in Southern California, and from an article reprinted from the *Times* of Los Angelos we gather that the Californian inhabitants have begun to appreciate the advantages to be derived. To put the matter briefly, the cost of transport is dear, and hence coal is very expensive in the inland districts. On the other hand, water power is very abundant. The rivers, as a rule, have comparatively small volumes in the summer,

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but very high falls of water. In this way the first cost of the civil engineering works in connection with the use of the power is kept down to a low figure, and electrical energy can be supplied cheaply. Apart from lighting purposes, for which these powers are largely used, electricity is now being extensively employed for pumping water for irrigation purposes, its advantages for this having been thoroughly demonstrated whenever tried. At a place called Colton the water provided last summer was supplied entirely by electric power, at a cost of only 1d. per miner's inch for 24 hours. This cost works out at one-fifth of what had been the cost when gas-engines were used. The article in question describes somewhat fully the works of the Redlands Electric Power Company, and the water powers which this company is now about to add to those already harnessed. It will be seen from the article that there is a large amount of work yet to be done in California, but it is too much to hope that any of it will come to English contractors.

Canadian Water Powers.—We understand from the *Canadian Engineer* that a map is shortly to be published in Ottawa showing the water power available within a radius of 45 miles of that city. An approximate estimate of the total power available, neglecting every case in which that power is less than 20 h.p., comes out at 890,000 h.p. This is said to be a very conservative estimate, based on a stage between mean and low water. The most important feature of the powers in this district, however, is the fact that the source of supply of each stream rests in large lakes that at small expense for retaining dams can be converted into enormous reservoirs, by means of which the powers can be largely increased and regulated during seasons of extreme high and low water. Within 25 miles of Ottawa is the vast water power of the Chats Rapids. It is estimated (from regular survey), at 120,000 h.p., not a pound of it being now utilised. With unlimited supplies of pulpwood, tan bark, furniture wood, mica, phosphate of lime, plumbago, feldspar iron and workable mines of galena and gold, and the cheapest and easiest controlled power in the world, Ottawa might be said to be almost destitute of manufacturers, and many of these valuable powers are lying idle in the hands of speculators. The vast possibilities of the electric furnace, the fact that so enormous a power can be concentrated at Ottawa by means of the dynamo, and a few miles of copper wire is attracting the attention of manufacturers and capitalists in a way that will in a very few years make the Canadian capital something more than a political centre.

Stock Exchange Call-Board.—The *Financial News* a few days ago, in referring to the new electric call-board which has been erected in the Stock Exchange for the purpose of calling members, says: "The figures are in black, on a background of white ground glass, and on a member being called a loud electric alarm is sounded, and his number is at once illuminated by a brilliant electric light. As the members called yesterday morning were signalled on the new board they were greeted with loud and continued cheers. It soon became apparent that this magnificent idea represented a fine field for speculation, and many dealers devoted the entire day to betting on which numbers would be the next called. The odds at the start were 44 to 1; but it early became apparent that Nos. 33, 27, and 56 were favourites, and the odds against them had to be moderated. The committee are being most heartily congratulated on this new medium for speculation, which supplies a much-felt want, and has quite superseded the old-fashioned game of pitch-and-toss. There are in connection with the game a variety of combinations which enhance its value as an invention. Owing to the arrangement of the numbers, bets can be made on the lines and also on the columns. The odd and even numbers are also useful. Again, there is some scope for talent in laying against numbers being called, especially if the member to whom the number refers is away for a holiday. A pair of strong champagne suppers might effectually prevent any given number appearing too frequently. Yesterday, a youthful jobber laid 40 to 1 against a number and promptly lost, being apparently unaware of the manipulation of the new invention."

Electricity in the Italian Navy.—The second article written on this subject by Mr. Giulio Martinez for the *Electrical World* of New York is mainly devoted to the switchboard arrangements now in general use in the Italian navy, and which are the outcome of many years' experience. It seems that for gun-firing, dry cells have been used very largely, and that these are made up in the Government laboratories from a formula prepared by the electricians and kept secret. The author, however, states that last year experiments were made with a view to suppressing the dry cells altogether, using instead small direct-current transformers. A number of these small machines were tested, the most satisfactory being those made by Elliott, of London; Einstein Garone, of Pavia, and the Officna Galileo, of Florence. The latter was one of the very best, being extremely small, entirely iron-clad and waterproof; the secondary furnished 200 watts at 12 volts. On open circuit, however, it gave 30 volts, and, owing to the relatively large inertia of the armature and the rather high speed, it furnished a very strong kick at the instant of closing the circuit. This effect rendered this machine much the best for the electric detonators of the guns, notwithstanding that its actual capacity was much the smallest. The electrical firing of guns was not, however, considered to be very successful; so the question of small transformers rather dropped to the ground for want of an object. It had been intended to use them for that purpose chiefly, each group of rapid-fire guns being provided with its transformer. This arrangement the author considers to be rather more rational than that which obtains in foreign navies, and on the Argentine cruisers built in Italy, where a special electrical firing circuit is laid and supplied from a single machine in the dynamo-room.

Braking Power.—With the heavier cars used for electric traction on our tramways the need for more powerful braking efforts than can be obtained from hand-brakes has been proved. It is not so much that a sufficient power cannot be obtained with a hand-brake, but that the use of these brakes entails much manual labour on the part of the driver of the car, and also the fact that if used without judgment the wheels can be locked and an accident caused, as at Bradford. We gather from an editorial from our New York contemporary *Electricity* that with the heavy cars and higher speeds now being used by the Metropolitan Street Railway Company in New York, the need of more ample braking facilities is again apparent. In this case a number of fatal accidents occurring at short intervals, due to the fact that the drivers could not stop the electric cars in time to avoid foot-passengers, has emphasised this need. Our contemporary calls on the company in question to take the matter up before the Street Railroad Commission passes any drastic regulations on the subject. It also states that the Third Avenue Company has decided to equip their new cars with air-brakes, the compressed air being obtained by means of a small slow-speed electric motor coupled to a compressor. Both the motor and the air compressor will be enclosed in an air and dust tight casing. The electric controller and

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the air-brake will be so interconnected that immediately the air-brake is put on, the electric controller will automatically shut off the current from the motor. It seems to us that on an electric car an air-brake is out of place, particularly as this will act on the wheels much in the same way that the present hand-brakes do. An electric braking arrangement is much less liable to cause the wheels to skid, and yet when well designed it will give enormous braking efforts.

Moscow Lighting.—We gather from the *Elektrotecnischer Neuigkeits-Anzeiger* the following particulars of the electricity works just erected by Messrs. Siemens and Halske in Moscow. The firm have adopted in this city a three-phase alternate-current system of distribution, with 2,000 volts between any pair of wires on the primary and 120 volts between the secondary conductors. The cables used for the primary currents are of the three-core type, while the low-pressure cables for distribution purposes are triple concentric, lead-covered and iron-armoured. By the end of last year the firm had laid down in all some 38 miles of high-tension cable and 18 miles of low-tension. The plant and engine-room have been designed to give the greatest possible economy, and to use little coal. For this purpose triple-expansion engines and ejector condensers are used. The steam pressure employed is 170lb. per square inch, and watertube boilers are used. The generating plant now erected consists of two engines of from 500 b.h.p. to 600 b.h.p., running at a speed of 150 revolutions, and two engines capable of giving from 1,000 b.h.p. to 1,300 b.h.p. at 100 revolutions. On the smaller of the engines both three-phase alternators and direct-current exciters are coupled, but the bigger machines will depend for their excitation on these smaller engines. Besides the plant now running, a larger set still, capable of giving from 1,000 b.h.p. to 1,300 b.h.p., is now being erected. Two rotary converters, each of 100 h.p., are also provided to excite the machines when the smaller engines are not running; and, besides this, a small battery of accumulators has been provided and is charged from these rotary converters. Unfortunately, our contemporary does not describe the system of mains which has been laid down, and hence the means by which the three-phase system is balanced is not to hand. Judging from the fact that the triple concentric cable is used for the low-tension work, we presume that the zero wire is not employed. The only thing we are told is that transformers in iron boxes are used in the streets.

Newcastle-on-Tyne Tramways. — What with reports and counter-reports, decisions and recisions, the Newcastle tramways question seems likely to extend over many years yet. A recent contribution to the question is a strong report by Mr. W. G. Laws, the city engineer to the Corporation. In this report, as will be found elsewhere in our columns, Mr. Laws condemns the overhead system in no measured language, and regards the proposal to erect overhead wires as an outrage that would rival the destructive efforts of the Goths and Vandals. When, however, the report is read carefully, it will be seen that no fresh facts are produced against the proposed system, excepting that, as the Council has compelled the Postal Telegraph Department to put its wires underground along the North-road, it would be unreasonable for the governing body to now proceed to put up overhead wires for traction. We could not state from memory the number of telegraph wires which were as a consequence removed, but we quite agree with Mr. Laws that these telegraph wires were unsightly. We, however, deny strongly that the large bundle of them which was disposed of is at all comparable with the side-pole construction supporting two trolley wires that would have to be erected. A great argument, however, is directed against a central-pole construction in the busy streets. It is complained that these poles would seriously check the already slow traffic in those main streets of the town which are of limited width. We think if before condemning the central pole so strongly Mr. Laws had considered that street-lighting from arc lamps in the centre of the roads had been found useful in London in keeping the traffic in two divisions, and also in facilitating the construction of refuges for the convenience of pedestrians, this might somewhat have modified his conclusions. It will be seen, however, that the Corporation do not propose at all to use a trolley in the main streets of the town, and that the question remitted to Mr. Laws was whether a trolley system outside could be worked in conjunction with a conduit system or accumulators in the main streets of the town. This question is answered in the affirmative in the report, and we trust that the tirade against the trolley will be disregarded when the report is under consideration. There is no reason whatever why the open roads on the Town Moor should not be equipped with a well-designed trolley system; the saving in cost over a conduit system is, in this case, fully justified.

Electric Lighting. — We have recently had an opportunity of perusing a report of a lecture delivered by Mr. J. T. Shorrock, L.D.S., R.C.S., at Darwen, on "Electric Lighting in our Houses and Workshops." The lecture is based on the many advantages of the electric light from a sanitary point of view, and the lecturer did not hesitate to go back to ancient history for quotations. Thus he said: "When the shadows of evening fell upon the Nevada canyons the Red Indian still sat in the glow of his camp fire as his fathers did ages ago; the Greenlander had for his only means of lighting the oil from the blubber of the whale; in some parts of Europe there might have been seen the Etruscan lamp of 2,000 years ago. To those who were accustomed to notice all the many strides which had been made during the past 20 years in the mode of production, distribution, and consumption of coal gas, it might seem absurd to liken gas-light in any way to the blubber oil-light of the Esquimo, but one sweeping indictment could be brought against all kinds which were in use in the world at the present time, for they had in common one serious fault, a fault which could not be eradicated by any improvement, and which, in the case of many, absolutely condemned their use for indoor purposes. He alluded, as might be imagined, to the fact that they extracted a greater or lesser amount of oxygen from the air." Mr. Shorrock proceeded to put very clearly before his audience the facts as to the way the gas-light polluted the air in rooms. In the question of cost the lecturer showed an equal appreciation of the true facts of the case when he said that while "the opponents of the new light had pointed out triumphantly how expensive had been up to the present time its application, he would ask them, however, to bear in mind that in many cases no attempt had been made to grapple with the question of cost upon a sufficiently broad basis, for up to the present time the electric current had been generated on an absurdly retail scale. Of what weight then could be the argument that six electric lights running from an engine in the back-yard cost more to illuminate a lecture hall than the gas which formerly lighted it? Or that 100 incandescent lamps in a draper's shop, the current for which was obtained from a dynamo machine working on the premises, cost very much more than 100 gas jets which were fed from a central supply in the town?" Or, we would add, that electric light supplied to one house in four in a long

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street costs more than gas-light taken by each house. The cost question is rapidly changing in favour of electric light even when the indirect savings are left out of consideration.

Incandescent Lamp Testing. — We recently described the equipment of a lamp-testing company in England for ascertaining the value of incandescent lamps, and for ensuring that its customers should only use lamps which would give them good results. We notice in a recent issue of the *Electrical World* a short account, written by Mr. Francis W. Willcox, of some exhaustive lamp tests made on behalf of the Standard Oil Company of America. It seems that this company uses about 17,000 lamps per annum, and that before orders were placed their engineer obtained samples from a large number of lampmakers and subjected these to careful tests. To ensure that there should be no collusion in the matter, the lamps were bought in the open market. The usual test as to vacuum, continuity, and uniformity of the carbon filament was made on all the lamps from each maker, and then they were tested for candle-power and watts. In the article in question a number of diagrams of the results of these tests are given, and in one or two of these diagrams it looks as though the squared paper had been fired at with a charge of small shot from a considerable distance, the points being so widely scattered that the lamps could not possibly be accepted. In another case all but two of the 50 lamps experimented with came within the following specification recommended by the National Electric Light Association Committee—namely, that no lamp which is run at market voltage shall show less than 15 or more than 17½ mean horizontal candle-power. The lamps also group closely round the line represented 3½ watts per candle. In fact, they took on an average less than this. The most important test after all, perhaps, is that of the behaviour of the lamp on extended runs. For this purpose 10 lamps were selected from each batch of 50, and a selection was so made that the lamps started practically at 3½ watts per candle. In the article, five of the curves connecting the candle-power with the light for each lamp are given. A cursory glance at these five curves leaves no doubt whatever as to which lamp-maker the order should have been given. The best curve shows that the average candle-power, starting at about 16, rises during the first 50 hours to about 17 c.p. It then steadily falls, until at the end of 600 hours the lamps gave about 14 c.p. The feature of this series of curves, however, is that all the filaments behaved practically in the same way. Only one lamp out of 10 failed to last the 600 hours, and this showed a life of 350 hours. Three of the other makes of lamps showed a fall in candle-power during the first few hours, while in the remaining set there were lamps which went up to 20 c.p. during the first few hours' run. These, however, had a short life. In all of these four curves there is seen a great divergency in the behaviour of individual lamps. The author considers that a good method in determining the value of these from the life curves is to take the area included below the candle-power curve for each lamp of the batch and to add these together. In this case, however, he does not reckon any area included above the 16½-c.p. line, because he thinks the undue rise at first is detrimental to the lamp. With the five batches in question, reckoning in this way, the following figures are arrived at in candle-power hours. The best batch gave 8,916 candle hours, while the other four gave decreasing values as follows: 7,518, 4,133, 2,819, and 1,993. The article also gives a description of the apparatus used in making the test. The engineer concludes that the best lamps he found were worth 2d. each more than the second best, and practically 3d. more than the third best, even when the cost per unit was taken as low as 1¼d. Of course, a higher cost of current would exaggerate the difference between the actual worth of the lamp to the consumer.

Teslaic Experiments.—In the issue of the *Electrical Review* of New York for March 29 there is an illustrated article written by Mr. Nikola Tesla on some experiments he has carried out with currents of high potential and high frequency. The value of the description in question is much enhanced by the numerous illustrations in which Mr. Tesla himself appears very frequently as operating or supporting the various luminous bodies. The article is chiefly devoted to vacuum-tube lighting, and in the first illustration a bulb 12in. in diameter is shown held in the hand of its inventor, in which a light equal to 1,500 c.p. is said to be generated by the vacuum bulb being held in front of a coil of four turns through which a condenser is discharging. Mr. Tesla adds that "such a powerfully energised coil, when the frequency, as in this instance, is measured in millions per second, shows little repellent action, but when the frequency of the impulses is low, closed conductors, as washers of conducting material, are thrown off with a force of a magnitude which can be only explained on the assumption that the currents have maximum values of many hundred thousand amperes." In the second illustrations a series of diagrams showing the connections adopted by Mr. Tesla in the construction of his high-frequency coils are clearly illustrated, the object being to produce one pole of exceedingly high potential so that it will discharge freely into the atmosphere. This type of coil Mr. Tesla calls the single-terminal coil, and a number of illustrations are given in which it is seen to be discharging very freely. For instance, in Fig. 11 a photograph of the actual terminal is shown such as Mr. Tesla wishes to use for the transmission of electrical energy to great distances without the use of wires. In this case, with a pressure on the terminal of about 8,000,000 volts, the width of space illuminated by the discharge is some 18ft. A good deal of attention is also drawn to the way in which such apparatus can be handled without danger. The author also claims that the energy developed in the bulbs is comparatively small. But no figures are given to enable one to judge whether the high candle-power obtained in several cases is more economically produced than by, say, arc lighting. Another point taken up is the action of these discharges into the air, in which E.M.F. is measured in millions of volts. Mr. Tesla states that such discharges excited powerful affinities in the atmospheric nitrogen, causing it to combine readily with the oxygen and other elements present in the air. This is particularly the case when aqueous vapour is present. In fact, to quote the author verbatim, "so energetic are these actions and so strangely do such powerful discharges behave, that I have often experienced a fear that the atmosphere might be ignited, a terrible possibility which Sir William Crookes, with his piercing intellect, has already considered. Who knows but such a calamity is possible? And who can tell with certitude that periodical cessations of organic life on the globe might not be caused by ignition of the air and destruction of its life-sustaining qualities, accidentally or as a consequence of some accumulative change?" One pleasing feature in the reproduction of the photographs taken in Mr. Tesla's laboratory is that a description of the apparatus used is placed underneath each of these. The author in certain parts of the article refers to his labours in other directions, such as an invention of a means for the annihilation of the English fleet. One cannot help wishing, however, that he would devote his attention more to the development of vacuum-tube lighting until its commercial possibility is either proved or disproved.

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THE PRACTICAL TESTING OF ELECTRICITY METERS FOR CENTRAL STATIONS.

BY C. A. L. PRUSMANN, A.M.I.E.E., ASSISTANT ELECTRICAL ENGINEER, BRADFORD.

(Continued from page 341.)

Resistances (continued).—The liquid resistances as used at Bradford are constructed as follows: Four glass vessels are used, such as the glass containing jars as employed for accumulators; each two of these are fixed in a wooden box, forming two sets of resistances boxes of two vessels each. The vessels are 14in. by 14in. by 12½in. high; the outside dimensions of each of the wood boxes being 32in. long, 16½in. wide, and 18in. high. Into each of these vessels dip two lead plates, 12in. square, the plates being ⅜in. thick, which are attached to a solid brass conductor of square section. These conductors to which the plates are fastened project over the edge of the wood box on either side, and terminate in large terminals suitable for clamping cables which are capable of carrying currents up to 200 amperes and over. Along each side of the wooden boxes run screws cut with a thread of four threads to the inch, the outside diameter of these screws being 1in. Gearing with these screws are metal blocks attached, one on either end of one of the solid conductors carrying the plates in each vessel. The other solid conductor is clear of the screw. These screws are actuated by means of a gear wheel 15½in. in diameter, and containing 180 teeth, which gears into two smaller wheels of 7in. diameter and of 88 teeth, which are fixed one on each of the screws. Fig. 15 gives a plan of one of these resistances. The terminals are numbered in the plan, and we will now trace out the connections on this resistance. Assuming the current to enter at T_1, it flows through the liquid in A to the negative plate; T_6 and T_8 are connected by means of a flexible conductor, and by this means the connection to T_8 is not made solely through the medium of the screws and metal blocks. The connection joining T_6 to T_8 must, however, be sufficiently flexible to allow of the plates connected to these two terminals to be capable of movement in either direction when operated by the gear wheels. From T_8 the current flows through the liquid in B to plate terminating at T_3, the current leaving the resistance at this point With these connections it will be seen the two vessels, A and B, are in series. If, then, two of these complete resistances are provided, by connecting all four jars in series, it will be seen a very considerable amount of resistance is able to be introduced into the circuit. For heavy currents the jars are connected in parallel, T_5 and T_7 being connected together, and also T_6 and T_8, the current entering at T_1 or T_3, leaving at T_2 or T_4. The liquid employed is water with a small percentage of sulphuric acid added. It is not recommended, however, to make the solution too acid, on account of the acid fumes which are given off. It may sometimes be found an advantage to have one of the sets of resistances more acid than the other, the rough adjustment for current being made on the weaker solution resistance, the final one on the stronger. Ordinary salt may be used in place of the acid, but, personally, the author prefers to use the acid. A cover is fitted over the wood boxes enclosing the glass jars, and the resistances themselves should be fixed in the room containing the battery, the gear wheels and operating handles of the resistances being carried through the partition separating the battery-room from the test-room. The operating handles should be situated just below the table used for the standard instruments. Anyone seated in a chair can then operate the resistances, having at the same time the scales of the standard balances in a convenient position for inspection. By this arrangement of resistances the actual liquid is practically kept outside the meter-room itself. In using liquid resistances of this sort it must be kept in mind that on closing the circuit to commence a test, the current will immediately vary, and must be kept constant by operating the plates. The author has found, however, that this variation is up to a certain point very regular, and the current is easily kept steady by a slight adjustment on the gear wheels. If the test extends over some time, it will be found that the current after a little while remains practically constant. The resistances as described above have been found to deal with currents as high as 800 to 1,000 amperes when the four jars are connected in parallel, for the very short periods of time such heavy currents are required for meter testing. This then disposes of the resistances required in the main circuit for ordinary meter work. We will next turn our attention to the adjusting resistances for the pressure circuits used in the cases of energy meters. The shunts of this class of meter are connected to a circuit having a pressure practically the same as that on which the meter is to work when fixed in the consumers' premises. Like the current in the main circuit, the voltage of the pressure circuit is also required to be kept constant during a test. A suitable resistance for this purpose will be described in the next section, and we may incidentally observe that it is similar to those used at the Bradford works.

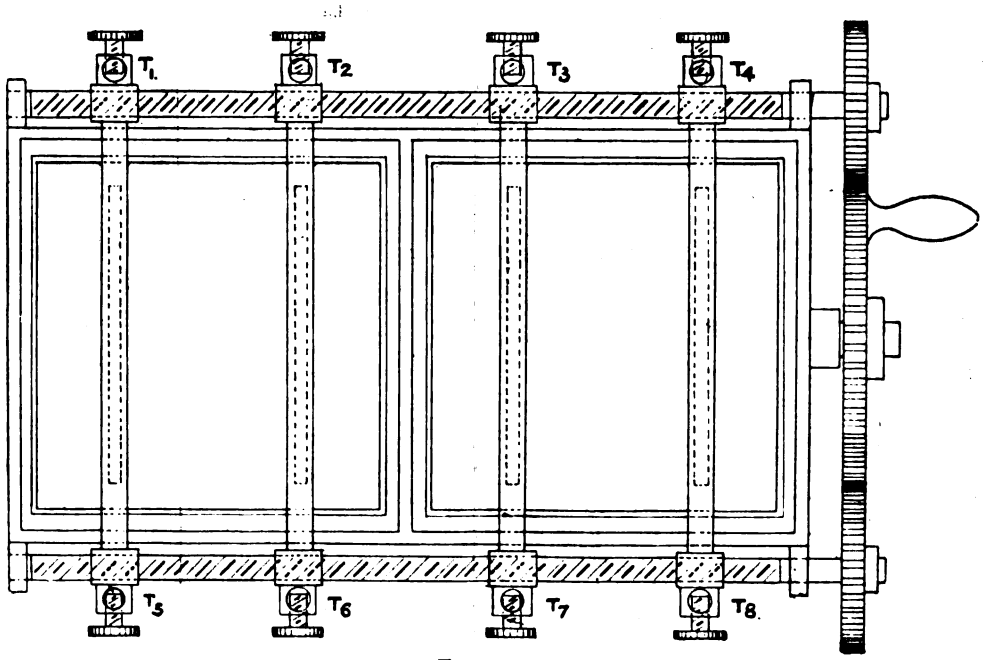

FIG. 15.

(To be continued.)

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NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

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CLVIII.

Before bringing these notes to a close, I think I am called upon to mention several forms of storage battery which, either in their present or in a modified form, have a greater or less chance of survival in the competitive struggle for existence which is now commencing in earnest. With these I would fain include some suggested improvements, some of which are of an original character, but are only in the experimental stage; for obvious reasons, however, most of these cannot be made public. Some batteries there may be that I do not know of or know little about; others there are which do not appear to me to have the slightest chance of survival.

Prima facie, the Gülcher accumulator* seemed, and seems, to be a very likely form of battery for traction. Its essential feature is that the supports of the active material consist of a tissue in which leaden wires form the warp and threads of spun glass the weft. The active material is retained within the meshes of the tissue, and is said to adhere so strongly that the most violent shaking cannot detach it. It must be admitted that plates so constructed are not liable to buckle. They are prevented from coming into contact by a layer of elastic spun glass, with which they are encased.

From the results of some experiments carried out in 1896 I arrive at the following values, in which, as usual, "lb." signifies pounds of cell complete:

$$\frac{\text{Amperes}}{\text{lb.}} = 1{\cdot}6\,; \quad \frac{\text{Ampere-hours}}{\text{lb.}} = 7.$$

From these it appears that the time of discharge was 4 hours 22½ minutes. These values are very high, and it is somewhat difficult to understand why the batteries of the Gülcher-Accumulatoren-fabrik at Berlin have not been brought into greater prominence.

Mr. A. Treadwell says that the Gülcher plates were tested for traction purposes by two large German firms, and that it was found after three months of hard usage that the plates were uninjured and their capacity unchanged. The plates were made with a frame, and with parallel lead wires, around which was woven elastic glass wool, the weaving resembling that of a wicker basket. In manufacture, the plate is said to have been "saturated with a concentrated solution of lead acetate and dilute sulphuric acid," which might more properly be called a solution of sulphate of lead in acetic acid. Mr. Treadwell gives the curves of rise and fall of potential in charge and discharge, and also mentions the capacity of the cell and the currents of charge and discharge. But the weight of the cell is not given, and without this the other information is of little practical use. The density of the normal current of discharge was about ·03.

CLIX.

According to the data published by the Lithanode Electric Storage Company, Limited, the specific rate of discharge and the specific capacity, under normal conditions, are expressed by the following ratios:

$$\frac{\text{Amperes}}{\text{lb.}} = \frac{3{\cdot}5}{8\,25} = {\cdot}42, \text{ and } \frac{\text{Ampere-hours}}{\text{lb.}} = \frac{30}{8{\cdot}25} = 3{\cdot}63.$$

The time of discharge under these conditions is

$$\frac{3{\cdot}63}{{\cdot}42} = 8{\cdot}64 \text{ hours, or 8 hours and 38 minutes.}$$

The maximum safe discharging rate per cell weighing 8½lb. is given as from three to four amperes—*i.e.*, from 1·1 to 1·45 amperes per pound of cell. The normal charging rate is three amperes for a 30 ampere-hour cell, and the normal period of charge would thus be 10 hours.

A battery of 240 cells of this company's manufacture was supplied in connection with the electric lighting and power installation at Vera Cruz, and appears to have given satisfaction. But the above figures, as compared with those applicable to other batteries, are certainly not very encouraging from the point of view of the use of this accumulator for electric traction. In connection with this battery, it has been stated that the storage capacity of 1lb. of lithanode at a low rate of discharge is about 16 ampere-hours, or almost exactly one ampere-hour per ounce, but that in practice this "high capacity" is never reached. Now, when a plate of lithanode is used, as in the original form of the battery, with a small platinum contact, so that, whilst local action is entirely obviated by the absence of any lead, the conductivity of the lithanode itself has to be depended upon for the discharge of the plate, one ampere-hour per ounce of active material may be considered a satisfactory capacity. But (Section III.) when the ordinary mode of establishing contact by means of a lead grid is adopted, the capacity of 1oz. of peroxide active material at a low rate of discharge should be at least 1·72 ampere-hours. The capacity actually obtained per ounce of the company's lithanode does not reach half this value.

CLX.

Mr. Thos. W. Allan, A.I.E.E., who was once in the employ of the Lithanode and General Electric Company, Limited, has done better with a peroxide active material very similar to lithanode, but of which the exact composition and mode of manufacture have been kept secret. The Allan cell is manufactured by Allan and Adamson, Limited; and, according to the latest data published, "its rate of discharge for three hours is 1·5 amperes per pound weight of complete cell, whilst its average capacity in watt-hours at a similar discharge rate is equal to nine per pound weight, the total ampere-hour capacity being equal to six amperes per pound weight, *also* of complete cell." These figures are puzzling, and apparently involve some mistake. If the time of discharge be three hours and the current 1·5 amperes, the capacity per pound is $3 \times 1{\cdot}5 = 4{\cdot}5$ ampere-hours, instead of six. Moreover, capacity is not measured in "amperes per pound weight." If the capacity per pound be nine watt-hours and the time be three hours, then the rate of discharge is $\frac{9}{3} = 3$ watts per pound. But in this case the mean voltage should be:

$$\frac{\text{Watt-hours}}{\text{Ampere-hours}} = \frac{\text{watts}}{\text{amperes}} = \frac{3}{1{\cdot}5} = 2 \text{ volts};$$

which is practically the maximum potential difference, and is too *high* a value for the mean E.M.F. during the discharge of any lead storage battery. On the other hand, if we take the watt-hours per pound at nine, and the ampere-hours at six, according to the figures given, then the mean voltage would be:

$$\frac{\text{Watt-hours}}{\text{Ampere-hours}} = \frac{9}{6} = 1{\cdot}5 \text{ volts};$$

which is far too *low* a value even for the final voltage of discharge—since this should be 1·85, or certainly not lower than 1·80. Possibly what is meant is that, although the rate of discharge was 1·5 amperes per pound of cell for three hours, the discharge was afterwards continued at a lower rate; the time of discharge not being limited to three hours. But, assuming this figure to be correct, the specific rate of discharge and capacity applicable to this battery would be:

$$\frac{\text{Amperes}}{\text{lb.}} = 1{\cdot}5\,; \quad \frac{\text{Ampere-hours}}{\text{lb.}} = 4{\cdot}5.$$

The latter value, however, is far from being in accord with the following quotation from a tender submitted by the firm in relation to a battery required for an electrically-driven cab:

"Forty cells of 210 ampere-hours *guaranteed* capacity. The weight of these cells, complete, will not exceed 1,300lb., and they will measure outside 35in. × 34in. × 12in. high."

Although this is not stated, we must assume that 210 ampere-hours is the capacity of *each* of the 40 cells, and that 1,300lb. is the *total* weight of this number of cells. Each cell, then, will weigh $\frac{1{,}300}{40} = 32{\cdot}5$lb.; and the ampere-hours per pound of cell will be:

$$\frac{210}{32{\cdot}5} = 6{\cdot}46.$$

* British Patent, No. 6,947, 1894; American, No. 562,396, 1896.

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Reporting, in 1896, on this accumulator in its original form, Mr. H. T. Harrison stated that "the capacity of these cells for their weight is decidedly good, considering the strong way in which the plates are constructed. In comparing them with the best known make of a similar type of battery, I find that the latest type of cell, weighing 8lb., has a capacity of 14 ampere-hours at a discharge rate of ·5 to 2·6 amperes; whereas an Allan cell, weighing less than half, at a discharge rate of ·5 to 2 amperes, has a capacity of 15 to 20 amperes, thus making it less than half the weight for a slightly greater capacity."

According to this, when the rate of discharge is from ·5 to ·125 ampere per pound of battery, the capacity is from 3·75 to 5 ampere-hours per pound.

From experiments which I have witnessed I am able to state that the original Allan cell would withstand, without apparent injury, enormous rates of discharge, the cell being nearly, if not quite, short-circuited.

The Allan cell is open to the objection, referred to in Section CLVII. and elsewhere, that the support, in the form of a hollow frame with lattices extending from edge to edge on both its sides, offers a considerable surface of metal in direct contact with the electrolyte. On one occasion it was noticed that the cell was placed under a disadvantage owing to the weight of the electrolyte not having been duly proportioned to the weight of active material, in accordance with the formula given under Section CVI.

CLXI.

The Hatch accumulator practically realises the idea of a "dry" or afluidic secondary cell. Its essential characteristic is that the active material is pasted on to a plate of porous earthenware, which, in the most recent form of the cell, is formed with square receptacles on the side to be pasted, and with broad grooves on the other. The elements are made up simply by placing a sheet of lead between the pasted sides of two earthenware plates: these elements, to be alternately peroxide and spongy lead when formed, being arranged so that the grooves cross, and allow some electrolyte to be confined between them.

The Hatch battery is suitable for a variety of purposes; but, although the elements constructed as above are considerably lighter than grid elements containing the same weight of active material, the resistance of the earthenware plates and the absence of circulation in the electrolyte, more especially where it is in contact with the active material, disqualify it as a battery for traction.

CLXII.

The Boese-Lutcke plate somewhat resembles lithanode. The solid slab of active material is enclosed in a lead frame, like that of a slate. The slab for the peroxide plate is formed of red lead, that for the spongy-lead plate being made of a mixture of litharge and red lead. These materials are made into a paste with alcohol containing in solution certain hydrocarbons, the one specially mentioned being *anthracene* ($C_{14}H_{10}$), obtained in the last stages of the distillation of coal tar.* After being moulded and pressed into the frame, the plates are perforated with a number of small holes, then baked, and placed in dilute sulphuric acid to harden, after which they are "formed" by electrolysis. According to Treadwell, more than 20,000 cells made with these plates are in use on the German and Hungarian postal railway cars for lighting, and are found very satisfactory.

ELECTRICITY ON AMERICAN VESSELS.

BY J. MCGHIE.

(Continued from page 436.)

In the equipment of the twin-screw ss. "Northwest" electricity enters not only into the lighting, but also a little into the power work of the ship. The "Northwest," built for passenger service only on the great lakes, plies between Buffalo at the extreme east of Lake Erin Basin to Duluth, at the west of Lake Superior, and is one of the latest vessels built for the Northern Steamship Company. She is 383ft. over all, 44ft. beam, and 34ft. 5in. deep to spar deck. She has a registered tonnage of 4,482 tons gross, and is constructed to carry 653 passengers and 147 crew. Her boilers, 28 in number with a total grate surface of 812 square feet, are of the Belleville water-tube type, supplying steam to the engines at 195lb. The two engines are vertical quadruple expansion, designed to develop 3,500 h.p. each at 120 revolutions per minute, and to propel the vessel at 20 miles an hour.

The electrical plant of the "Northwest" consists of three units, each a vertical triple-expansion engine directly connected to its own dynamo. The capacity of each unit is 400 16-c.p. lamps. The pressure of the current is 110 volts when the dynamos are making 300 revolutions. Each engine has a separate condenser. The bed-plates of engine and dynamo are cast in one piece, as are the cylinders, which are supported on eight steel columns. The main crank is a solid forging, and runs in self-oiling journals lined with gun-metal. One end of the crank is a forged flange, to which the armature shaft is bolted. The dynamos are of the four-pole type, with two sets of brushes, and outboard bearing. The switchboard is so arranged that the lighting

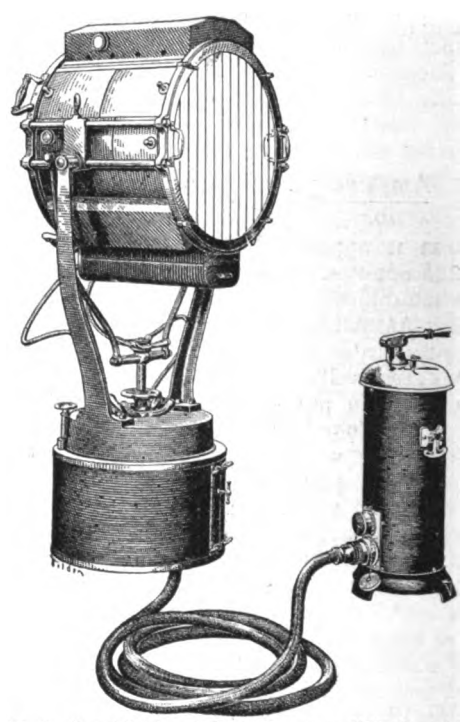

FIG. 9.—Searchlight and Controller on ss. "Northwest."

of the entire boat may be thrown on one machine, or the load can be divided equally and automatically between them, or one machine can be used for the searchlight and the other two for the ordinary lighting. The vessel is wired in accordance with U.S. navy rules. All wires are enclosed in heavy mouldings, and pass through the bulkheads through heavily rubber-bushed tubes. All the circuits are controlled from a 30-circuit switchboard in the engine-room, and the wiring system is so planned that fuses are necessary at two points only—on the board, and at the lamp bracket or chandelier. The distribution board is of white marble, with the circuits running from each side, the odd numbers to the right, the even to the left. The rheostats are of the enamelled type—*i.e.*, with the resistance wires embedded in the enamel. The fuses are enclosed in glass tubes, and are held in clips in a similar manner to those on the "Priscilla." All the wiring is effected on the face of the board, which is 40½in. wide, 80in. high, and 1½in. thick. The decorations and furnishings of the boat are in mahogany. The main saloon is almost barbarously luxurious with its amber-tinted glass and rococo decorations of mahogany with russet-green panels. The ladies' parlour is in primavera of Mexico with grey-blue carpeting. The dining-room is less gorgeous, although rich in mirrored sideboards, etc. It will seat 150 people.

* I think there must be a mistake here; for anthracene, or *paranapthulin*, is nearly insoluble in alcohol; this solvent being, indeed, used to dissolve out the *napthalin* which distils over with it.—D. G. F.-G.

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The lighting is effected from clusters and single lamps. The staterooms are lighted by 16-c.p. lamps, enclosed in ground-glass globes, lighted and extinguished by a switch placed at the head of the berth. Panels in the main saloon running parallel with the staterooms are also fitted with 16-c.p. lamps, also in ground-glass globes. The lighting in the engine-room is such that every part is fully illuminated. The signal lights, each of 100 c.p, are connected to an automatic alarm on the pilot-house which notifies the pilot by the ringing of a bell should either of the lamps become extinguished. Each stateroom is connected to the purser's office by an electric call-bell.

The "Northwest" is equipped also with a searchlight (Fig. 9) placed on the deckhouse of the pilot-house. It is 7ft. 6in. high, burns 1¼in. carbons, and has an initial power of 100,000 candles. The reflecting lens, 30in. in diameter, is of the spherical type, and the lamp mechanism is automatic. Movement of the searchlight drum, upward or downward and to the right and left, is effected by similar movements of the handle of a special controller placed in the pilot-house.

Between the pilot-house and engine-room is a very perfect system of signalling. By pressure of any one of the several buttons in the pilot-house and on the bridge the steam whistle is blown, and by setting an electric switch the fog signal is blown, giving a blast of 10 seconds' duration every minute. By a clockwork device each blast and its duration are recorded on a strip of paper. Between the main deck and the hold, where the ice is made and stored, is an electric hoist of 3,000lb. capacity. This is

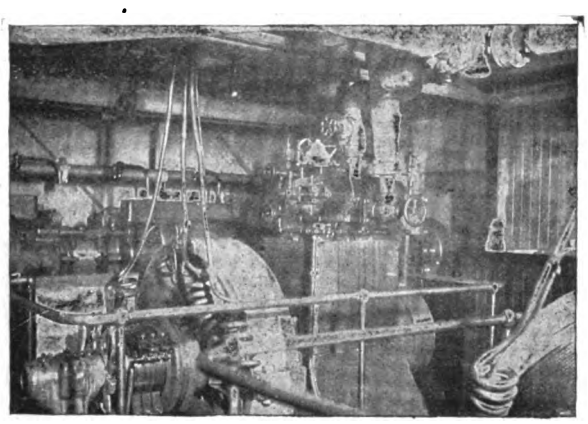

FIG. 10.—Starboard Side of Dynamo-room, ss. "La Grande Duchesse."

controlled by a double-throw switch, shown in the illustration. If the switch is closed while the elevator is on a level with the main deck, it is lowered automatically to the hold, where it is stopped automatically. Throwing the switch to the other points hoists the elevator, which is stopped automatically as soon as it reaches the main deck.

The electric equipment of "La Grande Duchesse," the latest edition to the Plant line of steamers plying between New York and Savannah, is much more complete than on the "Priscilla" or "Northwest." "La Grande Duchesse" is 404ft. long over all, 47ft. 9in. beam, and has a displacement of 5,600 tons on a mean draught of 17ft. 4½in. She is propelled 17 knots an hour by twin screws, each driven by a quadruple-expansion surface-condensing direct-acting engine of the marine type. Steam is supplied by eight water-tube boilers placed back to back along the centre line of the ship. The total grate surface is 550 square feet; forced draught is used. The working pressure of the steam is 225lb. She is constructed to carry 700 passengers and 150 crew.

Electricity on "La Grande Duchesse" is used for seven separate and distinct purposes. The dynamo-room is a separate room aft of the engine-room. The electric power plant consists of two 20-kw. generators, each directly connected to vertical compound engines. Steam for these engines is reduced to 140lb., at which pressure the engines give 550 revolutions per minute. The leads for the generators are led to a polished black slate switchboard 5ft. square and 2in. thick. This board is fitted with two dynamo switches, 15 feeder switches, motor switch, voltmeter switch, three ammeters, and one voltmeter, one ground detector, and two enamelled rheostats. Two of the ammeters are connected into the generator mains, the other into the searchlight circuit. The rheostat for the projector is bolted to the deck beams.

The vessel is wired on the two-wire system, and the wiring is carried out on the same manner as in the

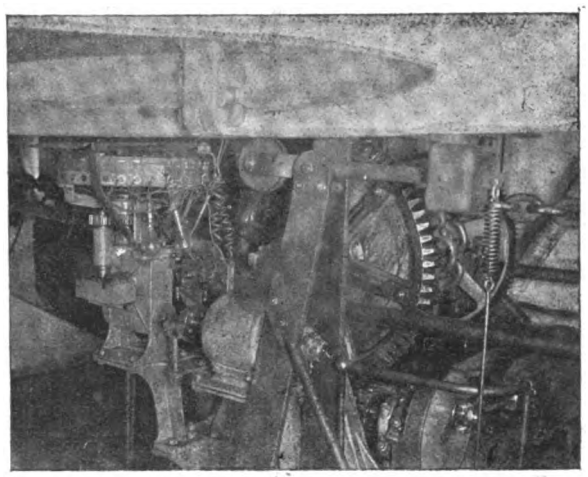

FIG. 11.—Telemotor attached to the Steering-Engine, ss. "La Grande Duchesse.

"Priscilla," the standard naval appliances previously mentioned being used. Ten distributing panels of blue Vermont marble are placed at convenient points on the different decks. The panels are enclosed in glass-fronted cabinets, and the wiring is so arranged that not more than eight lights are on each circuit. Each stateroom is fitted with a one-lamp bracket, with the switch placed at the head of the berth. The remaining five feeders are devoted, one to the searchlight, three for the cargo circuits, one for the running lights, and two for the motors operating the coal-trimming apparatus. The total number of 16-c.p. incandescent lamps on board "La Grande Duchesse" is 700. The searchlight is 12in. in diameter, fitted with a 12in. spherical reflector. It is fixed to the foremast just above the pilot-house.

The steering engine, instead of being placed below the wheel-house, is placed aft in the tiller-room. It is operated by a telemotor (Fig. 11) controlled from the pilot-house. In front of the steersman is an ordinary wheel, carried by a brass column, on top of which is an indicator showing the exact angle to which the engine should bring the rudder when the wheel is turned. The controller and telemotor are connected by No. 26 wire. The telemotor responding to the motion of the hand-wheel, instantaneously regulates

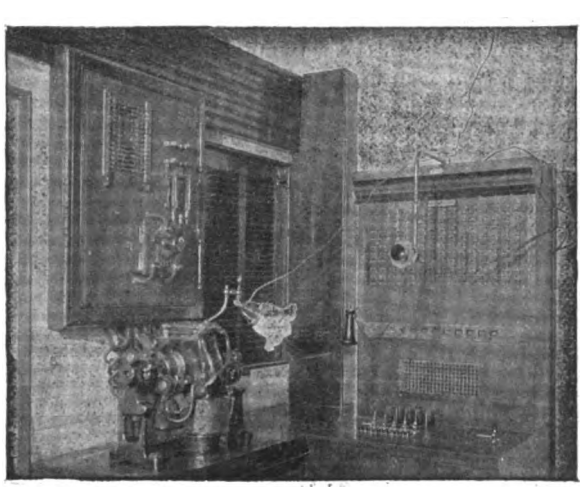

FIG. 12.—The Teleph ne Exchange, ss. "La Grande Duchesse."

the admission of steam to the steering engine cylinder. An electrical rudder indicator, wired to a sliding contact on the rudder quadrant, and fixed to the left-hand wall of the pilot-house, shows the exact position of the rudder. A "tell-tale" panel is also arranged in the pilot-house. This carries incandescent lamps corresponding to the running

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lights. Should any of these latter be extinguished a bell would be rung. At 14 different points on the hold are thermostats connected to an annunciator board in the house. This forms a complete fire-alarm system.

"La Grande Duchesse" is equipped with a telephone central station (Fig. 12) connected to 150 individual state-rooms, officers' rooms, pilot-house, and engine-room. This exchange is on the starboard side of the main deck cabins. The current for the telephone work is obtained from storage batteries, which are charged at eight volts from a motor-generator connected to the lighting circuit.

The coal-trimming apparatus is also electrically driven. The bunkers run across the vessel fore and aft of the boiler-room. Eight openings into these bunkers, each 20in. by 27in., are provided with cross-bars 7in. apart to prevent the passage of large lumps of coal into the conveyors; across the top of the bunkers run the conveyors, each of which is an endless sprocket chain with scrapers 16in. wide and 18in. deep, and 30in. apart. In the under sides of the conveyors are slides, each opened and closed by a rack and pinion worked by a hand-wheel. The driving shafts of the conveyors are on the starboard side, and are connected to 15-h.p. motors in the boiler-room through spur gearing, motors and gears being enclosed in dust-proof casings. The coal is loaded in the usual way into the chutes, and falling into conveyors through the grating, is carried along to the open slide, through which it falls into its allotted bunker. One man suffices to attend to the slides, and four or five to trim off the mounds which form in the bunkers beneath each. The average rate of coal-loading is about one ton per minute, from one side only.

(To be continued.)

ELECTRIC TRACTION AND ITS APPLICATION TO SUBURBAN AND METROPOLITAN RAILWAYS.*

BY PHILIP DAWSON.

(*Concluded from page 446.*)

The little locomotives in use on the New York system weigh 47,000lb., of which 31,500 are on the four 42in. driving wheels, and 15,500 are on the four 30in. truck wheels. The total wheel base is 193in., of which 60in. is rigid. The cylinders are 12in. in diameter, and have a 16in. stroke. The grate area is 16·5 square feet, and the total heating surface is 4,034 square feet. There are 154 flues, 1½in. in diameter and 75in. long. The standard Manhattan car weighs 29,088lb., has seats for 48, and frequently carries 100 passengers. It is mounted on eight 30in. wheels. The total weight of a five-car loaded Manhattan train is about 130 tons. The weight on the drivers is 12 per cent. of the total train weight, and with 25 per cent. adhesion, the maximum drawbar pull possible for the locomotive to exert is 7,875lb.

The electric locomotive car of the Metropolitan Elevated Railway Company, of Chicago, weighs 53,200lb. complete with motors, or 40,000lb. exclusive of motors. It is a standard American passenger car with full seating capacity, about one-half of each platform being taken up with the cab and necessary controlling apparatus. The trail cars weigh 33,000lb. The seating and standing capacity of both motor and trail cars is approximately 90 passengers. The average four-car heavily-loaded train will weigh about 100 tons, of which 32·5 tons approximately are on the four wheels of the locomotive's motor truck, and 67·5 tons are in the trail cars. From 30 to 35 per cent. of the entire train weight is available for traction under these conditions, and the maximum drawbar pull possible to exert without slipping of wheels is about 16,250lb.

The South Side Elevated Railway Company, of Chicago, is equipped with the Sprague multiple-unit system, by means of which two or more cars in a train are equipped with motors and may be operated in unison by a single controller from any point in the train. The company is now operating four-car trains on each of which is a motor truck carrying two motors. The cars weigh about 20 tons each without load, and about 60 per cent. of the train weight is available for traction.

There are therefore three distinct types of elevated railway equipment, the steam locomotive using 10 to 15 per cent. of the train weight for traction under heavy traffic conditions, the electric locomotive using 30 to 35 per cent., and the multiple-unit system using any amount desired up to 60 per cent. of the train weight.

The transportation expenses of the South Side Elevated Railway in Chicago for July, August, and September, 1897, when steam locomotives were employed, were 2·8 cents per car mile, while in the same months of 1898 they were 1·9 cents per car mile, or a saving of nearly 0·9 cent, or about 33 per cent.

Metropolitan District, London.

Average speed in miles per hour	13½.
Maximum ,, ,,	27.
Minimum time between consecutive trains	2 minutes.
Average time between consecutive trains	3½ to 4 minutes
Total weight of train	161 tons.
Average carrying capacity	450 passengers.
Weight of locomotive	47 tons.
Average distance between stations	2,600ft.
Time required, in seconds, to reach 25 miles an hour, starting from a standstill	30 seconds.

The figures in the above table show at once the great advantage to be gained by electric traction, by means of which a speed of 25 miles an hour could be obtained in 10 seconds, and by simple calculation it is easy to ascertain that this would greatly increase the average speed, and therefore decrease the time necessary to do the distance.

The characteristic difference between the acceleration curve of a train hauled by a steam locomotive and one driven electrically is that whereas the acceleration where steam is used as motive power increases at first slowly, following a curve which is nearly tangent to the horizontal or time axis, the acceleration curve in the case of electric propulsion is represented by a straight line rising very rapidly, and forming a very small angle with a vertical axis.

It may be interesting to mention a few details regarding the two large power stations which are now being equipped in New York, and which will operate the two large tramway systems of that city—namely, the Metropolitan and the Third Avenue. The Metropolitan station is now under construction, and will contain 11 direct-connected sets, each of 3,500 kw., room for extension being allowed, and a capacity having been foreseen of nearly double that amount. The following gives the particulars of the General Electric Company's dynamos which will be used.

The machine will have a frequency of 25 cycles per second at 6,600 volts. It will have 40 poles, and will run at a speed of 75 revolutions per minute. It will be of the stationary armature type, the core being built up of laminations ·014in. thick. Each lamination has two dove-tail projections which fit in corresponding slots in a heavy cast-iron spider. Spaces are left between the laminations at intervals through which currents of air are driven by the rotating field and circulating by intimate contact with core and windings. The armature winding consists of former-wound coils placed in slots in the core and retained by wooden wedges, the edges of which fit into recesses in the teeth. The field frame consists of a cast-steel ring supported upon a cast-iron spider; to this are bolted laminated core of sheet iron, the pole-pieces of which project over and support the copper field windings. The field windings consists of copper strip wound on edge with paper insulation between turns. The insulation is such as to stand a test of 4,000 volts alternating between the winding and the core. The exciting E.M.F. is 125 volts. The collecting rings are of copper, and carbon brushes are used. The armature winding is tested to 12,000 volts alternating. The temperature rise of the machine after 10 hours' run at full load is well under 40deg. C. The efficiencies are as follows:

	Per cent.		Per cent.
One and a-quarter load ...	90	Half load ...	92·5
Full load ...	95·5	Quarter load ...	88
Three-quarter load ...	95	Inherent regulation ...	9

The steam-engines which drives these dynamos are cross-compound Allis vertical engines, 46in. high and 86in. low pressure cylinders, and 60in. stroke. They will develop

* Paper read before the Society of Arts, March 22.

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4,500 i.h.p. at the rated economical load, and will be able to work continuously at 6,000 h.p. if required, and for a short space of time they are to be able to work at 7,000 h.p. The crankshaft is of solid steel, bored and forged, with a hole 16in. diameter the entire length, and it is 37in. in diameter where the wheel and armature are located. The diameter of the shaft in the bearings is 34in., and the length of the bearings 60in. The flywheel will have cast-steel centres, and the rim will be built up of steel plates riveted together. The rim will weigh 225,000lb., and the engine itself, complete, about 600 tons, and it is believed that as good results as 12½lb. of steam per indicated horse-power will be easily obtained. There will be several sub-stations, in which will be located step-down transformers of 300 kw. each, which will lower the voltage from 6,600 volts to 350 volts. At this pressure the current will enter rotary converters of 900 kw. each, and will be delivered in the shape of a continuous current of 500 volts to the tramway system. This company operates some 250 miles of tracks, and carries approximately 250 million passengers every year.

The Third Avenue road is now engaged in equipping all existing horse and cable lines with electric traction, and for this purpose has just given out a contract for a power station which will eventually contain 16 3,000-kw. generators. The generators will be very similar to those described above, and are being built by the Westinghouse Company, who are the sole contractors for the whole work. The engines will be marine type (vertical), and are being built by the Westinghouse Machine Company. Sub-stations with rotary transformers will be used, as in the case of the Metropolitan system.

To give an idea of what may be done as regards power transmission, the following few figures may be useful: The first attempts at this class of work were made during the Frankfort Exhibition of 1891, 300 h.p. being satisfactorily transmitted a distance of 106 miles with a pressure of 30,000 volts. Since that time electrical power transmission has largely increased, and the results obtained have been very satisfactory; 4,000 h.p. at the present moment are regularly transmitted a distance of 85 miles to the city of Sacramento, California, at a pressure of 30,000 volts, where they are transformed into low-pressure three-phase and continuous current for lighting, power, and traction purposes. At Telluride, Utah, 1,000 h.p. are transmitted 55 miles at a pressure of 40,000 volts; 4,500 h.p. are transmitted a distance of 40 miles to Salt Lake City at a pressure of 15,000 volts; 1,400 h.p. are being transmitted 35 miles to Fresno, California, at a pressure of 11,000 volts; 2,000 h.p. are being transmitted 30 miles to West Kootenay, British Columbia, at a pressure of 20,000 volts; 10,000 h.p. are being transmitted from Niagara to Buffalo, a distance of 22 miles, at a pressure of 10,000 volts. All the plants are working and giving satisfaction, and have nothing experimental about them, and there are hundreds more such.

In the designing and carrying out of a large system there are three points which are frequently overlooked, and which may cause a disastrous failure. These are good and adequate bonding; thoroughly good insulation, both mechanically and electrically; and trucks suited for the work for which they are intended. As regards the bonding, the bonds used should be flexible, but at the same time should contain no solder or brazed joint, and they should be expanded against the side of holes drilled in the web or foot of the rail, and held in place by pins. Bonds of this description, when properly applied, can be absolutely relied upon, the contact resistance of the bond with the rail not being greater than the resistance of the solid bond. With regard to the third-rail insulators, very good results are obtained by using insulating bolts screwed into base-plates which are fixed to the sleepers, cast-iron chairs being fixed to the head of the bolts to hold the rails.

Discussion.

Prof. Carus Wilson presided in the absence of Sir Frederick Bramwell, who was unable to attend in consequence of a severe cold. Diagrams and views shown on a screen were liberally furnished as illustrating electric traction developments at home and abroad.

The Chairman said he was sure he should only be consulting the feeling of all present in expressing his sense of gratitude to Mr. Dawson for having given them so much information on a subject of such wide interest. He then proceeded to allude to various points suggested by the paper. One of the most important considerations referred to was the practical impotence of steam locomotives to compete with electro-locomotives in regard to rapid acceleration. His own idea, however, was that steam engineers were only just beginning to awake up to the importance of designing steam locomotives for rapid acceleration, and he entertained very little doubt that when they began to find out the serious competition of the electro-locomotive they would introduce much better results than were at present apparent.

In the course of the discussion, **Sir Trueman Wood** said he considered the public ought to begin to insist on having electric traction on the Metropolitan Railway. When they were drawn through those awful tunnels, and through that frightful atmosphere in which they were nearly asphixiated every time they travelled, they had a right to demand that if anything could be substituted for the steam locomotive this should be done.

In the course of further discussion, electric traction in its various phases at home and in the United States was referred to, and a hope expressed that the idea would not emanate from the Society of Arts that the trolley system in America was doomed in favour of the conduit system, as it was only in special circumstances that the more expensive conduit system could be adopted. It was also argued that it was our pig-headedness which had kept us back in regard to electric traction, with the result, however, that when we really did start we did the work well, and much better than it was done in other countries.

Mr. Dawson replied to most of the points raised, and welcomed Sir Trueman Wood's remarks with respect to the motive power on the Metropolitan Railway. If transformed to electricity, this would not only cost less to work but, a great many more people would travel on the line, and of course increase the receipts correspondingly.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. Questions may be sent at any time. Answers must be written on one side of the paper only.

Questions.

157. What are the points to be attended to in switchboard design?—F. W. P.

158. Supposing a dynamo (shunt, series, or compound) fails to excite, make a list of the faults or defects that should be sought or tested for, putting them in their proper order.—J. C. R.

Answers.

Question No. 151.—Why do most dynamos spark less with carbon than with copper brushes, proper contact being given each?

[We have bracketed the first two answers as being equal in merit.—Ed. *E. E.*]

Answer to No. 151 *(awarded 7s. 6d.).*—While it is quite a well-known fact that the use of carbon brushes prevents sparking in dynamos, it is not easy to give the exact reason for their effect. C. A. Carus-Wilson discusses the question in his work on "The Direct-Current Motor," but expressly talks of "the little-understood action of the carbon brush." With copper brushes on a properly-designed dynamo no sparking should occur provided proper attention is given to the brushes, but in a power installation, where the motor load varies considerably without warning, it is not always possible to give sufficient attention to the brush lead, and it is in such a case as this that the advantage of carbon brushes is most felt, because they can be set in one position for all loads, and afterwards require no alteration. The reason, while not at all clear, is probably as follows: In the case where the brush is in the theoretically correct position—*i.e.*, when it rests on commutator strips whose coils have just passed the point where their E.M.F. changes sign far enough to allow the reverse current to reach its

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proper strength on commutation—there will be no sparking at all with any brushes. Assume, however, that the brush is in some other position. Then, without entering into explanations fully which do not actually come under the head of the question, it is sufficient to say that the passage of coils under the brush will no longer be done without any great change of current, but will rather occur accompanied by a "jerk" in the current flow in the coil short-circuited by the brush. If the brush be too far back, it will be actually generating E.M.F. in the wrong direction when under the brush; and as the resistance is low a large current will be set up, which, on the commutator segment leaving the brush tip, will cause sparking. And if the brush be too far forward, sparking is again caused in equally well-known ways. It is evident, then, that a large factor in sparking is the low resistance of the circuit composed by a single coil and a brush, if the brush be copper. But in the case of a carbon brush this is altered, because the contact resistance of carbon on the copper commutator is much higher than that of copper, and hence, even if the E.M.F.'s are generated, the currents are not large enough to cause the destructive sparking. The contact resistance of the two types was investigated in 1895 by Messrs. E. V. Cox and H. W. Buck, who published their results in the *Electrical Engineer* of New York for that year. Besides proving that the contact resistance of a carbon brush is higher, they further proved that the friction with a carbon brush is less than with a copper brush. This, too, has a preservative tendency, because it means that the commutator will not wear so much, and will hence probably remain true longer, so that there will be less unevenness to cause jerking of the brushes, another fruitful source of sparking. Even if sparking should take place it is not so severe with carbon brushes, for this reason, that the carbon is softer than the commutator, and hence is more easily rubbed away. The effect of the sparking therefore is to leave the commutator intact and consume the easily replaced carbon brushes.

Another point is that because of their high contact resistance, carbon brushes must be made of greater section than copper brushes. The usual density is about 25 to 35 amperes per square inch of contact surface as compared with, say, 150 to 200 in copper. This means that unless the commutators are very long the brushes will be fairly thick. This is also an advantage, because if the brushes be set so that at no load the point of commutation is just at the back of the brush, unless the variation in lead is great the point of commutation at full load will probably also come under the brush near the front. Hence there is no necessity to shift the brush even from a theoretical point of view. And even if the brush by its thickness covers two or more commutator segments, the high contact resistance will prevent any bad effects from the short-circuiting of the extra coils. As carbon brushes are of themselves rather soft to stand the tangential pull owing to friction, they are often strengthened by having copper wires run up their centre. In other cases they are supported by plates inserted in the brush-holder at either side.

Though this is by no means an exhaustive reply to the question, it will give an outline of the probable causes of the great advantages of carbon brushes over copper brushes under equal conditions, especially for loads subject to sudden variation.—T. C.

Answer to No. 151 (*awarded* 7*s.* 6*d.*).—For the proper understanding of this question we shall require to dip somewhat deeply into the theory of the armature short-circuits and the various causes of sparking. In the present answer we will, however, assume various strengths for the different currents, as the mathematical exposition of the values would only unnecessarily lengthen the article without making the argument any stronger.

Let us consider the case of the positive brush—that of the negative brush will be the same with the direction of the currents reversed—of a bipolar dynamo with Gramme armature supplying 200 amperes to the outer circuit, the brush covering approximately 1½ segments. Fig. 1 gives a diagrammatic view of part of the commutator and coils; one half of the current flows up the *c* series of coils and the other half up the *d* series, along the lugs *r*, *s*, and *t*, in proportion to the various resistances of these paths, and thence to the brush. Now, the condition for non-sparking is that at the moment of recession of the segment *l* from the brush there shall be no current flowing from it to the brush, or *vice versâ*; another way which is commonly employed of expressing this is, that at the moment of recession of the segment *l* from the brush the coil *g* shall be carrying a current equal in direction and strength to that carried by the *c* series. Now, when two segments are joined together by the brush the coil connecting them is short-circuited, and a short-circuit current flows round this coil; the strength of this short-circuit current depends upon *(a)* the resistance of the coil, *(b)* the rate with which it is cutting lines of force.

We will now take three cases: (1) brushes too far forward (Fig. 1); (2) brushes too far backward (Fig. 2); (3) brushes in the right position (Fig. 3).

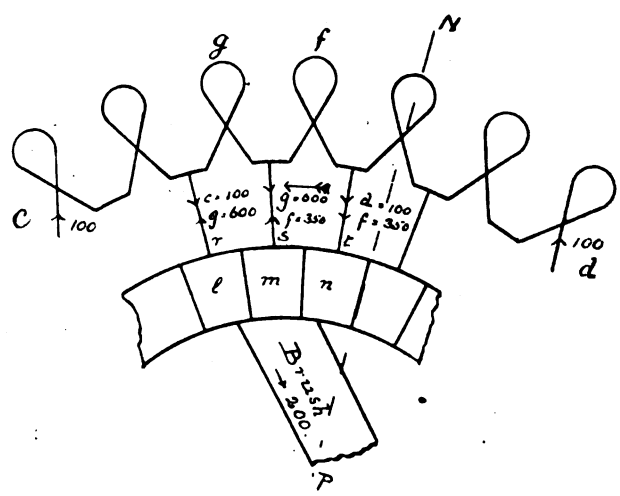

FIG. 1.

1. In this case the coil *g* will be in a denser field than coil *f*, and will, therefore, generate a stronger current, as the E.M.F. will be greater and the resistance the same. We will assume *g* generates 600 amperes and *f* 350; then the currents flowing in the various lugs will be thus: along lug *r*, 100 amperes due to *d* series + 350 amperes due to short-circuit current in *f*—total, 450 amperes; along lug *s*, 600 amperes due to short-circuit current in *g* – 350 amperes due to short-circuit current in *f*—total, 250 amperes; along lug *r*, 100 amperes due to *c* series – 600 amperes due to short-circuit current in *g*—total, minus 500 amperes: hence, upon the lug *l* receding from the brush, there will be 500 amperes broken and heavy sparking, the brush wearing away rapidly, as it is positive to the segment.

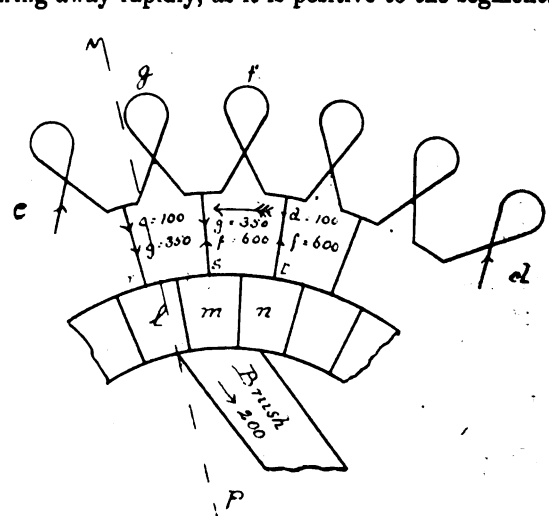

FIG. 2.

2. For the second case, let us take the neutral plane as passing in front of coil *g*, then, as *f* will be in the denser field, we may assume the following values for the currents flowing along the lugs: along lug *t* will flow 100 amperes due to *d* series – 600 amperes due to short-circuit current in *f*—total, minus 500 amperes; along lug *s*, 600 amperes

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due to short-circuit current in $f-350$ amperes due to short-circuit current in g—total, 250 amperes; along lug r, 100 amperes due to c series $+350$ amperes due to short-circuit current in g—total, 450 amperes; and again there will be heavy sparking, but the commutator will show most signs of wear, as it is positive to the brush.

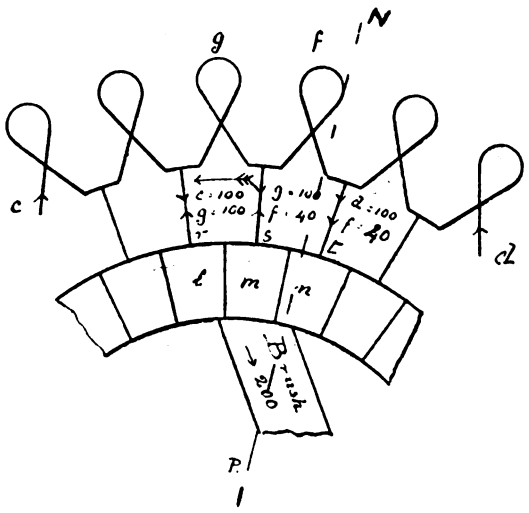


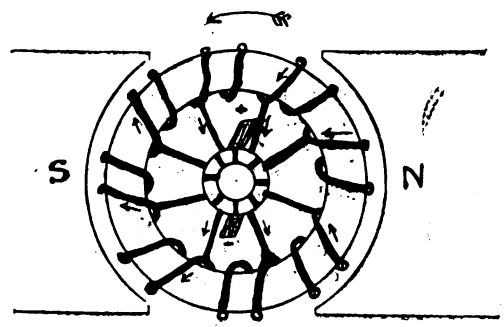
FIG. 3.

3. For the third case the neutral plane will pass behind coil f, but not so far behind as in case 1; therefore the coil g will be in a denser field than f, and will generate a greater current. For sparkless commutation g must generate 100 amperes, and we will assume f generates 40, then the following currents will flow along the lugs: along lug t 100 amperes due to d series + 40 amperes short-circuit current due to f—total, 140; along lug s, 100 due to the short-circuiting of $g-40$ due to short-circuit of f—total, 60; along lug r, 100 due to c main -100 due to short-circuit of g—result, nil; hence there will be no sparking at the recession of the segment l from the brush, as no current is flowing from the segment to the brush, or *vice versâ*. It will be noted that in sparkless commutation the brush does not collect equally over its area, but that the current is shifted from the toe to the heel. Given this lead and good contact, there will be no sparking with any brush. Unfortunately, the line of "requisite reversal," as this point is named, will not only vary with every alteration in the lead, as the density of the field will vary, owing to alteration in the number of both back and cross ampere-turns, but with a steady load it will also fluctuate, in consequence of the breadth of the coils, and hence there will be a difference in the E.M.F. induced in the short-circuited coils, and, as the resistance of the coils remains constant, there will be an increase or decrease in the currents generated.

As the voltage generated is very low it will only take a very small resistance to be relatively very high, and so stop almost entirely these short-circuit currents, and to allow of a fairly wide fluctuation in the line of requisite reversal without sparking. This is what is effected by means of carbon brushes. It is frequently stated that this is done by means of the higher resistance of carbon, *per se*, compared to copper gauze. But this is not so. It is effected in part by this, but chiefly by the resistance of contact between the carbon and the commutator, which is considerably greater, whatever care is exercised, than that of copper gauze brushes and commutator. If, then, the short-circuit currents be eliminated, the c and d currents will flow along lugs r, s, t in inverse proportion to the resistances of these paths, and it will be readily seen that as the segment l recedes from the brush the area of contact grows less and less, and consequently the resistance of the path through lug r increases, until at last just before breaking entirely from the brush the resistance has become almost infinite in comparison with that of the path through segment m, and consequently the current previously flowing along it has dwindled to a vanishing point, and there is no current to break.

Finally, if the sparking is caused through a flat, bad joint on the belt, or other vibratory cause, carbon brushes will intensify it, as the bedding not being so good nor so yielding the brushes will probably jump quite off the commutator, giving rise to a high and very destructive form of induction arc sparking.—F. J. A. M.

Answer to No. 151 (*awarded* 5*s.*).—The subject of commutation by carbon brushes, and the consequent diminution of sparking, has never, so far as the writer is aware, been clearly explained. We may therefore discuss shortly the various causes to which sparking of the brushes may be attributed, and consider which, if any, of these evils might be mitigated by the use of carbon brushes. Below is a diagrammatic sketch of a ring armature and commutator, the brushes and coils being shown, and the direction of the current in the coils being indicated by arrows. One



coil is short-circuited by each brush, which should in ordinary cases cover about one and a half segments of the commutator. The time of duration of this short-circuit will depend upon the width of the brush, the number of segments, and the number of revolutions per minute, and in any case is only a small fraction of a second. In this short space of time, however, the current has to be changed in direction, and on leaving the brush should be carrying the same current and in the same direction as those coils already in the field into which it is entering. Meanwhile, however, during commutation a current has been generated, by induction, in the short-circuited coil. This current may be very large in virtue of the low resistance of the coil and brush tips.

Here, then, we may have one explanation of the phenomenon, for it is natural to conclude that the greater resistance offered by the brush tips, if these were of carbon, would tend to check the flow of induced currents in the short-circuited coil. It is evident, of course, that the actual spark is due to the break of circuit when the coil moves from position of short-circuit into the field, where the current it is called upon to carry will be of the same value as that of the other coils already in that field, or, to be more accurate, the coils already under the influence of that pole. This induced current may be either greater or less than the normal current in the armature coils, but in either case a spark will result consequent upon the break or make as the case may be. In the case of a copper brush, this is more readily maintained, and increases if allowed to continue, and is more destructive than in the case of a carbon brush, which does not present the same facility to this "sparking current," and is practically harmless. With excessive sparking a copper brush becomes fused and the evil increases, while under similar circumstances the carbon brush might become incandescent, but with no greater resulting damage than disintegration or roughened surface.

The greater rigidity of the carbon brush is no doubt in its favour by permitting of more accurate setting, with the entire absence of ragged edges, which sometimes give rise to sparking with copper brushes. Anyone familiar with the working of dynamos will be aware that the application of vaseline or other lubricant is sometimes effective in putting a stop to sparking of copper brushes. Where carbon brushes are employed, the commutator carries round particles of carbon, which, we may presume, effects a similar purpose, assisted possibly by the application of a small quantity of graphite.

Other considerations affect the sparking of brushes, but these bear upon the design of the machine—*e.g.*, self-induction, current, number of wires per slot—and would be unaffected by a substitution of carbon for copper brushes.—A. M. O.

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Question No. 152.—What are the advantages of high-speed engines as regards steam consumption and initial condensation of the steam?

Best Answer to No. 152 *(awarded* 10*s.)*.—This question introduces to a certain extent the controversial subject of high *versus* low speed engines. In considering the advantages inherent to high speeds it will be well to discriminate between speed as referred to the number of revolutions per minute and piston speed respectively. The term "speed" as used in the former sense is entirely a misnomer, as when we refer to high and low speed engines we generally imply quick and slow revolution engines respectively, and, as a matter of fact, it is in this sense that our meaning would be construed. It should be borne in mind, however, that *quick revolution* and *high piston speed* are by no means synonymous, as the piston speed of a slow-revolution engine may easily exceed that of a high-revolution engine.

In order to show clearly the advantages of high-speed engines as regards initial condensation and steam consumption, it would be best to ascertain the value of these quantities, firstly, by tests of a certain engine at various speeds; and, secondly, by comparing tests between two different engines designed to run at "high speed" and "low speed" respectively. For this purpose we have at our disposal a very complete series of tests carried out by Mr. P. Willans, and communicated to the Institution of Civil Engineers. From this paper the following tables have been compiled, and these show at a glance the effect of change of speed on initial condensation and consumption of steam:

TABLE I.

Engine.	C $\frac{90}{3\cdot2}$		C $\frac{110}{4}$		C $\frac{130}{4\cdot8}$	
Revolutions per minute..	400	120	400	120	400	130
Pounds of feed water used per i.h.p. hour ...	24·1	27·0	21·4	24·7	20·3	23·7
Pounds of feed water accounted for at cut-off	22·8	21·5	19·3	18·5	17·9	16·6
Loss per i.h.p. hour at cut-off	1·3	5·4	2·0	6·2	2·4	7·0

TABLE II.

Engine.	S $\frac{50}{2\cdot2}$		S $\frac{70}{2\cdot8}$		S $\frac{90}{3\cdot6}$		S $\frac{110}{4\cdot4}$	
Revolutions per minute	400	110	400	110	400	120	400	130
Pounds of feed water used per i.h.p. hour	39·9	46·0	32·0	40·7	26·9	34·0	26·0	31·2
Pounds of feed water accounted for at cut-off	29·0	30·1	23 9	22·1	20·2	19·6	18·4	17·4
Loss at cut-off, pounds per i.h.p. hour	10·9	15·8	8·5	17·6	6·7	14·4	7·6	13·8

While these data are most valuable for their completeness and accuracy, the nature of the various losses involved rendered their determination a very difficult matter. Leakage losses, radiation losses, and loss due to priming are more or less involved, and to ascertain the precise value of these, individually or collectively, is almost impossible. These losses may for practical purposes be considered constant, but from an elaborate set of trials, Mr. Willans found initial condensation might vary very largely even at constant speed. The tables refer to tests made on both compound and simple engines.

Referring to engine C $\frac{90}{3\cdot2}$ (which designates steam pressure and ratio of cut-off respectively), we see that at 400 revolutions per minute the loss in pounds of feed water per indicated horse-power at cut-off is 1·31, about 5 per cent. At 120 revolutions per minute the corresponding loss is 5·47lb., about 20 per cent., an increase of 15 per cent. Similar figures are obtained regarding the steam consumption thus: at 400 revolutions per minute the steam consumption in pounds per indicated horse-power was 24, which, on a reduction of revolutions to 120, increased to 27, an increase of nearly 3lb. per indicated horse-power hour, or about 12 per cent. Similarly in engine C $\frac{130}{4\cdot8}$, the change of revolutions from 400 to 130 per minute resulted in an increase in loss at cut-off of about 18 per cent. In the same test we find the steam consumption of 23·67lb. per indicated horse-power hour at 130 revolutions per minute, which is reduced at 400 revolutions to 20·35, a decrease of about 14 per cent. Similar results are obtained from the single-engine tests. Taking engine S $\frac{50}{2\cdot2}$ we find loss at cut-off due to initial condensation was 10·91lb. per indicated horse-power hour at 400 revolutions per minute. At 110 revolutions per minute this quantity is increased to 15·81lb., an increase of 4·94lb., or about 9 per cent. In the case of engine S $\frac{110}{4\cdot4}$ reduction of speed results in an increase in steam consumption of 5lb. per indicated horse-power hour, while the amount accounted for was nearly 1lb. less. The loss thus showed an increase of about 6lb, or 15 per cent.

These tests prove very clearly that considerable reduction of steam consumption can be effected by increase of speed, while the corresponding reduction of initial condensation, as measured by water accounted for at cut-off, is even greater in proportion. There is no doubt, of course, that the economy is largely due to the less initial condensation, which in turn may be attributed to more favourable working conditions in the cylinder—that is to say, these become more nearly adiabatic. These are dependent on certain other circumstances, but the important bearing of "periodicity" upon the working conditions will be seen if we consider that by increasing our number of strokes per minute to infinity a perfect adiabatic cycle would be obtained.

The question of high-speed *versus* low-speed engines bears a certain analogy to that bone of contention well known to electrical engineers—viz., high-tension *versus* low-tension supply. For several reasons these discussions have never reached finality, the various systems having their advocates, each of whom rightly claim advantages for their own under certain conditions. The economical working of a steam-engine as regards steam consumption and initial condensation may not be entirely due to the fact of its running at high or low speed, or, to be more accurate, quick or slow revolution. The matter of piston speed and its independence of the revolutions has already been mentioned, and there is no doubt that in either case the results obtained are controlled in a great measure by certain characteristics of design, some favourable, some unfavourable to economical working of steam. High-speed engines are almost invariably vertical, employ high-pressure steam, and compound or triple expansion. The vertical engine gives facility for draining water present in the steam, and by uniform wear of cylinder reduces leakage past piston to a minimum. A number of expansions also reduce the range of temperature in each cylinder. It is interesting to note that in the case of the Willans engine not only is each cylinder jacketed on the upper side by the steam-chest or receiver, but the annular piston-rod, with its concentric valve-rod, moving from higher temperature to lower, should to a great extent do away with initial condensation.—A. M. O.

Answer to No. 152 (*awarded* 5*s.*).—Initial condensation in an engine cylinder depends upon several things; amongst others, the range of temperature through which the inner surface of the cylinder fluctuates during each stroke, or the size of the surface of metal exposed to the steam, or, most important of all, the time of contact during which heat is exchanged. "The influence of time," says Prof. Ewing, on whose remarks this answer is based, "is especially important, for the whole action depends on the rate at which heat is taken up and given up by the substance of the metal. The changes of temperature which the metal undergoes are mainly superficial; the alternate heating and cooling of the inner surface initiates waves of high and low temperature in the iron, whose effects are sensible only to a small depth, and the faster the alternate states succeed each other, the more superficial are the effects." He goes on to say that an indefinitely large number of strokes per minute would cause the cylinder to behave like a non-conductor, and the action of the working substances would be

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adiabatic. The conclusion, then, is that thermo-dynamic efficiency is increased by running up the speed of an engine, all other conditions of working remaining equal. This naturally leads to the conclusion that steam consumption will also be diminished, if for no other reason than that there is less heat absorbed in uselessly re-evaporating condensed steam, and hence more heat is available for useful work in the same amount of steam at the same pressure and initial temperature.

All this has been very clearly demonstrated by experiments, whose results are quoted by Ewing, and are abstracted from two papers read by the late Mr. Willans and published in *Min. Proc.* Inst.C.E. for March, 1888, and April, 1893, respectively. The first table, taken from the earlier paper gives the results of two sets of trials of a Willans non-condensing compound engine. In the three trials of each set the only thing varied was the speed. The following are the results:

I. Trials with Steam at 90lb.: Expansion Ratio = 3·2.			
Speed: revolutions per minute	401	211	122
Percentage of water present at cut-off in high-pressure cylinder	5·0	12·6	20·2
Consumption of steam per hour per indicated horse-power (pounds)	2·42	25·3	27
II. Trials with Steam at 130lb.: Expansion Ratio = 4·8.			
Speed: revolutions per minute	405	216	131
Percentage of water present at cut-off in high-pressure cylinder	11·7	19·1	29·7
Consumption of steam per hour per indicated horse-power (pounds)	20·3	21·3	23·7

The percentage increase in initial condensation is evidently much greater than the corresponding increase in steam consumption, but in both the amount varies inversely with the speed. Mr. Willans's second paper contains the following table (also quoted by Ewing) referring to a "condensing engine with an absolute admission pressure of 90lb., and a very moderate ratio of expansion (4·8)." The results, which point in the same direction, are thus:

Speed: revolutions per minute	401	301	198	116
Percentage of water present at cut-off in the high-pressure cylinder	8·9	12·2	17 9	20·9
Consumption of steam per indicated horse-power (pounds)	17·3	17·6	18·9	20·0

The above show conclusively that the effect of high speed is to diminish both the initial condensation and the steam consumption per indicated horse-power in an engine, and therefore to increase its thermo-dynamic efficiency. If the above results be plotted, it will be easily seen that the condensation and consumption both go up very rapidly as the speed is diminished more and more. This, of course, applies only to the range of the experiments given here. Considered with reference to thermo-dynamic efficiency only, therefore, high speed is a distinct advantage. Its other effects do not enter the scope of the question, and therefore need not be discussed here.—T. C.

ELECTRIC LIGHTING BILLS FOR LONDON.

The County of London and Brush Provincial Electric Lighting Bill.

(*Concluded from page 439.*)

The Select Committee of the House of Commons engaged in considering Bills for the extension of electric lighting and electrical energy in London sat again on Tuesday, Sir W. Coddington presiding.

Mr. PEMBER, Q.C. (for the promoters), said that the promoters had asked for provisional orders to enable them to supply with electricity the districts of Fulham, Battersea, Bermondsey, Rotherhithe, Lewisham, Lee, Greenwich, Eltham, Poplar, Bethnal Green, Hackney, and Stoke Newington. They applied for these powers months ago, but as late as April 4, when the committee were dispersed for the holidays, letters were received stating that the Board of Trade were "not satisfied that the consent of the local authorities should be dispensed with in respect to any of the districts included within the area of supply." The promoters had written to the Board of Trade to ask if they would not hold local enquiries in the districts concerned, but the Board of Trade had made up their minds in the matter. The Bill would therefore have to be amended, and the representatives of most of the districts had been told that they need not appear further before the committee. Clause 10 in the Bill, providing for the renewal and repair of electric cables, would have to be omitted, and other clauses would have to be modified. The promoters would still ask for powers to lay mains through Shoreditch, Bethnal Green, Islington, Whitechapel, Battersea, and Lambeth.

Mr. WORSLEY TAYLOR, Q.C., for the London County Council, said that what had taken place showed the inconvenience of the course adopted in promoting a Bill the lesser half of the object of which was disclosed within its four corners, while the greater half was concealed. He did not know what attitude the London County Council would be inclined to assume towards the altered Bill.

The CHAIRMAN said that the action of the Board of Trade in putting off their refusal of the provisional orders for so long seemed rather discourteous, but the committee had no jurisdiction in the matter.

Mr. RICKARDS, for the Chelsea Waterworks Company, declared that the action of the promoters so far as his clients were concerned had been vexatious, and asked for costs.

Mr. VESEY KNOX applied for costs on behalf of the district of Lee; Mr. WEDDERBURN, Q.C., on behalf of the Blackheath and Greenwich Electric Lighting Company; and Mr. LEWIS COWARD on behalf of the parish of Fulham.

The committee reserved their decision on the applications for costs.

Mr. WORSLEY TAYLOR said that he proposed to take no further action on the Bill, but to reserve the right of the London County Council to appear at a future stage. He would suggest, however, that it might be well for the committee to throw out the Bill so as to enable the promoters next year to come forward with a new and more carefully conducted measure. If the preamble were passed it would be well to insert a clause conferring on the London County Council powers of purchase.

Counsel and witnesses having been heard on behalf of the Lambeth and Camberwell Vestries,

Mr. E. MANVILLE, consulting engineer to the Vestry of Shoreditch, said that about 50 miles of electrical mains were already laid in that district, and he considered that it would be particularly objectionable to lay down further electrical mains. In the year ended March last the electrical undertaking of the Vestry supplied 1,030,000 units at a cost of a little over 1¼d. per unit, this low cost being due to the fact that steam was supplied from the dust destructor free for the purpose of producing electricity. With the exception of Edinburgh, the Shoreditch station was the most economical in the kingdom.

Cross-examined by Mr. Pember, WITNESS admitted that owing to the compactness of the area supplied—one square mile—the service was carried on in advantageous circumstances. There was still room for electrical mains to be laid along the High-street.

Mr. VESEY KNOX afterwards addressed the committee on behalf of the Shoreditch Vestry, contending that as a local authority it was doing the work of supplying electricity well, efficiently, and at a cheaper rate than any other body or company within the Metropolis, and in these circumstances ought to be treated by Parliament with the greatest consideration.

The committee then adjourned.

On Wednesday, counsel were about to proceed with the case, which had occupied four days of the time of the committee, when

The CHAIRMAN said: I may say the committee do not think it necessary to hear any more evidence in opposition to this Bill, as they have come to the conclusion that they cannot pass the preamble. The applications made by Mr. Rickards, Mr. Vesey Knox, Mr. Wedderburn, and Mr. Louis Coward on behalf of their clients for costs, the committee have considered, and have decided not to allow.

The Bill is therefore lost. As originally framed it affected the districts of St. Mary, Newington, Hackney, St. Mary, Stoke Newington, St. Matthew, Bethnal Green, St. Leonard, Shoreditch, St. Mary, Battersea, Fulham, St. Mary, Lambeth, Bermondsey, Rotherhithe, Poplar, Whitechapel, Lewisham, Lee, Greenwich, Camberwell, Wandsworth, etc., but, owing to the decision of the Board of Trade refusing provisional orders without the consent of the local authorities for the supply of electricity to the districts, many of these were dropped out of the Bill.—*The Times.*

The Association of Municipal Electrical Engineers.—The annual summer meeting of this association is this year to be held at Bristol, Mr. H. Faraday Proctor being the president. The date fixed for the gathering is Wednesday, June 14, and meetings will be held each day up to and including Saturday, June 17. Visits are being arranged to Cheltenham and Bath and the various electrical works in Bristol. The full programme and time table will be published shortly.

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LEGALITY OF CONTRACTS.

The latest phase of the City lighting imbroglio is interesting, though at the same time somewhat disheartening. According to this latest development, the agreement between the City authorities and the City of London Company is null and void, because some members of the authority were more or less interested in the company or the company's ancestor at the time the agreement was made. This may be good law, but under the circumstances lacks the least grain of commonsense. We are not going to argue as to the position of either company or authority if counsel's opinion as to the illegality of the agreement is supported; we are more concerned to call attention to a wider issue. If—and we assume it is correct—this agreement between the City and the company is illegal, then we contend there are not half a dozen agreements between local authorities and companies existing in the kingdom which are strictly legal. Most of those interested in electrical work can recollect the developments introduced by Gramme, Jablochkoff, Swan, and Edison, and the fanfarade of applause that greeted the lighting of some of the streets of Paris. The electrical exhibition at Paris in 1881 proved to many people that artificial lighting by means of electricity was not only possible, but commercially practical. The number of people thus convinced was small, and belonged mostly to manufacturers of electrical apparatus, together with a few capitalists. They saw a new field of profitable industry opening if they could convince users to use the wares offered and capitalists to embark the necessary capital for production. Unfortunately in one way, but fortunately in another, company promoters tried to rush investors before the time was ripe for action, and while many men made money—legitimately or otherwise, according to the opinion of him who loveth or who loveth not the promoter—as many lost money, and a cloud rested upon a promising industry. The scandalous promotions of the early eighties served one useful purpose, in that they made the multitude conversant with the term "electricity," and from more or less costly and unsuccessful experiments made the multitude acquainted with the "might be" of electric lighting. Then came the time of the stalwarts, the time of those who had studied the question, who knew what could and what could not be done. It was they who had to convince timid users that the new illuminant was more excellent than what had gone before, and bravely they buckled to their task. Where were they to get support, where to get capital when they got purchasers? It seems to us, and to those who are fully acquainted with the subject, that so far as street-lighting was concerned—and at that time street-lighting involved private lighting—that is, then so far as general lighting was concerned, the only method possible was to approach the members of the local authorities. If the members of the authority, or some of them, were convinced as to the superiority of the light, how could they show their conviction? The political purist will say by their votes. Just so; but at that time votes

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were of academic value only. The question was not only, do you support, but how much do you support; and without the monetary support of influential men at that time the extension of electric lighting would have been long delayed. The authorities were afraid to take up the work themselves. "It was still in its infancy," was the cry, and the ratepayers' credit was closed with a snap. Consider the position, not as it is now, but as it was then, and of a man who invested his money to help bring about an improvement, invested, too, at a time when 99 per cent. of his friends would have told him that he might just as well throw his money into the Atlantic Ocean for all he would get, we say that man deserves a generous share of praise, and not an inequitable legal censure. In the particular case made prominent, do the people who preach so fervently on the subject know how long or how arduously men worked to convince the City Fathers of the suitability and the necessity for the light? Have they ever considered the difficulties that existed in those days to get capital, and how necessary it was to follow the demands of the philanthropist and to show "how much" the sympathy was worth? We are not lawyers—we do not pretend to be so; but we say that if the agreement between the City and the City Company resulted in the introduction of the electric light into the City—and the agreement is worth a brass farthing to the company—then no court of justice and no honourable man ought to dispute that agreement because one or two or half a dozen of the members of the authority had shown their sympathy by investing money—investing at a time we say most people thought such investment utterly valueless. They invested because they believed in electricity, not because they were assured of dividends, for at that time the latter point was one of a very doubtful nature. But we have far outrun our space, and must leave for some future time the showing up of the avarice which is at the bottom of all this bother. Why cannot there be a little honesty among the municipal socialists; let them state plainly the intention of grabbing everything proved worth having by private enterprise? Why not buy honestly, if you want it?

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE TELEPHONE CRISIS.

SIR,—In my letter, for the insertion of which in your issue of the 7th inst. pray accept my best thanks, I referred to one aspect of the telephone question which has been mentioned by sundry correspondents in the daily papers as an example of the danger to the future of telephony if what may be called free trade in the industry is inaugurated by the Government Bill. I mean the aggravation of the complications in the working of inter-switchroom communication, if telephone areas and the trunk lines are controlled by independent authorities.

In his letter to the *Times* of the 11th inst., Mr. F. E. Baines describes it as "the allocation of two ends of a Government wire to independent communities in no way under its control, and with possibly antagonistic views of management." I think that we are bound to assume that the Government means to give their scheme a fair chance, and that as soon as possible. First, they will grant licenses to *bonâ fide* undertakers, whether those bodies are local authorities or companies under the auspices of local authorities. Second, that the Act now under consideration will deal with the *wayleave* question, and give to local authorities the same legal powers for running wires or for granting permission to do so as are now possessed by the Postmaster-General. Third, that licenses will be renewable beyond 1911 for separate telephone areas if conditions of efficiency and rates of charges to be settled by a competent public authority are fulfilled and upheld. Thus capital to be now invested will be secured against arbitrary confiscation. The National Telephone Company fulfilling the same conditions will be on the same footing as their competitors, if any, in the respective areas in which they will be still at work in 1911. Fourth, that in the next few years all those portions of the country which are now not allotted as telephone areas will be so appropriated and occupied by undertakers licensed by the Post Office. Lastly, that the Post Office will see their way to fall in cheerfully and loyally with a scheme, the inherent complications of which, whether the control is divided or not, can in no way be surmounted without cordial co-operation by the service which provides the trunk wires, and which would exist in another form and with equal disabling effect if the unity of management consequent on nationalisation were brought about.

In the first instance, let us consider the subject from the Post Office point of view. By the *classification* described in my previous letter, the Department are relieved of all responsibility for the machinery, mechanical and physical, by means of which 19 out of 20 "talks" will be conducted. Only the subscribers in Class I. will have anything to do with the Post Office. The "calls" on the switchroom by both classes of subscribers giving a number (and name in case there is more than one exchange in the area) will be dealt with as at present, but the calls of the Class I. subscribers will have to be identifiable by the switchroom clerk, so that *she* will not be misled by any attempt of a Class II. subscriber to obtain an advantage to which he is not entitled. Thus from possibilities of complication 95 per cent. of the talks may be eliminated by *classification*.

Only when a Class I. subscriber requires to "talk" outside his area with a Class I. subscriber in other areas and on other lists does a new factor operate. First, he must be identified as a Class I. subscriber, and then he must take his turn on the trunk wire that is available; and lastly, when his "call" reaches the distant exchange system the subscriber he calls must be again identifiable as in Class I. He then takes his chance of delay by his correspondent being engaged or inattentive in the same way as if he was trying to "get through" to any subscriber on his own system.

Now, what has to be realised, and is little understood, is admitting that (1) the lines and instruments used with Class I. are the most efficient that can be installed; (2) that the trunk wires are in perfect order; (3) that the switchboards are the best of their kind; that then sub-division of supervision over the three sections of the road cannot at the moment affect either way the consequences of (*a*) inefficiency at the switchboards, and (*b*) inattention of the subscribers.

I repeat, the Post Office must reserve the right to specify the pattern of the switchboard, and of the instruments, etc., of the Class I. subscribers, before granting to any exchange system the power and right to use the trunk lines. If the switchboards are good enough for inter-communication outside the area, they will undoubtedly be suitable for all the purposes of switching Class I or II. subscribers within the area.

Next as to the complaints arising out of difficulties which prevent or delay the accomplishment of the conditions to allow of conversation—*i.e.*, of a "talk." In telegraphy the complaints from the public particularise no part of the operation of transmission of a telegram, only the results as affecting the accuracy and punctuality of the delivery of the written document. In telephony the user is the

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operator; in fact, does what in telegraphy is called the "commercial" part of the work, as distinguished from the "engineering" part. In effect there is a new condition, with no parallel in telegraphy—namely, the operator (who in telegraphy is the telegraph clerk) and the user are one. Hence the user, instead of being in the position of complainant only of mistakes and delays, is also in a position similar to that of the telegraph operator, who is directly dependent on the efficiency of the machinery by which he operates, and upon whom the efficient working of that machinery, if it is in working order, depends.

In telegraphy, if anything is wrong, the clerk initiates at once the operation by which it is put right, reports to the executive, whose duty it is to remedy the defect, and has a record on his slip or message form, or diary, of what happened. There is no waiting for the receipt of the complaint from the user, and the tedious correspondence through the head office, the cause of the "fault" (again to use a telegraphic term), is known, and the remedy applied long before the person consciously or unconsciously inconvenienced has moved in the matter.

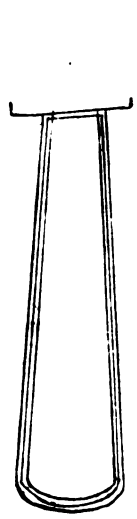
In telephony all is different, and fortunately 95 per cent. of the "trouble" need never be heard of outside of the immediate area of the responsibility of the management in charge of that area. Hence the necessity of the users being in direct and immediate speaking communication with the manager responsible to them for the area within which they are subscribers, and of the allegiance of the manager being due to the service of the subscribers and to nothing else. The efficient working of each local telephone exchange system must depend on its being self-contained, and on the personal relations between the users and the management. The occurrence of difficulties or delays, if their investigation is to produce improvement, must, for the reasons I have given, be immediately reported to the responsible management; and this will only be possible when the persons who complain, and who investigate and remedy complaints, are on the spot. Emphatically, the importance of this condition is increased when it is recollected that one frequent cause of complaint essential to telephony is *inattention*; that the only way to cure this is by bringing it home to the delinquent, who in this case is one of the users; and that, unless traced and brought home *at once*, in nine cases out of ten the facts are forgotten or inaccurately remembered, and the lesson for future avoidance of similar causes is lost.

I claim to have proved that amongst all the examples in the management of human organisations in existence in which *de*-centralisation is beneficial, there is none more striking than that of the telephone industry. If the Post Office assumes the responsibility, centralisation is absolutely unavoidable. There is no organisation in the world in which centralisation is so emphasised as in the Postal Telegraph Department. If the Post Office through local postmasters (the excellent representatives of the Department) in every locality attempts to provide local management of this kind I describe as essential, there is less probability of securing efficiency from a gentleman who is charged with the multifarious postal, money order, and other local businesses undertaken by the Post Office (greatly to the benefit of the public) than from the one telephone expert, whose experience and practice has been devoted to nothing else, whose calling will in future become more recognised, and whose whole energy will be enlisted in the efficiency of his own system as compared with those in its neighbourhood.

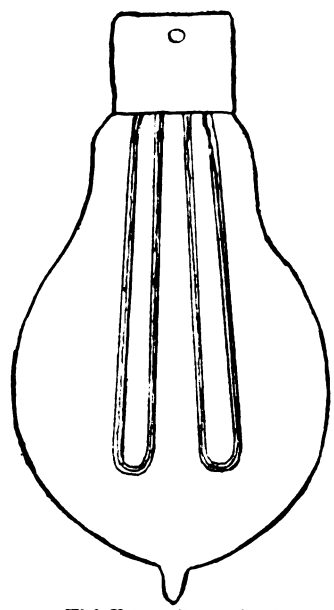
Lastly, is it not clear that increased local efficiency will all tend to the general efficiency upon which the successful working of the trunk wires must depend, and, as I have said, is it not clear that *classification*, which, by the way, is much more simple than the so-called "toll" system, advocated by the Post Office experts, is the key to the future success of the service? At the same time, there is nothing to prevent classification and the "toll" system being worked together.—Yours, etc., C. E. WEBBER.

IMPROVED INCANDESCENT LAMPS.

SIR,—I am very pleased to forward you an idea relating to an incandescent electric lamp, which you may publish in your paper if you wish. The filament of this lamp is encased in a continuous tube of mica (as shown in the accompanying sketches), which is fixed rigidly into the



Filament Enc e with Mica Tube.



High-Voltage Lamp, showing Mica Tubes.

brass collar of the lamp. The advantages claimed by this lamp are (1) that the filament will be protected from being shaken to the sides of the bulb, and hence may be extensively used for shiplighting, or for all purposes where the lamp has to be moved about; (2) increasing the brilliancy of the light.—Yours, etc., R. H. WAITE.

[We publish the above letter and illustrations as asked, but are afraid that Mr. Waite will find that there are insuperable difficulties in the way of manufacturing this improved lamp. To make mica tubes of the form shown is the first difficulty, and the next will be to get the carbon filament into them, while it is doubtful even then if the tubes could stand the temperature of the filament when incandesced.—ED. *E. E.*]

REVIEWS.

The Slide-Rule Practical Manual. By CHARLES N. PICKWORTH. Fifth edition. Messrs. Emmott and Co., Limited, New Bridge street, Manchester, and 157, Strand. Price 2s.

The fifth edition of this manual, which has been revised and enlarged, is a work which should find a place on the bookshelf of every engineer after he has perused the same and gathered from it the useful hints on the working of that great labour-saving device, the slide rule. In the preface the author comments on the fact that four editions of the manual have been exhausted in practically as many years. In this edition a number of additions have been made, and a large part of the book is entirely re-written. One part in which great improvement has been effected is in the tables of conversion factors. These conversion factors are exceedingly useful for changing units in one system to measurements into another. The author comments on the fact that in the usual way it is difficult to set the zero of one scale exactly opposite the point of the other scale required when converting, say, ounces troy into grammes, or feet per second into metres per hour. To get over this difficulty the author has carefully prepared a list of divisions on each scale. At each the same result is obtained by placing these two different gradations, or lines, opposite each other. For instance, in the first case, if the 9 on one scale is placed against the 28 on another, the exact ratio is obtained, whereas in the second case all that is required is to place the 7 on one scale against the 128 division on the other. This operation is much easier than trying to get the zero mark against the part of the scale representing 18·288. The author carefully explains the principle on which the slide rule works, and then proceeds to describe in detail the best and shortest

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way of calculating with it in both simple and involved cases. Examples are given of technical computations in mensuration, steam-engine designing, in calculating the ratios of driving pulleys, horse-power, water-wheels, the selection of screw-cutting gears, and so on. The author in the last part of the book describes the various calculators designed on the Baucher type, and long-scale slide rules of the Fuller type. A little information is also given on the design of slide rules for specific calculation. To anyone who has not professionally had experience in working the slide rule, this book will be found an invaluable assistant to the rapid acquiring of a comprehensive knowledge of an instrument which should be in all engineers' hands.

FORTHCOMING EVENTS.

FRIDAY, APRIL 14.

Royal Institution.—At 9 p.m., "Earth Currents and Electric Traction," by Prof. A. W. Rücker, M.A., D.Sc., Sec.R S., M R.I.

Institution of Junior Engineers.—At 8 p.m., "Piles and Pile-Driving," by Mr. H. C. Reid, M.I.J.E.

SATURDAY, APRIL 15.

Institution of Junior Engineers.—At 3 p.m., visit to the works of the new Vauxhall Bridge.

WEDNESDAY, APRIL 19.

Royal Meteorological Society.—At 7.30 p.m., "Soil Temperature," by Henry Mellish, F.R.Met.Soc. "Some Phenomena Connected with the Vertical Circulation of the Atmosphere," by Major-General H. Schaw, C.B.

THURSDAY, APRIL 20.

Royal Institution.—At 3 p.m., "The Atmosphere," by Prof. Dewar, M.A., LL.D., F.R S., M.R.I.

Institution of Civil Engineers.—At 8 p.m., "Magnetism," by Prof. J. A. Ewing, M.A., F.R.S., M.I.C.E.

FRIDAY, APRIL 21.

Physical Society.—At 5 p.m., "Effect of a Solid Conducting Sphere in a Variable Magnetic Field on the Magnetic Induction at a Point Outside," by Mr. C. S Whitehead, M.A. Demonstration of Richards's Method of Standardising Thermometers, by Mr. R A. Lehfeldt, D.Sc.

Institution of Civil Engineers.—At 4 p.m., Redelivery of Prof. Ewing's Lecture on "Magnetism."

TELEPHONES.*

BY JOHN GAVEY.

GENERAL.

The invention of the speaking telephone, which was the outcome of the labours of Page, Reiss, Graham Bell, Edison, Hughes, and numerous successive inventors, has entirely modified the means of rapid and accurate intercommunication, not only within limited areas, but between cities and towns many hundreds of miles apart, and this method of communication, which is proving such a rival to the older form of telegraphy, has aroused such widespread interest that your council have thought it desirable that a paper on the subject of telephones and telephone exchanges should be laid before you.

THE TELEPHONE RECEIVER.

Although many forms of receiving telephones of varying degrees of merit have been designed, it is only necessary here to refer to the first perfect articulating telephone that was practically used—namely, that invented by Graham Bell. It may be said that not the least remarkable feature of this invention is the fact that since its introduction in the year 1877, beyond the mere perfection in its manufacture, it has been found impossible to effect any material improvement in the type of instrument then introduced when used as a receiver. At the present the original drawings or diagrams prepared for the first public lecture on the Bell telephone still serve for purposes of illustration. A very brief description only of this receiver is necessary. Bell's telephone as now used comprises a permanent magnet, preferably of the horseshoe type, with a small coil of insulated wire surrounding each pole-piece. Opposite these pole-pieces is placed a thin diaphragm of soft iron, which is set in vibration when undulating or vibrating currents traverse the coils. This telephone can serve both as a transmitter and as a receiver, but in practice it is now used only for the latter purpose. Fig. 1 illustrates its present form.

THE TELEPHONE TRANSMITTER.

The modern telephone transmitter is based on the discoveries of Hughes and Edison, on the fact that loose or imperfect contacts, preferably of carbon, when subjected to vibrations, vary their resistance to the passage of an electrical current, and that within certain limits this variation bears a direct relation to the amplitude and to the frequency of the disturbing variations. Thus, musical or articulate sounds, producing sonorous vibrations in the air, impinge upon a diaphragm and set it in vibration, and if this diaphragm press upon or set in movement loose contacts of a suitable character, a corresponding variation arises in the resistance of the circuit of which these contacts form part, and a current of electricity traversing the circuit can be made to describe precisely the same curves as those due to the sound waves. It is the function of the receiver to convert these electrical curves into mechanical vibrations, and thus to reproduce actual sound. The action of speaking by telephone thus involves a number of successive transformations of energy. The

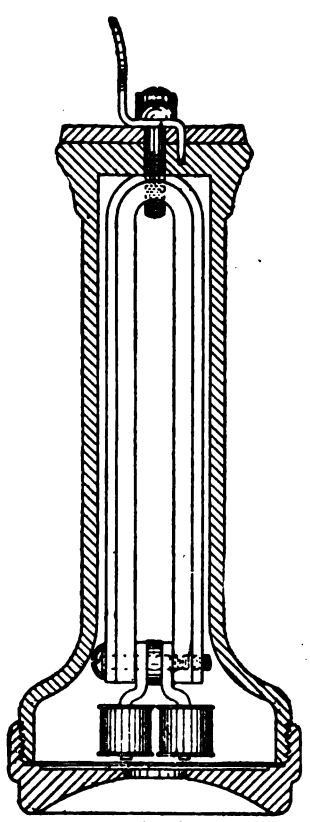

FIG. 1.—Bell Telephone.

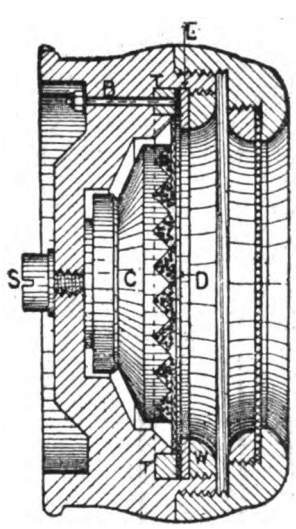

FIG 2.—D ckert's Granular Transmitter.

sound waves, which impinge on the diaphragm of the transmitter, set up mechanical vibrations, which give rise to electrical undulations. These undulating currents traverse the connecting wires, causing variations in the magnetic field of the receiving telephone, and setting up vibrations in the diaphragm similar to those which originated the disturbance. In this manner music and speech are reproduced. Innumerable forms of carbon microphones have been devised. In some cases pencils of hard carbon rest loosely in sockets formed in carbon blocks attached to the diaphragm of the transmitter; in one form—still largely used, with single-wire circuits—a button of carbon rests against the diaphragm, but the most effective transmitter consists of small granules of carbons enclosed between two carbon discs, one of which is fixed, and the other free to vibrate. In the design of a transmitter care must be taken to provide against the vibrations of the diaphragm causing an actual break of the circuit, as this gives rises to disagreeable sounds, and renders speech inarticulate. The two former types of transmitter are subject to this defect should the speaker shout or approach too closely to the telephone, but with the latter it is

* Paper read before the Society of Arts on April 12.

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possible to speak close to the transmitter, and with considerable force, without rupture of the circuit, so that it is well adapted, not only for intercommunication on short lines, but also for use on long trunk circuits. The various types of receivers and transmitters are fully described in the text-books, so that it is not necessary to refer to them at large at the present moment.

The Circuit.

When the telephone was introduced as a practical instrument it was discovered that it formed by far the most delicate detector of alternating or vibratory currents that had been placed in the hands of the scientific investigator or the practical electrician. When joined to a single wire, the circuit of which was completed through the earth, and which was in proximity to other circuits similarly joined up, innumerable noises were heard when the neighbouring wires were worked. Disturbing secondary currents, some due to earth leakage, some to electrostatic, and some to electromagnetic induction, were generated by the adjacent working currents, so that if these were used for telegraphic purposes buzzing and frizzling sounds were heard on the telephones of such intensity as to render speech impossible. On the other hand, if the neighbouring circuits were used telephonically, and were in excess of a certain length, the conversation held on one circuit could be heard on all the neighbouring ones. When, however, two wires were used to form a complete metallic circuit, and when they were so placed in regard to all neighbouring wires that the average distance between any one of the latter and the two former was the same throughout, then the E.M.F. due to induction in one of the wires of the circuit was equal to and opposed to that in the other; no disturbing currents circulated, there was no leakage from earth, and a silent circuit was provided, in which nothing interfered with satisfactory speech. As early as 1881, when the first Post Office telephone exchange was opened, the Department erected metallic circuits, and this policy has been adhered to throughout. Most of the other administrations and companies throughout Europe and America, however, started with single-wire circuits, and this is one of the principal causes of the dissatisfaction which many members of the public have felt with the telephone service. To reduce the overhearing between neighbouring single-wire circuits, it was found necessary to use somewhat imperfect transmitters, which only admitted of good articulation when the users spoke in gentle tones, and even then the circuits were noisy, inefficient, and unsatisfactory. In justice, however, to those who started on these lines, it must be said that in the early days of telephone exchange work there was no form of insulated wire thoroughly adapted for use for underground purposes, and it was practically impossible to erect aerial wires in the enormous numbers that soon became necessary to provide metallic circuits for the large exchanges that rapidly arose. Guttapercha and indiarubber insulated wires were very costly, they took up much space, and their static capacity was so high that the limit of distinct speech was soon reached. The invention of paper-insulated air-space multiple cables has led to a revolution in telegraphic practice. They are relatively cheap, they take little space, a conduit that would hardly hold 80 guttapercha wires will accommodate 400 wires insulated with paper, and the static capacity of the latter is but one-fourth that of the former, which practically means a fourfold increase in the range of speech when underground circuits are in use. [Specimens exhibited.] All European and American administrations and companies have availed themselves of this new form of underground cables, and at present about three-fourths of the exchange service in these countries is provided by means of complete metallic loops. Their use is being rapidly extended, so that within a relatively short period the single-wire telephone exchange circuit will be a thing of the past. It may, however, be well to refer to the fact that for long-distance speech over trunk lines connecting distant places we are still practically restricted to the use of open wires, for the relatively high static capacity and the considerable electrical resistance of the small conductors used in these paper cables, although not very detrimental on short lines, would render speech over long distances utterly impracticable under present conditions.

The Switch.

In its elementary form the history of the modern switchboard extends back to the early days of telegraphy, for the most serious problem which has confronted telephone engineers—namely, the ready method of placing a large number of subscribers in rapid and simultaneous intercourse with one another—arose in a minor degree when public telegraphs were first inaugurated. It was obviously impossible to erect wires between every two individual towns throughout any country, and in order to avoid re-transmission of messages at intermediate points—*i.e.*, the writing down of a message received at B from Station A on one wire, and the sending of it to Station C on another wire—a system was devised by means of which all the circuits in a central office were terminated on a series of brass bars fixed horizontally on a suitable base, and a second series of suitable bars was fixed at right angles to and insulated from the former. The two lots of bars were pierced with holes and provided with pegs, and it was possible to make direct connection between any two of the horizontal bars on which the telegraph circuits were connected by inserting pegs through these into one and the same vertical bar. [Old type switch exhibited.] This was termed an Umschalter switch, but it gradually fell into disuse, as it was soon found to be more speedy and more economical to transmit the messages by writing them down at one instrument and handing them to another operator to send over the second instrument, rather than to wait till both the circuits were free and ready to be connected through direct.

(To be continued.)

INSTITUTION OF ELECTRICAL ENGINEERS, Apr. 13.

At last night's meeting of the Institution the following were the candidates balloted for:

Members.—H. M. Peikert (P.O. Box, 1 804), Johannesburg, S.A.R.; F. J. Satchwell, Lightfoot-road, Hornsey, N.

Associate Members.—F. J. W. Ashlin, 30, Thornhill-road, Handsworth, Birmingham; S. G. Brown, Van Buren, Bournemouth.

Associates.—L. E. Auglagnier, 63, Church-road, Hendon; J. S. Barnes, Cudworth, near Barnsley; N. E. Beves, care of Messrs. P. C. Middleton and Co., Limited, 6, School-hill, Aberdeen, N.B.; Lieut. F. M. Close, R.E., R. M. Academy, Woolwich, S.E.; G. R. Drummond, 75, Church-lane, Charlton, S.E.; W. J. Ferguson 27, Arnold-street, Rugby; Stephen Arther Hardstone, National Telephone Company, Oxford-court, Cannon-street, E.C.; William Richardson P. Hobbs, H.M.S. "Vernon," Portsmouth; V. Martos, Budapest, Hungary; J. B. McIndoe, Scottish House-to-House Electricity Company, Limited, Coatbridge; K. J. McMullen, 1, South-street, Redditch; E. Shenpard, 20, Bucklersbury, London, E.C.; A. Sims, Ferreira Gold Mining Company, Johannesburg, S.A.R.; F. H. Wilson, 5, Sunnyside, Chelmsford.

Students.—G. H. Burgmann and C. F. Farlow, Faraday House, Charing Cross-road, W.C.; E. A. Rosenheim, B.Sc, 1, Croxteth-road, Princes Park, Liverpool; G. Stevenson, 36, Roslea-drive, Dennistoun, Glasgow; G. N. M. Tyrrell, 11, Norfolk-square, Hyde Park, W.; F. R. Webb, Randalstown, co. Antrim, Ireland.

ELECTRIC LIGHTING IN THE CITY.

BOARD OF TRADE ENQUIRY.

(Concluded from page 418.)

Sir Courtenay Boyle, at the Guildhall on Tuesday, resumed the enquiry instituted by the Board of Trade into the question whether there should be a competitive supply of electricity in the City. The three electric lighting companies desiring to obtain such access were the Charing Cross and Strand Electricity Supply Corporation, Limited, the Smithfield Markets Electric Supply Company, Limited, and the Metropolitan Electric Supply Company, Limited. The existing company, the City of London Electric Lighting Company, was represented by Mr. Pope, Q.C., Mr. Cripps, Q.C., Mr. Freeman, Q.C., and Mr. Roskill; the Smithfield Company by Mr. Balfour Browne, Q.C., and Lord Robert Cecil; the Charing Cross by Mr. Shiress Will, Q.C., and Mr. Sidney Holland; the Metropolitan Company by Mr. Fitzgerald, Q.C., and Mr. Moon; and the Corporation by Mr. J. H. Gray.

Position of the Corporation.

Sir Courtenay Boyle asked whether the Corporation were prepared to supply evidence or tender other information?

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Mr. GRAY intimated his intention of calling the City Solicitor, who would communicate the result of a meeting of the Common Council on the previous day (Monday).

Mr. H. H. CRAWFORD, the City Solicitor, then put in the resolutions passed at that meeting. He also handed in a copy of the opinion of Mr. Danckwerts, and remarked that he had been instructed to consult other counsel as to the validity of the existing agreement with the City Company. The resolutions were as follows:

"(*a*) That evidence be tendered, on the resumption of the said enquiry, by Mr. Engineer, in accordance with the request of Sir Courtenay Boyle."

"(*b*) That, in view of counsel's opinion, Sir C. Boyle be informed that the Corporation prefer to withhold further evidence at present, thus leaving itself free to consider the providing its own supply."

"(*c*) That if, notwithstanding the terms of the agreement with the City of London Electric Lighting Company referred to in the resolution of the Court of Common Council of Feb. 23, 1899, the Board of Trade see fit to exercise the power conferred upon them by Section I. of the Electric Lighting Act, 1888, this Court is of opinion that the Board of Trade should not grant more than one provisional order, for the reason that a multiplication of the systems of supply would be prejudicial to the interests of the Corporation when the time comes for them to take over the responsibilities of electric undertakers."

"(*d*) That this Court is of opinion that the Board of Trade should not dispense with the consent of the Corporation, unless in the case of an applicant who is prepared to accept the insertion in the provisional order of such terms and conditions as will secure the immediate and future interests of the private consumers and the public."

"(*e*) That should the Board of Trade decide to grant competition in the City, it should be subject to the Corporation having the right to purchase the whole of the undertaking, whether within or without the City, on terms to be previously agreed upon by the Corporation and set out in the provisional order."

"(*f*) That provision should be made in any provisional order to guard against the possibility of combination between two competing undertakers to the disadvantage of the electric light consumers and of the City of London."

Sir COURTENAY BOYLE remarked that one of the resolutions gave a right to the Corporation to purchase any undertaking, whether within or without the City.

It was pointed out that that was a purely optional matter.

Mr. POPE said a right had been reserved by the Corporation to purchase without having regard to the interests of the citizens.

THE CITY ENGINEER'S EVIDENCE.

Mr. D. J. Ross, the City engineer, stated that he had been connected with the City for the last 28 years. He for many years was the chief assistant to the late Colonel Haywood, being associated with him in the first installation of the electric light in 1870. From an engineer's point of view, there was no doubt the laying of mains within the City would cause a very large amount of public inconvenience. He was present when the laying of the mains took place in the City in 1892 and 1893, and this interfered with the traffic very seriously indeed. To his knowledge £30,000 was spent in relaying the pavements alone. He thought it was very possible that the cost of electric light would be cheapened by competition. The Corporation possessed very strong power indeed under the Sewers Act of 1848 for controlling public companies in opening up the streets. It would be possible to reduce the inconvenience to a minimum if the work were carried out continuously, and by night. There were a great many subways within the City, and a considerable number were under the control of the Corporation. The space beneath the pavements in the City was in nearly all instances occupied by pipes or mains of some kind, consequently any new mains would have to be laid in the carriageways. The City Company was, under Section 30 of the existing agreement, liable to a fine of 1d. per lamp in cases of failure, and these penalties were deducted from the half-yearly account with the company. The fines in 1892 amounted to £119 on a total payment of £3,341; in 1893 to £136 on £11,946; 1894 to £138 on £12,785; 1895 to nearly £137 on £12,819; 1896 to £362 on £12,841; 1897 to £352 on £12,955; 1898 to £156 on £12,927. This showed an average in fines of about £200 a year for seven years.

Mr. POPE asked the witness how he accounted for the circumstance that the shortcomings of the summer seemed to exceed those of the winter.—The WITNESS said he believed the City Company had renewed many of its cables, and in 1898 it appeared to be in a better position to perform its business.

Mr. POPE: I presume that originally the City mains were laid under the supervision of the Corporation under the Act of 1848?—Yes.

Mr. POPE: Did you as the city engineer superintend the laying of those mains under the footways?—The work was done under the control of Colonel Haywood, but I was acting as his chief assistant.

Mr. POPE: You exercised just as much control as you thought necessary to cause as little public inconvenience as possible?—That is so. Such immense operations must necessarily cause inconvenience.

Mr. POPE: If a second company were to come in, that inconvenience would be largely increased?—Yes; from the fact that the carriageway would have to be used for the mains instead of the footway.

Sir COURTENAY BOYLE: About these penalties—are they penalties relating to public or private lighting?—They relate entirely to the public lighting.

Mr. SHIRESS WILL: Do you think that competition in electric lighting in the City of London would be a public advantage?—I can scarcely answer that.

Mr. SHIRESS WILL: Do you say that because you have no opinion on the subject, or because of your official position?—Well, until all the circumstances are elicited, it is very difficult to express an opinion.

Mr. SHIRESS WILL: You say the City Corporation have stringent powers for controlling persons breaking up the streets?—Exactly. The witness went on to say, in further cross-examination, that he did not think that any competing company or companies could get the whip hand of the Corporation under the powers that that body possessed. Great public inconvenience must follow the breaking up of the streets. In parts of the City—in Cheapside, for instance—there was an enormous number of tubes and pipes underground. It was impossible to find a place to put anything else in. There was no new element introduced, but the mains, he thought, were larger and probably more numerous than was the case outside.

Mr. BALFOUR BROWNE: Is it your duty to report to the Corporation on any shortcomings in particulars relating to the public lighting?—Yes.

Mr. BALFOUR BROWNE: You said that you thought competition would result in a reduction in the price of electric light?—I think that is obvious.

Mr. BALFOUR BROWNE: Your public lamps are supplied by a continuous current, and private consumers are supplied by an alternating current?—Yes.

Replying to Mr. FITZGERALD, who said he could not find a single place where the charge was as high as in the City of London, the WITNESS said he himself could not tell of a place where this was higher.

Mr. GRAY: In your opinion would the public put up with the inconvenience caused by the breaking up of the streets if they were assured that the price of electric light would be reduced?—I think that would form a very strong factor for consideration.

Replying to Sir Courtenay Boyle, the WITNESS said it was impossible for him to estimate the number of householders in the City who would be inclined to use the electric light if it were cheaper.

Mr. GRAY intimated that this was as far as he was in a position to carry the case for the Corporation at present.

Mr. POPE said that before he addressed the Court he would like to know exactly the position of the City.

Mr. GRAY understood that it was arranged at the previous meeting of the enquiry that the Corporation should speak last.

Mr. POPE remarked that this would be absolutely unfair. He added that he must know the views of the Corporation before he spoke.

Sir COURTENAY BOYLE suggested that Mr. Pope might apply for leave to reply if the Corporation had anything to say.

Mr. POPE intimated that he was quite ready to accept that course.

A WITNESS RECALLED.

Mr. W. H. PATCHELL, engineer of the Charing Cross and Strand Electricity Supply Corporation, was then recalled and examined on certain matters in respect of which he had promised to give information before the adjournment for the Easter recess. He stated that the total units sold by his company last year amounted to 3,241,331. After deducting the total used for motive power (103,003) there would be left 3,138,328 units, which were used for lighting. The total revenue was £58,985. 3s. 2d. Allowing £1,582 10s. obtained from the supply of motive power, it would leave £57,402. 13s. 2d. as the revenue from lighting. The witness then went on to show that the average price worked out at 4·389d. per unit used for lighting if the power units were deducted, as against the company's published figures of 4·367—the difference being ·022. The average price per unit sold for motive power was 3·68d. He was also examined as to the load curve of his stations.

THE CITY COMPANY'S CASE.

Mr. POPE, on behalf of the existing company—the City of London—said it seemed to him that the attitude of the Corporation was one of the most important factors to be considered in this case, and the main point of the argument he had to submit would be based upon that. He would assume that that

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attitude was correctly described in the resolutions submitted that morning. He did not think that in discussing the effect of the first clause of the Act of 1888 he need go back to the Act of 1882. Nor was he disposed to discuss the question as to whether the agreement between the Commissioners of Sewers and the City of London Company was or was not a valid agreement. This was a matter which lay between the company and the Corporation, and was not one that was very relevant to the enquiry. The simple question was: Is the attitude of the Corporation such as to give consent to the admission within the City area of a new competitive company? If it was not, then he should contend that no such special circumstances existed in this case as would justify the Board of Trade in dispensing with that consent, and that, therefore, Clause 1 of the Act of 1888 would practically decide this question. The consent of the local authority was a condition precedent to the granting of a provisional order, and some special circumstances must exist for the Board of Trade to pass over the consent of the local authority. What other sort of circumstances would justify that Board in dispensing with the consent of the local authority? Clearly the advantages of competition could not be described as such as it was something that was common in every case. Yet he could only find this advantage of competition as the reason why an order should be given. The question was not whether *ab initio* competition should be allowed in the City, but whether the Board of Trade, having decided that this was not desirable, they should seek to disturb that arrangement now without the consent of the contracting parties or the local authorities. He contended that it would be a great hardship for any other company to be allowed to enter and pick out the eye, so to speak, of the existing company by supplying electricity at the particular points at which the supply was the most profitable. What was the attitude of the City? It certainly was not consenting to competition, and he did not think it had offered refusal. With reference to the resolutions passed by the Corporation the previous day, he understood them to mean that the City authorities did not desire to disturb the existing arrangements unless a way could be seen of taking the electrical supply into their own hands. If, however, those arrangements were to be disturbed, then the Corporation desired that the change should be made under certain conditions. On the part of the Corporation there was neither consent nor a definite refusal. If the existing agreement was void, the Corporation asked to be left alone until it was decided what to do in regard to obtaining possession of the supply. The position, he admitted, was an awkward one for both parties if the agreement was void, as most onerous conditions under which the City Company laboured were determined, not by the provisional order, but by the agreement in question. Among other things, the public lighting was so determined. It was a matter for grave consideration on the part of the City, and it was a question whether it would throw open the whole of the public lighting. That might be one of the effects of the agreement being declared void. It only showed how important it was that the Corporation should be left alone, as it did not know its present position. The City might consider it advisable to supply its own electric light, and it might also ask the Board of Trade that there should be no interference at present with its right to determine its own position. As to the claims of the other companies, he might say "A plague on all your houses." He would leave them to settle amongst themselves which was the worst. It seemed to him, looking at the series of resolutions which had just been adopted by the Corporation, that that body did not wish to be interfered with, and that it wanted to consider what its present position was in the event of counsel's opinion being found to be correct. He thought the City was wise, even if it was looking to its own interests rather than to the fairness the present supply company had a right to expect from it, in asking the Board of Trade to let it alone and to decide what would be to the general benefit of the citizens. Cheap electric lighting might, however, be bought too dearly, and the inconvenience caused by the introduction of a competitive supply might be greater than the subsequent benefits of a cheaper supply. No strong case had been made out against the City Company as to its inability to perform its work, and certainly the failures reported would not justify the Board of Trade in believing that the company was unwilling to do its duty, or too careless to fulfil its obligations to the consumers. What were this company's shortcomings? It seemed to him that they meant rather the shortcomings of two special occasions. Of course, every electric light company might be liable to occasional default. The only cases in which bad service had been alleged was when the fog of last winter brought an unusual stress of demand upon the resources of the conpany. As regards the public lighting, it could not be a bad service when the penalties enforced were in the slightest proportion to the amount of service rendered. During one six months only £36. 5s. 5d. was paid upon a total amount of £12,000. If, then, there was no serious default on the part of the company, what justification was there for the Board of Trade to disturb the relations of the company with the local authority if the latter did not come to the Board and ask for this? On the other hand, the company were deserving of very great consideration.

The Corporation Silent.

Mr. Gray, on behalf of the Corporation, said he had no observations to make.

Sir Courtenay Boyle asked if the Corporation desired to say anything at any time, or was it proposed that there should be a temporary adjournment of the enquiry so that the position of the Corporation might be considered.

Mr. Gray said unless some of his learned friends made statements that he should be bound to reply to, he did not propose to say anything more either on that or on any future occasion.

Metropolitan Company.

Mr. Fitzgerald (for the Metropolitan Company) said the position of the Corporation had been consistent throughout. They found themselves in a difficulty, owing to an agreement between the Commissioners of Sewers and the Brush, or whatever company it was, that originally got these provisional orders. Having referred to the opinion of Mr. Danckwerts, he said the Commissioners of Sewers professed by that contract to grant the exclusive right for supplying for private purposes within the City, which they had no power to do. The Corporation thought they had no right to depart from what had been done by their predecessors, and ought not to give their consent to competition. It was obvious from the tone of the resolutions which had just been accepted that that body desired to leave the Board of Trade to deal with the present applications in whatever way it thought best for the public interest. Having referred to the necessity for competition, and the circumstances which justified this in the City, he said it had been urged that the City Company was unable to cope with a November fog. But fogs were not peculiar to that area. West of Temple Bar these were quite as bad as they were east of it, and if competition were permitted within the City it would soon be seen that that great local phenomenon—a November fog—would be successfully combatted. He referred to the evidence which was given before the adjournment with respect to St. Bartholomew's Hospital. The governors of that institution desired to have it lighted with the electric light, but found the price prohibitive, as £2,000 a year would have to be added to their lighting bill to admit of this. Notwithstanding that it was a large and charitable institution the governors found they could get no reduction. If the hospital had been situated a little further to the westward, a company might have been found to supply electric lighting at a reasonable cost. Referring to certain clauses in the agreement which were stated to be a hardship upon the City Company, he would remind the Board of Trade that the private lighting part of the concern, the most profitable portion of the undertaking, could be purchased upon most favourable terms, while as to the public lighting being unremunerative, it was a common practice, and for very good reasons, for companies to supply that current at a cheaper rate, one reason being that a large sum of money was annually received in respect to it. This sum in the present case was £13,000 per annum. Another reason was that it was used for a longer time than the demands required by private lighting, and were it not for the public lighting the machinery would not be continually in use. Any company would be willing to take up the contract on the terms on which the City Company held it. Having referred to the Smithfield Company, which up to now had said so little in its own favour as to make him reluctant to rob it of its own argument, he proceeded to review the position of the Charing Cross Company. In conclusion, he said that if competition was to take place in the City supply, as he believed it would, that competition should be allowed by the Board of Trade to the Metropolitan Company.

Charing Cross Company's Case.

Mr. Shiress Will, for the Charing Cross Company, referred to the position occupied by the Corporation as contained in the resolutions. The Corporation said it had left itself in the hands of the Board of Trade, for in those resolutions there was not a single word of assent or of objection to any of the companies. It had determined to loyally abide by the existing agreement as long as it stood. That was the reason why it had tied its hands and its tongue. But its recently passed resolutions did not suggest that the Board of Trade should stand still and do nothing. Nothing was to be gained by delay. If the Corporation possessed the right of supply, would the demands which were now made for competition be met? He denied that this would be met, and said the City would be left just where it was at the present time. With reference to the resolution advocating the right to purchase an undertaking outside the City, he did not think this was scarcely a reasonable or a business-like one. It would practically mean that the Board of Trade should give up its rights, leaving its discretion wholly in the hands of the Corporation. The Charing Cross Company, however, would be ready to meet the Corporation in this way—they would be perfectly willing to keep separate the generating station or stations that would supply the City, so that the City could purchase in case they ever desired to do

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so. Of course his company proposed to begin the supply from the existing generating station, but it would be compelled to secure other generating stations, and these would be kept distinct. Referring to the price charged by his company for current, he mentioned that its record in this respect was a good one, as also in meeting the wishes and demands of its customers. The average cost of its light was 4·38d., as compared with 5·22d. charged by the City Company, and 5·2d. by the Metropolitan Company. The Charing Cross Company was also prepared to increase its power to 360,000 lamps. At present there was a demand for 142,000 lamps. With regard to the Smithfield Company, it had a grievance to urge, and this was that it supplied public light free to the avenues of the market to the tune of £900 per annum. He urged that the Corporation in making such an arrangement with that company had acted contrary to the policy of the Acts of 1882-8. No local authority in the exercise of a discretion given it ought to make any bargain of the kind.

THE SMITHFIELD MARKETS COMPANY.

Mr. BALFOUR BROWNE, in his address on behalf of the Smithfield Markets Company, referred to what he called the laboured address of Mr. Shiress Will and the melancholy speech of Mr. Fitzgerald. He then urged that, as the City had neither assented nor dissented in regard to the matter before the Court, there was clearly a case for the intervention of the Board of Trade. He drew attention to the fact that a petition bearing 10,000 signatures had been signed in favour of his company's proposal to supply the City. This company was already there with the consent and encouragement of the Corporation, and as it was the only company whose whole works when completed would be located within the City, and could be purchased by the Corporation, it ought to be the first to be allowed to compete. In making the bargain it did with the Smithfield Markets Company for the free lighting of the avenues referred to, he denied that the Corporation had departed from the Act of 1888. His company had the refusal of several sites in the City for extended accommodation, and it was prepared to pledge itself to duplicate the supply of electric lighting there in a shorter space of time than any other company.

Mr. GRAY intimated his desire to say something with reference to the Smithfield Company.

Sir COURTENAY BOYLE asked whether the Corporation had power to purchase a portion of an undertaking or a generating station outside its own district, independently of any powers conferred by the Act.

Mr. GRAY said yes, and the Corporation were buying outside their own district at the present time.

Sir COURTENAY BOYLE said he understood that the Corporation possessed powers which other bodies did not enjoy.

Mr. GRAY wished now to say that the Corporation desired most distinctly to state that it did not recognise the Smithfield Company in any shape or form.

Mr. BALFOUR BROWNE: You are getting your supply for nothing, and receiving £900 a year from us. We are giving the Corporation a great benefit, and I do not think it gracious for them to try and repudiate it. As to the power of buying outside the City, I should like to see where they get that.

Mr. POPE said he had nothing further to say.

CONCLUSION OF THE ENQUIRY.

Sir COURTENAY BOYLE: The matter will receive the most careful consideration, and the Board of Trade will communicate with the Corporation before coming to any conclusion in the matter. I should like to add that I am very much in the position of the lady in the story-book, who listened to three eloquent suitors for her daughter's hand and could not get the daughter to tell her which of the suitors she preferred.

Mr. BALFOUR BROWNE: Don't take the rich suitor.

Mr. POPE: Then she did not give her consent at all.

This closed the proceedings.

MANCHESTER TRAMWAYS.

The question as to whether the electrical energy required for the proposed electric tramways in Manchester shall be supplied by the electric light department, or whether the Tramway Committee shall erect their own generating works, is now being considered by the Corporation. The Tramways Committee has, says the *Manchester Guardian*, had two reports before them. One of these is the report of Mr. Parshall to the Glasgow Corporation, in which separate works for the traction plant is recommended. The second report, by Mr. Wordingham, is directly opposite to this course. Mr. Parshall's report was given verbatim in our issue of March 24, p. 379. The following is a *résumé* of Mr. Wordingham's criticism of this report.

Mr. C. H. Wordingham says he believes that to apply the conclusions which Mr. Parshall has arrived at in Glasgow to the case in Manchester would be wholly misleading, and would result in disastrous waste to both the tramways and electricity departments. Although the two cities are identical in many respects, as, for instance, in acreage, population, method of tram traction as adopted in Glasgow and proposed in Manchester, etc., yet the great difference between them in the matter under consideration is that whereas the Glasgow Corporation are already committed in respect of their lighting to a system which is unsuited for a large tramway network, in Manchester the question of tramways has been kept steadily in view by Mr. Wordingham from the beginning. He says: "My scheme was devised so as to be equally applicable to both lighting and traction." In dealing with the question of the overlapping of the load in traction and lighting Mr. Wordingham acknowledges that for three or four months of the year the maximum loads may overlap. This would not, however, occur during the remaining eight or nine months, and even in the period when they did they would not do so for more than four hours per day at the utmost. Dealing with the statement that the machinery used for lighting is commonly of a different type from that for traction, Mr. Wordingham says that "the type of machine used in Manchester is absolutely identical for the two purposes, and in the new station the high-tension switch gear will be common—that is to say, the current which passes through it will be used for both purposes." In reply to the suggestion that a greater range of voltage is permissible in tram haulage than is desirable in electric lighting, Mr. Wordingham does not think that "large variations of pressure are desirable even in traction work. They mean diminished efficiency of transmission, and this would have the disadvantage—to which, I think, the Tramways Committee would attach great importance—that the light given by the lamps in the cars would fluctuate, and I understand that they intend to make a feature of comfortable cars. This comfort would be destroyed if the light were constantly flickering." The figures which Mr. Parshall gives of the comparative cost of energy for traction and lighting respectively are accepted by Mr. Wordingham so far as they relate to the latter, but he is careful to point out that Mr. Parshall's estimate as to the cost of haulage is purely hypothetical, and that experience may prove it to be wanting in accuracy. Mr. Wordingham adds: "I do not wish to dispute Mr. Parshall's figures, but I do say that if Glasgow, with a purely traction station, can attain them, Manchester, with a combined station, using exactly the same system of generation and distribution, can beat them." In opposition to Mr. Parshall, Mr. Wordingham thinks that a combined system will result in an economy of staff. He "cannot agree that a different class of attendant is required by the two kinds of work." In his own scheme for Manchester "they have absolutely the same kind of plant to attend to in both cases."

In dealing with the subject of "Combined Stations Elsewhere," Mr. Wordingham points out that in Bristol (an illustration on which Mr. Parshall relies) the lighting is in the hands of the Corporation, and the tram service is supplied by a private company. "In Manchester both lighting and traction are in the hands of the Corporation, and neither department has any interests to serve other than those of the ratepayers generally." In Sheffield the lighting and tram services have recently been acquired by the Corporation from private companies. The plant of the lighting company is unsuitable for tram haulage. Mr. Wordingham says that "the absence of combined stations in the United Kingdom is not to be wondered at, seeing that there are so few traction stations." He does not know of any town in the United Kingdom in which the municipality is operating lighting and tramways from separate stations. Halifax, Blackburn, and Plymouth have combined stations. "In those towns in which there are two distinct stations it will be found either that both are in the hands of companies, or one is in the hands of the corporation and the other in the hands of a company." Mr. Wordingham does not believe that Continental or American practice can be taken as a sure guide in this particular matter, since the conditions obtaining there are so widely different. Dealing with the broad principles of his scheme of combined lighting and traction for Manchester, Mr. Wordingham points out that it presents the following points: "The generators are common to lighting and traction, and the same generator supplies both loads simultaneously; the high-pressure mains are common to both loads, and the same mains suffice for both simultaneously; the static transformers and rotary converters are common to both loads, but the same set does not supply lighting and traction simultaneously, though they are entirely interchangeable. The combination of the two undertakings renders it possible to have a larger generating station with less cost for attendance per unit generated. It also reduces the losses from idle plant, etc. The cost of supervision is also minimised. Under a dual system the repairing staff would require to be duplicated. Another advantage of combination is the reduction in the amount of spare plant required. If a dual system were adopted it would involve the 'great inconvenience to the public of opening practically the

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same routes twice over when a single opening would suffice.' Corresponding gains would follow in the size of the mains themselves." Mr. Wordingham concludes his report as follows: "I trust that I have plainly demonstrated that in Manchester, whatever may be the case in other towns, there is everything to be gained by both the tramways and electricity departments by the combination of their respective undertakings. I am convinced, and cannot too strongly urge, that were the idea of separating the two generating stations carried into effect, both committees would bitterly regret having abandoned their original intention, and that at no very distant date."

The foregoing reports were discussed at a special meeting of the Manchester Tramways Committee which was held on Tuesday. Mr. Boyle presided over a large attendance of members, and after a lengthy consideration of the whole subject it was decided that a special committee should be appointed to confer with the Electricity Committee in regard to the generation of electrical energy for the working of the tramways. Messrs. Boyle, Wainwright, Wilson, Bishop, M'Cabe, and Plummer were selected to represent the Tramways Committee, and they were also empowered to obtain such advice and assistance as they might deem to be necessary.

HANLEY ELECTRICITY WORKS.

From the accounts of the Hanley Corporation electricity works just issued it appears that the total expenditure up to Dec. 31, 1898, amounts to £60,785. 7s. 11d. We give herewith the revenue account, general balance sheet, and statement of electricity generated, sold, etc., for the past year:

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal, including carriage, etc.	£1,398	8	0			
Oil, waste, water, and stores	330	15	1			
Wages	777	14	11			
Repairs and maintenance as follows: buildings, £140. 11s. 10d.; engines, boilers, £527. 13s. 4d.; dynamos, transformers, etc., £140. 14s. 10d.; other machinery, instruments, etc., £16. 0s. 9d.—£825. 0s. 9d.; less old material, £26. 4s. 6d.	798	16	3			
				3,305	14	3
Distribution of Electricity.						
Wages to linesmen, etc.	80	1	4			
Maintenance of mains, less £7. 5s. refunded	59	12	7			
Maintenance of meters, switches, fuses, and other apparatus on consumers' premises	166	12	0			
Maintenance of apparatus at distributing stations	114	12	3			
				420	18	2
Public Lamps.						
Attending and repairs	349	18	10			
Renewals of lamps	36	9	1			
				386	7	11
Rents, rates, and taxes				553	6	6
Management Expenses.						
Salaries—engineers' department	536	1	2			
Stationery and printing	21	6	10			
General establishment charges, less £3. 3s. refunded	30	4	5			
				587	12	5
Law and parliamentary charges				2	9	6
Special charges—insurances, etc.				34	14	7
Total expenditure				5,295	3	4
Amount carried to net revenue account				2,420	1	4
				£7,715	4	8

Cr.	£	s.	d.
Sale of current per meter	6,141	2	2
Public lighting	1,345	0	0
Rental of meters and other apparatus on consumers' premises	214	13	8
Sale and repairs of lamps	14	8	10
	£7,715	4	8

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	46,110	0	0
Overdraft on account of loans sanctioned	14,675	7	11
Sundry creditors	329	18	10
Net revenue account—balance due to general district rate account	376	12	7
Balance	2,264	5	5
	£63,756	4	9

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	60,785	7	11
Stores on hand at Dec. 31, 1898: coal, £63. 6s. 8d.; oil, waste, etc., £37. 1s. 8d.; general, £222 4s...	322	12	4
Sundry debtors for current supplied	2,568	2	9
Other debtors	80	1	9
	£63,756	4	9

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			551,259
Quantity sold..	Public lamps	118,494	474,247
	Private consumers by meters	355,753	
Quantity used on works			5,109
Total quantity accounted for			479,356
Quantity not accounted for			71,903
Number of public lamps			133
Total maximum supply demanded (kilowatts)			460

NEWCASTLE TRAMWAYS.

The following is the full text of the report by Mr. W. George Laws, the city engineer of Newcastle-on-Tyne, on the question of the introduction of electric tramways into that city. The report is dated April 5, 1899, and is addressed to the chairman and members of the Tramways Committee. It reads as follows:

On Feb. 21 the Council passed the report of the Tramways Committee, with the proviso that they should have a report from myself, and from an expert, as to whether "in the streets in the centre of the city some system other than overhead traction is practicable to be worked in conjunction with the overhead system in other streets." In carrying out my part of this combined report, the Council will expect me to dwell chiefly on the effect on our streets of adopting a wholesale system of poles and overhead wires, as against some other system in which all the apparatus is kept below ground, or, better still, is absent altogether. As to the practicability of such system, its cost of installation and working, they will naturally be guided chiefly by Prof. A. B. Kennedy, the gentleman they have chosen to report thereon, at the same time as myself. At the same time, having for some years now been gathering materials for forming a judgment on the many proposed systems, and that without any preconceived prejudice for or against any of them, I hold myself free to express the result of such examination, and the opinions formed, even at the risk of travelling out of my own domain. Indeed, one cannot help believing that a practical, common-sense opinion from outside is often of more value as between rival systems than that of experts, who are, quite naturally, biassed in favour of the system with which they are most familiar.

It is to be regretted that the attention of the special committee has been confined within such narrow limits, and that they have not at least glanced at other systems, of which there are several, that are all worth serious consideration; and it is the more to be regretted since there have been very evident signs that the question of whether or not the streets are to be encumbered by poles and wires, would be a prominent factor in the popular decision on the choice of a system. Possibly it may be that the very decisive action of the Corporation in dealing with overhead wires put up by other authorities has lulled the public into a sense of security that their interests were quite safe in the hands of so vigilant a body of representatives, and it has not occurred to them as likely that the Corporation, after firmly and successfully insisting that the Post Office authorities, for instance, should remove their telegraph wires from the North-road as an eyesore and a nuisance, would themselves, within so short a time, actually propose to reinstate that eyesore in another form, and so as to be even a greater nuisance, and that not only on the North-road but even in the central streets of the city. They will naturally ask, "Why this change of opinion? And is it warranted?"

It seems to me a pity that the committee did not in their report even touch on this aspect of the tramway question, or by their enquiries into other possible systems fortify themselves with arguments to meet the objections that were certain to be raised. That they have somewhat tardily seen their error, and endeavoured to rectify it by what is practically a confession, that even their main conclusion may have to be modified or reversed, seems to be a confession of weakness that has seriously jeopardised the fate of their present Bill. But it is not for me to criticise their action further than is absolutely necessary to explain the position, and I will only say that, in my humble opinion, it would have been wiser to have accepted the suggestion of Alderman Sir Chas. Hamond, and gone to the Council and the ratepayers with the definite and logical conclusion: "We advise you to adopt the best system of electrical traction, whatever that may be, as against cable." That they would have certainly carried, and would have been in a strong, logical, and unassailable position.

To return to the points on which my opinion is more particu-

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larly asked—"What is best for our streets?" I have always been a consistent opponent of interference in any way with the surface of our streets, and have viewed with alarm the increasing tendency to allow them to be obstructed by erections which, however useful in their way, do hamper and restrict their usefulness for ordinary traffic. We have not yet felt the acute pinch of "traffic pressure" as it has been felt in London, for instance, but that it is coming upon us, and at no distant date, anyone who has watched the increase of vehicles during the last 20 years must realise. And we in Newcastle are likely to feel it sooner than other towns of similar size, for the reason that our traffic is more cumbrous than in other places. There is a larger proportion of slow, heavy vehicles. The prevailing practice of "caulker shoeing" is in some degree the cause of this. Heavy caulker-shod horses have been adopted to cope with our numerous and heavy hills, and their pace is rather majestic than swift, even in flatter streets. No one can watch London traffic without being struck with the much greater average speed with which heavy loads are there drawn through the streets. The horses are lighter, chiefly flat-shod, and usually move at a trot. One cannot avoid the comparison that the heavy traffic in Newcastle seems rather to be going to the funeral of trade than to its active aid. To this heavy, slow traffic we have lately had added the even more unmanageable traction engine, with its train of beer-laden wagons, going at two miles an hour—a nuisance in more ways than one, but one that will probably prove so burdensome as to cure itself. This great variation in the moving speed of the traffic, varying from the two miles per hour of the traction engine to the "anything-you-like-over-ten" of the scorching cyclist renders it still more important that there should be no hindrance to the mutual 'get-out-of-the-way" that alone renders progress possible, or prevents actual block.

Central poles, at even considerable intervals in the streets, present a much greater obstacle to the free manœuvring of the traffic than is merely represented by their actual size. The pole may be no more than 6in. in diameter, but it is a block that effectually prevents, say, a traction engine with three wagons from getting out of the way; that is, it can paralyse the traffic for three-quarters of a minute. This, of course, is an extreme instance, but quite within the ordinary daily experience. Anyone who chooses to watch the "beer train" passing up Pilgrim-street and across Blackett-street will admit that I have in no way overstated the block it can cause. The importance of uniformity of speed within certain limits has been recognised by the police authorities in London in their recent action—directed against "crawling" cabs—which seem to have had a material effect in preventing blocks. Most of you will agree with me in the opinion, that if Newcastle had to be rebuilt, you would insist on wider streets wherever they were, or were likely to become thoroughfares, and it logically follows that any further narrowing of their present width by lamp-posts, tram poles, and the like, would be a step backwards. America is recognising this, and actively insisting that the companies shall remove the overhead system in the large cities, and substitute some system that leaves the streets clear. Paris and Berlin have acted in time, and stopped overhead erections in the cities proper. London seems likely to be wise in time and do the same. Newcastle citizens will do well to pause before they commit an error of which they are certain to repent, and that rather sooner than later. There is no necessity to resort to a "cheap and nasty system" here. Tramway traffic will pay interest on even heavy capital expenditure. Success, under good management, has been shown to be certain, and has even occasionally resulted under corporate management, probably the severest test to which it could be put.

So far no stress has been laid on the æsthetic objection to the overhead wires as an eyesore that will seriously damage the appearance of a fine old town—a town that, to quote the dictum of a former respected chief magistrate, "elways wes an aad toon," which, as an apt epigram, conveys a sense of hoary antiquity that is not easy to improve upon; a town that most of us are proud of, and would be reluctant to see spoilt. Being myself a native of Newcastle, and having seen it develop over 60 years, and increase to four times its size, 3½ times its population, and certainly 10 times its importance, I cannot help feeling that there must be very many who, like myself, would bitterly regret to see it become a happy hunting ground for electrical enthusiasts, and a museum of their monstrosities. It deserves a better fate, and certainly such a blow should not be dealt by the representatives it has trusted. In this matter, however, there is still hope that those whose sense of the fitness of things led them to successfully resist the proposed invasion of the telegraph, telephone, and electric light companies (who would cheerfully have spun their unsightly web over the town to save their own pockets), will yet hesitate to do themselves what they rightly refused permission to others to do. There are towns that cannot be spoilt by any addition of ugliness; there are districts that cannot afford to indulge in expenditure to preserve their amenities; but Newcastle is in neither category. They have a town that can be spoilt, and a purse that will bear the strain of protecting it—if any strain there may be—which is certainly not yet proven. Let us, at least, know what are the facts before we consent to an outrage that would rival the destructive efforts of the Goths and Vandals.

After carefully reading the reports of many deputations from large towns who have made municipal picnics to the *habitat* of the "overhead wire," both at home and abroad, I am struck by the fact that, eliminating the wildest of the "trolleyites," expert and amateur, there is no sober-minded alderman or councillor who has not admitted that the eyesore is a real one. "Oh, yes," they say, "but you will get accustomed to it, and then you forget it." "In some towns, such as Hamburg or Brussels," they say, "the poles and wires are partly hidden by the foliage of the Boulevards." What comfort is that to Newcastle? One has heard of the monkish hero who, by way of mortifying the flesh, slept nightly on tenpenny nails, and after 20 years or so of such slumbers found he could not rest comfortably on anything else. One hopes that St. Peter, when applied to by him for admission, did not give him the time-honoured reply that "Heaven was not for fools, for whom another place was provided." We may get accustomed to the poles and wires; we may even stick an electric lamp on the top and try to enthuse; but in our hearts will always lurk the suspicion that both pole and lamp are in the wrong place. There is but one place where a lamp-post or tram-pole is not an obstruction—viz., on the kerb, and even there it is not an object of art, nor can it be made so by any amount of curly hoop-iron or decorative painting. It is "matter in the wrong place." The idea of glorifying it, by making it carry a lamp, is ingenious, but fallacious in principle. The lighting of the streets should not be run from the same circuit as the trams, or the consequences of temporary failure are made worse, and just when the trams are left helpless in the streets, the light that should guide other vehicles is wanting. Possibly there may be a mistaken idea that the lamps on tramway poles cost nothing to work. This is not so. There is not the least saving in running them on the tramway circuit. Each lamp lighted requires so much coal to be burnt at the generating station, in addition to that required for the cars. There are other objections to the arrangement, though it may be frankly admitted that it is sometimes useful to have two strings to one's bow when accounts have to be balanced.

Having now marked my standpoint, I will try to show that the proposed sacrifice is uncalled for. The question is: Is there any system by which electrical traction is possible without the poles and wires? Speaking broadly, there are only three—the underground conduit, the surface contact, and the self-contained automatic car—but of each of these three, there are several modifications, all of which have been tried, and several of them successfully. Siemens and Halske's conduit has been very successful in Budapest and some other places. Love's conduit has been installed in Washington and New York, and is said to be so successful that it is proposed to lay down many miles of it. The "Simplex" has been laid down experimentally at Prescot, and to my mind is the most promising of the open conduits, and well worth considering. It is to be regretted that the committee did not think it worth their while to visit Prescot while on their travels. I did so 12 months ago and was much struck with the ingenuity and simplicity of the arrangements. It is said to be very little in excess of the "trolley system" in first cost, and one can see that there may be good reason for the claim. The culvert or conduit is so shallow—only 17in. below rail level—that it can be constructed within the thickness of an ordinary first-class paved road, and so avoids the extensive alterations to gas or water pipes that have proved so costly with the deeper conduits. In fact, a trench 2ft. wide and deep is sufficiently large for its construction, while the hand-holes and openings for getting at the insulators are comparatively small. The whole of the rail-laying and conduit work can be executed before any of the electric apparatus is put in, and once in renewals or repairs of conductors or insulators can be carried out without again opening the ground. This alone gives the "Simplex" an immense advantage over the Budapest conduit, where any renewal of apparatus can only be carried out by removing a rail and pulling down the brickwork that forms the top of the culvert. The Love system has a fairly shallow conduit, but even that is 24in. deep and requires a trench 2ft. 6in. deep to get it in, a depth at which most water and gas pipes would be touched, while the Love manholes are 4ft. deep. These latter, however, are not so fixed in position that they could not be moved to right or left a few feet to get over a difficulty where pipe or sewer came in the way. The Love system has, however, one great advantage over the "Simplex," in that it has a separate conductor for the return current, thus avoiding danger of electrolysis to neighbouring pipes, which any system carrying its return through bonded rails is liable to cause by leakage. Both systems are defective in one thing—viz., that they form the slot by a double rail, in which the flange of the wheels run. Where this is done, not only must the slot be originally wider, say at least 1in., instead of ⅝in. or ¾in., but it is rapidly worn by friction till it is rarely less than 1½in., and more often 1¾in.

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or 2in. wide. Now, much more mud, snow, or rain will get in through a 1¼in. slot than through a ¾in., and on comparative freedom from slurry or water depends to a great extent the success of the conduit system. There is no mechanical reason that can be seen why the conduit and slot should not be quite independent of the running rail, and so avoid the objectionable enlargement in width; nor is there any reason, except additional expense, why the "Simplex" could not have an independent return, instead of the bonded rail. Of all the conduit systems, these two seem to promise best, and, subject to the technical point of whether they will work in the English climate as well as the underground system undoubtedly does in Budapest, and is now said to do in New York, they appear to me to be mechanically right. Probably some modification, including the best points of both, will be the conduit of the future.

As to the cost of working, we have no information yet as regards the "Simplex," and only one report from New York. The last is rosy enough certainly, but must be taken like most American electric figures, *cum grano*. On comparing it with Mr. Greene's figures from Chicago, one is inclined to think that the New York figures may have been "reduced to a common basis." The three sets of figures are as follows for operating expenses per car mile:

	Chicago, 1895.	Chicago, 1893.	New York, 1898.
Horse.....	12¾d.	13d.	9d.
Cable	5d.	5¼d.	8¼d.
Electric ...	8½d.	6¾d.	5⅛d.
	(Trolley)	(Trolley)	(Conduit)

If the New York figures are reliable, they show that underground electric is run at even less than overhead. This requires some explanation. When, in 1893, the favourable results at Budapest were announced, I expressed my doubt as to whether these results would be realised in the English climate. I still hold those doubts, though they are to some extent shaken by the New York results. But if in America conduit can rival trolley, there is no apparent reason why it should not do so in England. The recent blizzard in New York has been quoted as having stopped traffic on the conduit system, and it did so; but it did so on the trolley system also. This information was given to me by a New York gentleman whose business is the manufacture of electric machinery for overhead traction, and it may be relied on.

The improvement in conduit construction since 1893 has been considerable. The "Simplex" system decidedly shows the practicability of a conduit so shallow that it can be constructed in the 18in. of depth occupied by the bottoming and paving of a first-class road, and so avoid costly interference with pipes. This should materially reduce first cost, and bring it, not certainly down to that of a "cheap" trolley, but to much less than that of a cable line. A still shallower conduit was that adopted in the Brain system—a cast-iron channel 6in. deep only, with a covering of flexible steel, which was lifted by a trolley attached to the car to allow the collector to reach the conductor, and which fell into place again when the car had passed. The plan was ingenious enough, but did not strike me as one likely to go beyond the experimental stage. A 6in. deep conduit that would protect the conductor and keep clean would solve the conduit problem by reducing the first cost to about that of the trolley, but such a conduit has yet to be invented. The surface-contact system has been tried, notably in Washington, U.S., and in Paris; also proposed by Dr. Hopkinson for Boar-lane, Leeds, but not adopted. The general principle of all these systems is, that the current is communicated from an underground conductor to studs in the track between the rails, from which it is taken up by a sort of shoe or skate attached to the car. Evidently these studs, if alive, are a danger to the street traffic, and, therefore, by an ingenious contrivance they are so arranged that only the particular studs covered by the passing car are energised, and being placed at intervals of 8ft. or 10ft., the skate-shaped collector is always in contact with one, at least, which remains alive so long as the collector touches it, and "dies" when it has passed. The apparatus for securing this result is rather delicate, and its durability open to doubt. The projection of the studs over the general surface of the street paving, though not more than ¼in. at first, will, of course, become greater as the pavements (especially if of wood) wear, and there is always a possibility of a small stone, or any object more than ½in. in size, getting under the skate and preventing contact with the nearest stud, so stopping that car until it has been removed. In Newcastle the large proportion of macadam would always secure a supply of such small stones or mud sufficient to jeopardise the continuous working of the system. In Paris, at least, there has been one accident to horses on the system, arising probably from a stud being accidentally left alive after the passage of the car. Both horses were instantly killed. On the whole, the objections to "surface contact" seems to me to be fatal. It is said to have given satisfaction in Washington, but to have been since removed in favour of the Love conduit.

Coming, now, to the "automotive" or "accumulator" system, one must admit that if financially possible there is no other system that can offer such advantages. There is no more interference with the streets than in the case of a horse tramway; no underground complications; no overhead abominations, except the carrying of the return current by the bonded rails, and consequent risk of leakage and damage to pipes; it is free from objection *qua* streets. The power is stored in "accumulators" usually placed under the seats of the car, and which are charged at the termini for the run either in the car-sheds, or, as in Copenhagen, in the open street. The great objection to the system is the great weight of these "accumulators," increasing the deadweight to be hauled (always large in electric cars) by about two tons. The relative weights of the dead load in the various systems may be taken roughly as follows:

	Dead load.	Passengers.	Proportion.
Horse	3 tons.	1½ tons	2 to 1
Cable (inclusive of cable)	4½ ,, ...	1½ ,, ...	3 to 1
Electric.....	7½ ,, ...	1½ ,, ...	5 to 1
Accumulator	9 ,, ...	1½ ,, ...	6 to 1

That is, in other words, that while in horse traction one-third of the load pays fare, in trolley only one-sixth does so, and in accumulators only one-seventh. The experiments hitherto made in England have not been financially successful. In Birmingham they resulted in a loss of 2d. per car mile, but there the arrangements were cumbrous and very costly.

The whole question hinges on the invention of a suitable storage battery—lighter, more effective, and more durable than anything hitherto tried. That this want will be supplied the rapid progress of electric knowledge leads one to believe. That it is being gradually improved one sees. During my visit to Copenhagen in 1897 I found a short automotive line in full work running from Kongens Nytorv to the Jagt Vej, a distance of something over 1½ miles. The fare for the run (over which I travelled several times) was ¾d. I was unable to ascertain anything about costs of working, being told that they were not made public yet, but came to the conclusion that if with such fares the line could even exist the system was by no means out of the running, and, indeed, had a future before it, and by no means a distant one. The charging of the batteries was done in the public square, Kongens Nytorv (which is in the heart of the town), from small pillars, less than an ordinary hydrant, with a small flexible hose or cable attached. The car, as soon as it reached the terminus, was shunted on to a short siding, the plug of one of these cables stuck into a small hole in car side, and there it waited its turn for service, a charged car being run out of the forward end of the siding for the next journey. The charge was enough to carry it to the other end of the line and back, probably 3½ miles or so. The cars were as neat and comfortable as any electric car; there was no unpleasant smell or vapour from the batteries to be detected, and they were even more manageable and handy than the trolley car, as there was no "fishing-rod" to manipulate. It was clear to me that, mechanically, the whole of Newcastle could be worked on such a system, from one central charging station. The only doubtful point was that of working cost. If the fares were any measure of this, the system is worth enquiring into. It is possible, of course, that this may be a subsidised line, and running at the cost of the ratepayers. This I could not ascertain, my knowledge of Danish being too elementary to help me in making technical enquiries, and though my friend, Herr Agerskov, the electrical engineer at the Free Port, spoke English well, he unfortunately could not give me any tramway information.

There is one question the Council asks—viz., whether, if they adopt the conduit in the centre of the town, it would be possible to work this in conjunction with the trolley in the outskirts? Quite possible! It is done in many places, not, as has sometimes been stated, without any stop to the cars, but with so trifling a delay that it is not serious; and if the foreign system of having fixed stopping places for the cars be adopted, and in my opinion it certainly will be, that delay is minimised. Dr. Hopkinson, in his Leeds report, puts the delay at 10 seconds. Mr. Harris, in his Liverpool report, says 10 or 15. Putting it at 20, or even on occasion 30, it is not a fatal one. All that is required is time to take up or put down the collector and adjust the fishing rod at the points of change. A more serious objection is the enlarged slot required at the point where the collector is put down. In Brussels, this is sometimes 3in., and in Berlin as much as 3½in. wide; and unless the car is stopped very accurately at the spot this enlargement must be longer than is actually needed to pass the collector, or a little manœuvring of the car to and fro will be needed, thus taking up time.

As to the question of within what radius the conduit or other poleless system should be adopted, my opinion is clear that the wider such radius is the better. If it be wide enough to prevent disfiguration of the streets, then there will be so little left of the scheme outside that it will not be worth while to leave it out. Probably it would be better to consider in what parts the poles and wires could be allowed. On the Walker-road, perhaps, beyond the Ouseburn, Arthur's-hill and Elswick-

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road, Heaton-road, Shields-road, Raby-street, Glasshouse-street, Brighton-grove, and Hunter's-road. As to the North-road, decidedly not! Nor can it be conceived how, after insisting on the removal of the telegraph wires, the Council can, with any conscience, propose to replace them by a worse thing. The same as to Back Eldon-street and Claremont-place. All the Moor roads should be spared. Probably, however, the ratepayers will themselves settle the matter by saying that it must be all or none. No partial treatment of districts, rich or poor.

To sum up, and put my opinion on record, it is this: Unless expert opinion condemns the conduit as unworkable in this climate, it should be adopted as against the trolley, certainly in the major part of the town. If the Council comes to that opinion, the "Simplex," or some modification of it, is the most promising, and failing that, "the Love." But, again, unless expert opinion condemns the "accumulator" as worked at Copenhagen, and it proved to be financially impossible, that is preferable to either conduit or trolley. There is one advantage in its adoption—viz., that being no more difficult to lay down than a horse tramway, no delay need occur before beginning to relay the present worn-out lines in the city, and the operation will make less disturbance in the streets.

(Signed) W. Geo. Laws.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Salford.—The Electric Light Committee invite tenders for concentric lead-covered cables by 28th inst.

Reigate.—The Town Council are prepared to receive tenders for the supply and erection of various electric plant. Tenders by May 1.

Edinburgh.—The Corporation are prepared to receive tenders for a 12 months' supply of coal, carbons, and pipes. Tenders by April 24.

London.—The County Council invite tenders for the supply for one year from July 1 of engineers' goods and electrical stores. Tenders by 24th inst.

Peterborough.—The Corporation are prepared to receive tenders for the supply and erection of the plant for the municipal electricity works. Tenders by April 20.

Epsom.—The Urban District Council are prepared to receive tenders for the supply and erection of various electric plant. Tenders by 12 o'clock noon on May 8.

Belfast.—The Electric Committee are prepared to receive tenders for laying conduits, building junction boxes, and laying cables. Tenders by 12 noon on April 27.

Newport (Isle of Wight).—The Committee of Visitors of the County Asylum invite tenders for the supply of a combined engine and dynamo. Tenders by April 29.

Darlington.—The Corporation invite tenders for the supply and delivery of various plant, together with the fixing of the same, at their electric generating station. Tenders by May 8.

Dublin.—The Directors of the Great Northern Railway Company (Ireland) invite tenders for the various works in connection with their line between Sutton and Howth, near Dublin. Tenders by April 20.

Buxton.—The Urban District Council invite tenders for the following works in connection with their electric light station in Buxton: (Contract No. 7) arc lamps; (8) arc lamp posts. Tenders by April 17.

Hull.—The School Board invite tenders for an adequate installation of the electric light at their central higher-grade school and school of science in Brunswick-avenue, Beverley-road. Tenders by 25th inst.

Poplar.—The Board of Works invite tenders for engine and pump room equipment and all electrical plant in the works except the battery, boiler-house equipment, battery and battery stands, and public street lighting. Tenders by 10 a.m. on April 25.

Bolton.—The Corporation invite tenders for the work required in laying the tramway rails in Lostock and Horwich. Specification and other particulars may be obtained from the borough surveyor, Mr. W. H. Brockbank, Town Hall, Bolton. Tenders by 19th inst.

St. Helens (Lancs.).—The Electric Supply and Tramways Company invite tenders for the construction of about six miles of tramways in sections. Specifications, etc., may be obtained from Mr. Geo. J. C. Broom, M.I.C.E., borough engineer, on payment of £2. 2s., which amount will be returned on receipt of a bona fide tender. Tenders by 12 noon on 19th inst.

West Ham.—The County Borough Council invite tenders for two 1,500-i.h.p. engines, two 800 kw. alternators and exciters, or two 800-kw. 1,500-i.h.p. steam alternators and exciters. Specification, etc., may be obtained from the Borough Electrical Engineer, Abbey Mills, West Ham, on the deposit of a £5 Bank of England note, which will be returned on receipt of a bona fide tender. Tenders by 4 p.m. on April 25.

Hampstead.—The Vestry invite tenders for the supply, delivery, and erection of electrical plant, including steam alternators and engines, switchboard panels, boilers, feed-water heaters, vertical steam feed pumps, exciter, water-softening plant, air pump and condenser, Green's economiser, and overhead travelling crane. Particulars may be had of Mr. A. P. Johnson, vestry clerk, to whom tenders must be sent by 12 noon on May 18.

South Shields.—The Corporation invite tenders for the supply and erection of steam and water pipes and valves, and a 15-ton hand-power overhead travelling crane. Specification, etc., may be obtained from the Borough Electrical Engineer, West Holborn, South Shields, on payment of £1. 1s., which sum will be returned on receipt of a bona fide tender. Tenders by noon on April 20.

Belfast.—The Electric Committee invite tenders for the supply and erection of the following: (Section C, 8) mechanical stokers; (C, 9) economisers; (C, 10) pipe work; (C, 11) condensing plant. Specifications, etc., may be obtained on application to Mr. Victor A. H. M'Cowen, city electrical engineer, on payment of £1. 1s. per copy, which sum will be refunded on the return of the specification with a bona fide tender. Tenders by noon on 20th inst.

Perth.—Applications will be received at the City Council Office from persons desirous of applying for a concession for the installation and working of a system of electric lighting for the municipal buildings and streets of the city of Perth, as well as house-to-house lighting. Conditions of contract and full particulars may be obtained on application to the Agents-General for Western Australia, 15, Victoria-street, Westminster, London, or Gordon and Gotch, St. Bride-street, Ludgate-circus, E.C. Tenders by May 2.

Egremont.—The Wallasey Urban District Council invite tenders for the supply for 12 months from June 30 of the following stores required for the use of the gas, water, and electrical works: paper-insulated concentric cables, oils, lead and wrought-iron pipes, cast-iron main pipes, cotton waste, meters (gas, water, and electricity), lamp columns and lamps, main switches, and cut-outs. Particulars, etc., may be obtained at the Gas and Water Engineer's Office, at the Works, Great Float, near Birkenhead. Tenders by 24th inst.

RESULTS OF TENDERS.

Bury (Lancs.).—The Electric Lighting Committee have accepted the tender of Mr. W. Lord, Lord-street Works, Bury, for supply and erection of one Lancashire boiler, with steam and other pipes.

Sheffield.—The tender of the Wheeler Condenser and Engineering Company, of London, for the supply of two condensers for the Kelham Island power station at a total sum of £1,346 has been accepted.

Gloucester.—The Town Council have accepted the following tender for additional plant required for the municipal electricity works: (Section G) public arc lighting, British Insulated Wire Company, Limited, Prescot, £969. 16s.

Brighton.—The Town Council have accepted the tender of Messrs. J. Carrick and Sons, Limited, Dalry Ironworks, Edinburgh, at £415, for supplying and erecting a 24-ton travelling crane at their electricity generating station.

Rothesay.—The Town Council have accepted the tender of Messrs. Louden Bros., Dundee, to fit up the electric light installation for the front of the town and harbour at a cost of £2,501, the whole work to be completed before the middle of July.

Winchester.—The Town Council have accepted the tender of Messrs. E. H. Gudgeon and Co., Winchester, at £214. 7s. 9d., for the electric lighting of a portion of the public offices, clock tower, etc., at the Guildhall, and at the public library and art school.

Burton-on-Trent.—The Town Council have accepted the tender of Messrs. Tinker, Limited, of Manchester, of £1,980, for the supply of electric light boilers, and that of Messrs. Westwood and Wright, of Brierley Hill, for the ironwork required in connection with the electric light extension scheme.

Bury (Lancs.).—The Sewage Committee have accepted the following tenders: Scholes and Son, Manchester, for wiring for lighting and motive purposes at the sewage works, Bury; Ashton, Frost, and Co., Blackburn, for supply and erection of three electric motors at their sewage disposal works, Livsey Fields.

Hammersmith.—The Vestry have accepted the following tenders: Messrs. Babcock and Wilcox for supply of three water-tube boilers, according to specification, £3,320; Messrs. J. Musgrave and Co., for supply and erection of two vertical engines, according to specification, £7,284; Messrs. Siemens Bros., for supplying and fixing two alternators, according to specification, £5,684; Messrs. Callender, for the supply of cables, according to specification, at schedule of prices; Mr. James Ritchie, for supply of cast-iron pipes, according to specification, at schedule of prices.

Plymouth.—The Corporation have accepted the following tenders:—Steam coal: J. Friend and Co., Tredegar washed pea nuts, 15s. per ton; cylinder oil: J. Laing, Son, and Co., Manchester, 11½d. per gallon; engine oil: C. Hawken and Co., Plymouth, 1s. 1d. per gallon; arc lamp carbons: Edison and Swan Electric Lighting Company, Limited, £5 per 1,000 pairs; sub-station transformers: Edison and Swan Electric Lighting Company, Limited, prices as per schedule; street box transformers: Brush Electric Engineering Company, Limited, prices as per schedule.

Canterbury.—The Town Council have accepted the following tenders for additional plant and mains required for the municipal electricity works:—(Section A) boiler-house plant—one boiler complete, mechanical stokers: R. Taylor and Sons, Marsden, £707. 10s.; (B) engine-house plant—one 150-kw. steam dynamo, steam, exhaust, etc., pipes, condenser and accessories, centrifugal pump and motor, tools, painting, etc.: India Rubber, Gutta Percha, and Telegraph Works Company, Limited, Silvertown,

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£2,622; (D) underground mains, cables, etc.: Western Electric Company, North Woolwich, £1,314. The tenders for the switchboard extension (Section C) are still under consideration.

Aberdeen.—The Corporation have accepted the following tenders for the supply and erection of materials for the equipment of their George-street and Woodside tramway route:—Roadwork: J. McAdam and Sons, Charlotte-street, Aberdeen, £18,085. 16s. 8d.; overhead line construction, tramway cars, switchboard instruments, etc., Macartney, McElroy, and Co., Limited, 53, Victoria-street, Westminster, £7,793. 15s. 5d.; feeder, pilot, and test cables: British Insulated Wire Company, Limited, Prescot, £5,340. 9s. 8d.; 400 tons steel girder rails and 20 tons fishplates: P. and W. MacLellan, Limited, 129, Trongate, Glasgow, straight rails £7. 15s. per ton, curved rails £10. 15s., fishplates £8 17s. 6d.

Glasgow.—The Corporation Tramways Committee have accepted the following tenders for the conversion of several routes of the tramway system to electric traction, to connect the south side and east end of the city with Kelvingrove Park: Whiteinch to Anderston Cross, A. Stark and Son, Glasgow, £25,739; Langside, viâ Eglinton-street, Renfield-street, and Sauchiehall street, to Overnewton, A. and J. Faill, Glasgow, £32,610; Anderston Cross to Bridgeton Cross, and also London-road to Terminus, M'Cartney, M'Ilroy, and Co, America, £20,754; Bridgeton Cross to Dalmarnock Terminus, Pollokshaws and Pollokshields to Eglington Toll, and Rutherglen-road, from Braehead-street to Crown-street, D. Murray, Maryhill, £22,973.

BUSINESS NOTES.

Mexico Electric Tramways Company.—The receipts for March were £16,100.

Harrogate.—The Corporation have resolved to borrow £15,750 for the purpose of electric lighting.

Ecclesshall.—The Guardians have decided not to instal the electric light at the workhouse at present.

Yarmouth.—Another Corporation kiosk will be erected on the central beach and illuminated with electricity.

South Shields.—The price of current has been reduced from 7d. per unit and 3d. after the first hour to 7d. and 2d.

Teignmouth.—Approval has been given to the provisional order for electric lighting, all opposition having been satisfied.

Removal.—Mr. P. Lawrence, importer of lubricating oils, has removed from 63, Farringdon-road to 57, Shoe-lane, E.C.

Ayr.—During the last month seven connections were made, bringing the number of consumers connected to the mains up to 301.

Northallerton.—The agreement between the Urban District Council and the Northallerton Electric Lighting Company has been sealed.

Chorley.—A report on the best mode of carrying out the Chorley electric lighting order will shortly be presented to the Town Council.

Globe Telegraph and Trust Company, Limited.—The directors recommend an interim dividend of 2s. 6d. per share on the ordinary shares.

Ingleton.—The directors of the electric light company are confident of being in a position to supply the light by the end of the present summer.

Redditch.—It is expected that the electric lighting scheme will be in working order for either public or private purposes in at most four or five weeks.

Blackburn.—The Town Council have decided to apply to the Local Government Board for sanction to the borrowing of £25,500 for electrical purposes.

Wallasey.—Mr. R. H. Bicknell, C.E., held an enquiry on Wednesday into the application of the Council to borrow £10,000 for the purposes of electric lighting.

Salisbury.—At the meeting in May the Town Council will discuss the advisability of entering into negotiations for the purchase of the electric lighting works.

Barnet.—Active steps are being taken to transfer the Barnet Electric Lighting Order, 1893, to the North Metropolitan Electrical Power Distribution Company, Limited.

Widnes.—The gas and water engineer has been instructed by the Town Council to report on the cost of providing an electric light installation suitable for the borough.

Lowestoft.—A Local Government Board enquiry has been held into the Town Council's application for a loan of £30,000 for electric lighting by Lieut.-Colonel A. E. Smith, R.E.

Ormskirk and Southport Electric Light Railway.—The survey of the above light railway has been commenced by Mr. R. H. Scotter, C.E, M.I.Mech.E., who is engineer of the scheme.

Pontefract.—The Guardians have instructed the Building and Furnishing Committee to take steps with a view to lighting the workhouse and infirmary buildings by an electric installation.

West Hartlepool.—The preparations for the general introduction of the electric light are proceeding steadily. The latest date fixed for the opening ceremony is Christmas of this year.

Weybridge.—In view of the Urban District Council's opposition to the proposed provisional order of the Walton and Weybridge Electric Works Company, Limited, it is not intended to proceed with the application for the order.

Motherwell.—The Police Commissioners have approved of the plans of the proposed electric lighting station, and Prof. Kennedy has been instructed to push on the work as rapidly as possible.

Manchester.—The City Council have resolved to send a deputation to the Chancellor of the Exchequer in support of the application of the Mutual Telephone Company for a telephone license.

Middleton.—The Gas and Electric Light Committee expect soon to come to some definite arrangement with the Manchester Corporation in regard to the supply of electricity for the tramway scheme.

Woking.—With regard to the resolution of the Urban District Council, referred to in our last issue, we hear that the chairman of the Urban District Council at present refuses to call a parish meeting.

Newcastle.—The result of the poll of the ratepayers as to whether the Corporation should seek parliamentary powers to run electric tramways was declared on Wednesday as follows: for, 12,633; against, 11 416.

Oswestry.—A London valuer has been engaged at a fee of 50 guineas to value and report on the undertaking of the Oswestry Electric Lighting and Power Company, Limited, which the Town Council propose to acquire.

Cuba Submarine Telegraph Company, Limited.—The directors recommend a dividend at the rate of 6 per cent. per annum and a bonus of 2s. per share on the ordinary shares, both income tax free, for the half-year ended Dec. 31.

Eccles.—The consulting electrical engineer (Mr. Clirehugh) attended the last meeting of the Town Council and reported that the machinery at the station was still in the contractor's hands, as the official tests had not been completed.

Rotherhithe.—A special meeting of the Vestry will be held at 7 p.m. this evening to consider the advisability of applying to the Board of Trade for the grant of a provisional order to generate and supply electricity within the parish.

Glasgow.—The appointment of Mr. Parshall as consulting engineer to the Corporation tramway department was confirmed on Friday last. Contracts for the new sheds and offices at Dalmarnock, amounting to about £2,700, have been fixed.

Bradford and Leeds Light Railway.—The Board of Trade have announced their intention of taking into consideration at their offices on the 19th inst. the above order, when an opportunity would be given to objectors, or their representatives, of being heard.

Anglo-Argentine Tramways Company.—The directors recommend a final dividend of 2s. 3d. per share, free of income tax, making, with the interim dividend of 1s. 6d. per share paid in October last, 3s. 9d., or 3¾ per cent., for 1898, against 3s., or 3 per cent., paid in 1897.

Whitefield.—A conference of representatives from Little Lever, Radcliffe, Prestwich, and Whitefield Councils has been held at Radcliffe to consider question of joint action for provision of electricity for lighting of district and the adoption of Light Railways Act in these districts.

Wolverhampton.—The Tramway Committee have been authorised to negotiate with the Dudley and Wolverhampton Tramways Company for the purchase of so much of the undertaking as lies within the borough, upon the basis of the clause proposed to be included in the Corporation Bill.

Gillingham.—The Urban District Council have agreed to support the proposals of the Chatham Corporation with reference to powers being obtained by municipalities and urban districts to establish separate or joint district telephonic systems for the greater convenience of the public.

Oriental Telephone and Electric Company, Limited.—The directors recommend, subject to final audit of the accounts, a further dividend of 8d. per share, free of income tax, making, together with the interim dividend paid in October last, 5 per cent. for the year ended Dec. 31, 1898

St. Marylebone.—At a meeting of the Vestry yesterday it was proposed: "That all references to the Electric Lighting Committee be cancelled, and that committee dissolved, and that a committee of five be appointed to enquire into the position of the whole matter and report to the Vestry."

Douglas.—The Town Council on the 12th inst. decided to establish an electrical undertaking on the lines suggested by Prof. Fleming, and a committee was appointed to take steps to establish the same, reporting to the Council as to details. The cost of the installation will be about £16,000.

Hastings.—The Local Government Board have written to the Town Council with reference to the application for the Board's approval of a resolution to promote in Parliament the Hastings Corporation Tramways Bill, 1899, that the Board approve of the resolution referred to, so far as it relates to matters within their jurisdiction.

Bath.—At a meeting of the Surveying Committee on the 10th inst., the question of the introduction of electric trams into the city as a municipal undertaking was discussed. The joint committee recommended that an order for powers under the Light Railways Act be applied for, but the report was defeated by eight votes to seven.

Weston-super-Mare.—At a meeting of the Urban District Council on Wednesday last a letter was read from the promoters of the Weston-super-Mare electric tramways scheme, stating that it was not their intention to proceed with their application to the Board of Trade for an amendment of their provisional order.

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Cardiff.—The chairman of the Tramways Committee and the borough engineer are to visit various towns and prepare a report regarding the generating of powerful tramway traction. The report is also to contain a recommendation as to which of the towns visited the committee should proceed to.

Hampstead.—A letter is before the General Purposes Committee of the Vestry from Messrs. Brash, Wheeler, Umney, and Chambers, solicitors, of Queen Victoria-street, enquiring whether the Vestry would be prepared to entertain a proposal for the construction of an efficient and cheaply worked system of electric tramways or light railways in the parish.

Carlisle.—The Town Council have agreed to extend the electric lighting cable to various parts of the city. Mr. B. Scott said from enquiries that had been made he did not think the committee would be justified in spending £522 in extending the cable to St. James's-road. It was expected that the light would be in operation in a fortnight or three weeks.

Derby.—The Electric Lighting Committee at the last meeting of the Town Council reported that tenders for the building of the foundations of the extensions to the electric lighting station had been invited by advertisement. Mr. Arthur Eaton, of St. James's-street, Derby, had been engaged as architect to carry out the works. The report was agreed to.

Eastbourne.—The borough engineer has been instructed to prepare plans for tramways or light railways for routes as amended at the Council's meeting on the 11th inst. The Corporation having determined to apply for an order for the construction of electric tramways themselves, they will oppose any application which might be made by any other party.

Islington.—At an adjourned ordinary meeting of the Vestry to be held this evening, the consideration of a report from the Electric Lighting Committee recommending that the salary of Mr. C. H. Yeaman, assistant electrical engineer, be increased to £250 per annum as from 25th inst., and by two further increments of £25 each at Lady Day, 1900 and 1901, will be resumed.

Darwen.—In view of the near approach of the time when the Corporation shall take over the tramway system to work under their own supervision, the following gentlemen have been appointed to constitute a Tramway Committee: Aldermen Davies, Cocker, Eccles, Lightbown, and Councillors Cooper, Forrest, Gillibrand, Rawlinson, Shackleton, James Tomlinson, and Walmsley.

Chesterfield.—Messrs. Davies and Saunders have offered to the Town Council to supply electricity at 2½d. per unit without any cost save the laying of mains. A committee appointed by the Council to consider the matter of electric power supply seem to think they could do it at 1d. per unit. The Mayor has promised that the matter should be brought before the next Council meeting.

Eastern Extension Telegraph Company, Limited. — The directors of the Eastern Extension, Australasia, and China Telegraph Company, Limited, recommend a dividend for the quarter ended Dec. 31 last of 2s. 6d. per share, together with a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year 1898. The dividend and bonus will be paid on 27th inst.

Edinburgh.—The Electric Light Committee have agreed that estimates should be got for copper and cable to connect the new station at M'Donald-road with the rest of the system throughout the city, at a probable cost of £28 000. Estimates for the erection of four new boilers for Dewar-place station are before the engineer for report. Applications for 3,682 8-c.p. lamps were received during the past month.

Warrington.—A copy of the notice and descriptions for the electric light installation for the workhouse buildings and new infirmary having been received and estimates obtained for the wiring of the building, the Town Council have resolved that the town clerk be authorised to submit a tender for the execution of the work and to undertake to supply electric light at a price not exceeding 5d. per unit.

Folkestone.—The Lighting Committee have considered the question of lighting the fish market with electric light, and deferred it. The surveyor is preparing a statement of the cost incurred by the Council in the purchase, erection, and painting of the electric light standards in the streets and public places. The profit made by the Folkestone Electricity Supply Company available for dividend is £405. 2s. 3d.

Hereford.—At the monthly meeting of the Town Council last week it was stated that there was every hope of the work at the Corporation's electricity station being so far completed as to be able to light the city by electricity early in October next. Colonel A. G. Durnford, R.E., Local Government Board inspector, has held an enquiry into the proposed borrowing of the sum of £20,000 for purposes of electric lighting.

Bournemouth.—The Corporation having received a notification from the Board of Trade stating that the Board would be prepared to grant the provisional order for public purposes only, it has been decided to take the necessary steps to urge the Board to grant the order as drawn, and, if necessary, to hold a local enquiry. The engine and dynamo for the electric lighting in the gardens, etc., are practically ready, and will be fixed within a few weeks.

St. Annes.—The General Purposes Committee proposed at last week's meeting of the District Council that Mr. Tonge, the electric lighting engineer of Preston, be asked to report upon the electric lighting engineer's proposed scheme, at a fee not exceeding 25 guineas, but an amendment was carried to the effect that the report of the electrical engineer be supplied to the members of the Council, and that until that was done there should be no consultation with Mr. Tonge.

Huddersfield.—The Town Council have decided to create £600,000 of redeemable stock. Loans of about £430,000 will be paid off from the proceeds of the issue. The amount will be apportioned as follows: tramways—redemption of existing loans, £15,800; waterworks—redemption of existing loans and further extensions, £290,488; general fund (general purposes), including electricity supply, redemption of existing loans, and further extensions, £293,715.

Appointments Vacant.—The Electric Committee of Belfast are prepared to appoint an assistant electrical engineer, at a salary of £150 a year, with annual increments of £25 up to £200.—The Corporation of Salford invite applications for the appointment of assistant electrical engineer, at a salary of £160 per annum. Particulars of these vacancies, and also of a draughtsman, under-foreman, armature winders, and an engine driver and fitter wanted, will be found elsewhere.

Kilmainham.—The Urban District Council have under consideration a draft agreement, proposed by the Municipal Industries Syndicate, for the electric lighting of the township, providing that the charge should not exceed 5d. per unit for private and 3d. per unit for public lighting. The syndicate would agree to the insertion of a clause enabling the local authority to purchase it in 21 years. The syndicate could have the option of combining the installation with a destructor.

Durham.—A draft of the electric lighting provisional order was submitted recently to the Board of Trade, in which was included power either to sell to a company or to lease. The Board of Trade struck out the provisional power to sell absolutely, and they have since intimated their intention of striking out the provision for leasing. The Corporation have been endeavouring, and, from what we can ascertain, successfully, to persuade the Board of Trade to reconsider their decision.

From Refuse.—Many minds are exercised over the problem of utilising the waste heat from refuse destruction, and it is a pity that more definite information is not forthcoming. Of course, the great "swear by" is at present Shoreditch, and as we have again and again shown, there is every reason to be satisfied with the result of this experiment. The actual results from Shoreditch will probably show that from this station 75 per cent. of its output is derived from the destruction of its refuse.

Parliament.—The St. James's and Pall Mall Electric Light Bill was read a third time and passed in the House of Commons on Tuesday. The Select Committee of the House of Commons presided over by Sir W. Coddington, on Wednesday rejected the Bill of the County of London and Brush Provincial Electric Lighting Company, Limited. The applications made by Mr. Rickards, Mr. Vesey Knox, Mr. Wedderburn, and Mr. Lewis Coward on behalf of their clients for costs was disallowed.

Indo-European Telegraph Company, Limited.—The directors recommend a dividend for the six months ended Dec. 31 last of 17s. 6d. per share, making, with the interim dividend already paid, 6 per cent., and a bonus of 20s. per share, both free of income tax, making in all 10 per cent. for the year. The dividend and bonus will be payable on and after May 1 next. The thirty-second ordinary general meeting of the Company will be held at Winchester House on the 27th inst. at 12.30 p.m. The transfer books will be closed until the 27th inst. inclusive.

Trans-Pacific Cable.—The Dominion Government have decided to introduce a Bill into Parliament securing that Canada shall provide for five-eighteenths of the cost of laying a cable across the Pacific from Vancouver to Sydney whenever the Imperial Government makes appropriation for the same proportion of the cost, and Australia undertakes to furnish the balance. The Bill further proposes that an Imperial Commission should control the management of the cable, and that membership of the commission be proportioned to the contributions of the Government concerned.

Wehnelt Interruptor.—At a meeting of the Hunterian Society at the London Institute, Finsbury-circus, on Wednesday, Messrs. Harry W. Cox, Limited, exhibited the above interruptor, working with one of the firm's 14in. spark coils. The tube used was a Cox record. There were 24 two-volt accumulators, and no resistance. The current taken was from five to six amperes. The tube worked with perfect steadiness the whole of the evening, and the interruptor was almost noiseless. The experiment showed that it is possible to use this interruptor for long runs with the ordinary tubes.

Lancaster.—The Town Council have granted applications from Mr. Wm. Wilkinson for a supply of electricity for motor purposes to a workshop in Marton-street; and from the Lancaster and Morecambe Motorcar Company for a supply for lighting purposes to a warehouse in Lodge-street. The engineer is to provide and lay the necessary mains, subject to the applicants giving a guarantee, for a period of three years, that the income from electricity supplied by means of such mains respectively shall not be less than 15 per cent. per annum upon the cost of providing and laying the same.

Automatic Telephone Company, Limited.—At the adjourned meeting of this Company held on the 6th inst. at Winchester House, Mr. Maurice E. Alexander, the only director present, presiding, a resolution was passed forthwith removing Mr. Margowski from the office of managing director. A proposal to amend the articles so as to alter the voting power in such manner as to prevent Mr. Margowski from outvoting the general body of shareholders was also agreed to. It was further decided that the committee should be authorised to take such steps as might be advised to be necessary to enforce the resolutions passed at the meeting.

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Hyde.—The tramways should have been finished last August, but the company have applied to the Board of Trade from time to time for extensions, and they are now proposing to apply for another extension until August. At the last meeting of the Corporation dissatisfaction was expressed with this delay. It was stated that the delay was caused through the electric light apparatus at Ashton not being ready. The company, however, have been given as much latitude as was reasonable, and it will be for the committee to consider the advisability of opposing any further extension of time.

Bangor.—The installation of electric light at Messrs. Dixon and Co.'s New Deanfield Slateworks, Port Penrhyn, has been practically completed, and the usual preliminary tests and trial on Saturday proved entirely satisfactory. This installation is the first appearance of the electric light in Bangor. There are upwards of 200 incandescent lights in the works. The plant consists of a dynamo of a capacity of 16½ kw. at a pressure of 105 volts, and a vertical open-type engine by Messrs. Robey and Co , Limited, of Lincoln. The installation has been designed and erected by Messrs. Lindsay, Browning, and Co., Limited, electrical engineers, of Bangor.

Lincoln.—At the last meeting of the Town Council the Electricity Works Committee reported that they had under consideration a report of Mr. Vesey Brown on the question of electric power for tramways. They proposed to appeal against the assessments to the poor-rate of the electricity station and works, etc., in the various parishes when they are all completed. They had resolved that the clocks over the Stonebow be electrically lighted. The sanction of the Local Government Board having been obtained to the borrowing of £19,000 for electric lighting, the committee asked the Council to empower them to obtain tenders for steam piping and valves and for foundations and extensions of flues for the new plant.

Southport.—At Tuesday's meeting of the Town Council it was stated, in reference to the proposed extension of the tramway system, that the Board of Trade had expressed approval of the Council's application, and it now only waited the sanction of Parliament. A long discussion took place on a recommendation of the Electricity Committee that application be made for borrowing powers for £55,000 for extensions of the plant and mains, £15,000 being required for traction purposes in connection with the tramways, which they expected to be in operation in 12 months' time. It was eventually decided to refer the application back in order to consult with the Finance and Tramways Committees.

Newington.—At the last meeting of the Vestry the Electric Lighting Committee recommended that they be empowered to appoint the requisite working staff at the station. The amount of wages would be £1,120 for the year. Upon the matter being referred back, a statement was made to the effect that the committee hoped to open the electric lighting station this month, and if the matter were referred back it would probably mean delay. The Board agreed that the price per unit for current supplied for lighting purposes be at the following rates: 6d. for the first hour, 4d. for the second hour, 3d. for any time after, and that the charge for motor power be at the uniform rate of 2½d. per unit.

German Electric Industry.—The Berlin correspondent of the *Financial News* wires as follows: The German electricity works are announcing through the medium of a circular, that in consequence of the higher prices of raw materials they have decided to increase by 5 per cent. the prices of various electric products. The circular is signed by the seven most important works in Germany—viz., Messrs. Siemens and Halske; the General Electricity Company, at Berlin; Schuckert and Co., at Nuremberg; the Helios firm, at Cologne; Kummer, at Dresden; and Lahmeyer and Co., at Frankfort. Only a few smaller concerns have not yet made known their decision. Their adhesion to the "ring," however, is very probable.

Perth.—The County Council have agreed to consent to the use of electric traction by the Perth and District Tramways Company on the following undertaking: (1) that the poles would be erected on the footpath at the places to be pointed out by the district road surveyor, and to his satisfaction; (2) that the height of the wires from the ground will not be less than the headway required by the Board of Trade in the case of railway bridges over the highways; and (3) also embodying the same obligations, if any, as undertaken by the town of Perth. The Police Commission have appointed a committee to enter into negotiations with the Perth District Tramway Company for the purchase of the tramways.

Brighton.—The proceedings of the Electricity Committee, adopted by the Town Council, contained the following minute: "The letter from Messrs. Collins and Sons, quoting price for the insurance of workmen employed in connection with the electricity undertaking, was again submitted. Mr. Wright stated that, in his opinion, it is desirable to insure the workmen employed in the electricity undertaking against claims under the Employers' Liability Act, the Workmen's Compensation Act, and also third party risks. The manager presented a return of the number of accidents which had happened to employés at the electricity undertaking since 1893. It was resolved that the consideration thereof be deferred for 12 months."

Shrewsbury.—The Water and Lighting Committee presented a report at Monday's meeting of the Town Council stating that since the electric light undertaking had been taken over by the Council the committee had been considering what steps should be taken in order to put the works and mains in a thoroughly efficient state, so as to meet the increased demand to be expected from private consumers, as well as to proceed with the lighting of the streets and public buildings. As a start four arc lamps were recommended in the street, and the lighting of all the public buildings. The electrical engineer estimated the total cost of the required new works at £4,139. The report was referred to a committee of the whole Council and discussed privately.

Worcester.—The City Council intend to employ a tramway engineer to advise the Streets Committee as to the desirableness and cost of acquiring the existing tramway undertaking now as compared with the expiration of the term of 21 years, and of converting the tramways into electrical tramways, and of constructing extensions in any part of the city, and as to the probable annual cost of working the tramways and the revenue derivable therefrom. In connection with the electric light failure last week, which, however, only lasted for about a quarter of an hour, Mr. Sutherland, the engineer, explains that the insulation of a connection of one of the dynamos broke down, cutting that machine out of circuit and blowing out the fuses of the other machine running at the time. Two other machines were put on as soon as possible.

Helios Electrical Construction Company.—We are informed that a new addition to our electrical contracting firms has been started with the above title. The Company in question will act as agents of the Helios Company of Cologne, whose works are both extensive and well equipped. The scope of the new firm will include complete electric lighting plants, and everything required for the equipment of electric tramways. They will also make a speciality of electric motors, both the enclosed and open types, to work on circuits at 200 and 500 volts. Besides this, they will also supply plant for distribution of power on the polyphase system. The chief engineer of the new Company will be Mr. A. A. Eborall, whose experience in polyphase working is well known. The office of the Company will be opened shortly at 49, Cannon-street E C.

Belfast.—The suggestions formulated by the Right Hon. W. J. Pirrie, J.P., and submitted to the Council on Wednesday regarding the desirability of acquiring the street tramway system for the ratepayers, contain the following items: The date of transfer is taken as July 1, 1899. The whole system is assumed to be worked by electric traction from Jan. 1, 1901. The total amount of Corporation bonds issued for the following purposes is taken as amounting in all to £1,051,000 in 3 per cent. bonds: (1) purchase of the Belfast Street Tramway Company's shares; (2) transfer of Belfast Street Tramways Company's debentures; (3) compensation of Belfast Street Tramway directors and officers; (4) purchase of three leased lines; (5) construction of extensions; (6) complete installation and equipment of present system and extensions for overhead electric traction.

Musselburgh.—The Town Council have entered into an agreement with the Drake and Gorham Electric Power and Traction (Pioneer) Syndicate, Limited, which provides for their assent to the order applied for by the company under the Electric Lighting Acts from 1882 to 1890 for the electric lighting of the burgh of Musselburgh. The charge for electricity will be 6d. per unit, irrespective of quantity, and 4d. to the Corporation for all public lighting purposes. At the end of 14 years the Council may purchase the works as a going concern on mutual valuation, with the addition in name of goodwill of a sum equal to the profits during the four immediately preceding years, or after 21 years on the same terms, with a sum equalling two years' profits as goodwill, or after 28 on the same terms with one year's profits as goodwill. The going on with electric lighting is contingent on the syndicate obtaining a provisional order for the establishment of an electric tramway.

Canterbury.—Incandescent lamps of 50 c.p. are to be erected in various streets. Messrs. Crompton have been asked to supply 75 additional lamps at the contract price. Six dozen opal glasses and six dozen bent glasses for the public lamps are to be purchased for stock, and a junior electrician is to be appointed at a salary not exceeding £52 per annum. The consulting engineer, Mr. R. Hammond, has submitted a report, which has been adopted, in which he states that a fair start has been made with the incandescent lamp-pillars, and from date these will be cast at the rate of at least 25 per week, two separate foundries having the work in hand. With regard to the extensions of mains recently decided upon, 74 lamps and two brackets would be required at an estimated cost, including separate switch wires, switch pillars, etc., of £1.150. As to the possibility or otherwise of erecting arc lamps in Northgate without alteration to the present system of mains, he reports that, though just possible, a change of this description would be undesirable.

Personal.—The Tramways Committee of the Manchester Corporation have appointed Mr. John Eades of Manchester, as works manager of their carworks shortly to be erected.—Mr. James Taylor has been appointed as clerk of the works for the electric equipment of tramways, and Messrs. B. S. Hornby and A. T. Gordon Smith assistant electrical engineers at the Corporation electricity works at Bolton.—Mr. J Pilling, one of the assistant electrical engineers at Bolton, has been appointed borough electrical engineer under the Corporation at King's Lynn. Mr. Pilling was presented by the members of the staff at the Spa-road works with a handsome marble clock, with side ornaments to match. The presentation was made by Councillor Dr. Panton, chairman of the Electricity Committee, supported by Mr. A. Ellis, M.I.E.E., borough electrical engineer.—The Barnsley Town Council have appointed Mr. S. E Bastow, of Hull, as clerk of the works of the Corporation at £150 during the construction of the plant, and at £200 after its completion, the engagement to continue for at least two years.

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Battersea.—At a meeting of the Vestry on Wednesday a report from the Lighting Committee was submitted, stating that the committee had examined, by a sub-committee, the plant, etc., at the town hall electric lighting station, and found the same satisfactory. The committee recommended that advertisements be inserted in the *Electrical Engineer*, *Engineer*, *Engineering*, and the *Municipal Journal* and *London*, inviting tenders for works in connection with electric lighting to specifications, as follows: (Specification No. 1) feeders, distributing mains, and arc-light leads; (2) water-tube boilers; (3) steam dynamos and engines. The Special Committee on Parliamentary Schemes reported that the Board of Trade had declined to grant the provisional order applied for under the Electric Lighting Acts by the County of London and Brush Provincial Electric Lighting Company, Limited, in respect of that parish.

Sheffield.—The Tramways Committee have received a petition from the ratepayers of Darnall asking the committee to take immediate steps to complete the section of tramway to Darnall. The city surveyor has reported his intention shortly to commence the tramway work in Ecclesall-road. The committee have resolved, "That if an expert, to be named by the Corporation, certifies that the wire put up by the British Thomson-Houston Company is as good for the purpose for which it is to be employed as wire of the description contracted to be supplied by Messrs. F. Smith and Co. for the Walkley section, this committee will recommend the Council to accept the wire supplied, the British Thomson-Houston Company to bear the cost of the examination and report by the expert." As the regulations of the Board of Trade do not permit of persons standing at the ends of electric tramcars, the designs of the two sample cars to be ordered from Messrs. G. F. Milnes and Co. (as per the recommendation of the General Sub-Committee of Feb. 21, 1899) are to be modified so as to provide seating accommodation for six smokers.

Leeds. — The Corporation tramways show a considerable increase in the receipts during the past month as compared with March last year. The total takings were £9,036, as against £6,840. 19s. in the corresponding month last year—an increase of £2,195. The figures relating to the electric route are: through cars from Boar-lane to Kirkstall, £1,144 3s. 2d. in March—an increase of £161. 16s. 3d.; to the Cardigan Arms only, £547. 12s. 9d., or an increase of £336. 16s. 4d.; through cars from Briggate to Roundhay, £1,485. 13s. 5d., or an increase of £322. 9s. 4d.; to Harehills-road only, £622. 17s. 3d., or an increase of £380. 4s. The Highways Committee on Wednesday decided to complete laying down the tramlines from Meadow-road to the Midland Railway bridge in Dewsbury-road, with a view of a tramway service being commenced as early as possible from Briggate to the railway bridge. When the latter structure is finished, which it is not expected to be for some time, tramcars will be run from Briggate right along Dewsbury-road to Cross Flatts Park. By the end of the week it is expected that Tong-road, Armley, which has been undergoing repairs, will be reopened for vehicular traffic.

Colchester.—The Lighting Committee have accepted the offers of Messrs. Siemens to light and maintain four large lamps each by incandescent light of 100 c.p. at the same price per annum as is now paid for the lighting thereof by gas, the committee to bear the cost of fittings in the first instance. The borough surveyor's report, embodied in the minutes of the committee adopted at the last meeting, stated that he had been in communication with Messrs. Siemens respecting the additional plant which it is anticipated will be required for the winter of 1901, and he submitted a letter from Messrs. Siemens, stating they have now obtained estimates for the boiler, engine, etc., which enabled them to quote for the additional 350-h.p. plant which it was proposed to put down. Their price for the whole additional plant (which they detailed), packed, delivered, and erected in Colchester, was £2,744. In addition to the plant, it would be necessary to provide meters, extend mains, etc., the total estimated cost being about £4,700. The committee resolved that further consideration be deferred to the next meeting, and that the surveyor then present a report giving further particulars, together with details of the suggested extensions of mains, etc.

Edwards's Air-Pump Syndicate, Limited.—The first annual report of the directors to be presented to the shareholders at the second ordinary general meeting of the syndicate to be held at Winchester House on the 18th inst., states that after payment of all expenses of management and after writing off one fifth of the organisation expenses, the net profit for the period amounted to £128. 8s. 11d. The revenue from royalties was naturally of slow growth at the commencement, consulting engineers and builders not unreasonably hesitating to adopt a new type of pump as their standard design until they had had some little experience of the working efficiency of the first pumps built for or by them. Consequently the sum of £1,767, included in the revenue account, although small in amount, was representative of a much wider *clientèle* than the figures would seem to indicate. The pump was steadily gaining in popularity with superintending engineers and marine engine builders, as well as with consulting engineers, who are more particularly identified with stationary engines for electric light and power plant. Pumps had been built for stationary engines to run at a speed of from 300 to 400 revolutions per minute, and the Edwards pump was specified for some of the largest corporation electrical installations in the United Kingdom.

Llanwrst.—The works of the Llanwrst Electricity Supply Company, recently opened by Lord Carrington, contain a 120-h.p. Babcock and Wilcox water-tube boiler, with Hopkinson's mechanical stokers attached, the water feed being by a Worthington's double-action feed pump; a 55-h.p. compound engine by Alley-Maclellan, of the Westinghouse type, and a dynamo by the Electrical Supply Company, London, which supplies a pressure to the mains of 250 volts. The mains laid at present are somewhat over a mile in length, with feeders. Already about 50 connections with business premises and private houses have been made, equivalent to over 600 8 c.p. lamps, and applications have been received for a considerable number more. The work was commenced at the beginning of January. The charge at present is either 8d. per unit for energy supplied, as measured by meter, or 10s. per 8 c.p. lamp per annum, to be used as long and as often as required. Mr. G. R. Peers, the engineer of the company, having given a brief description of the works, Lord Carrington declared the works open, and switched on the light, using a switch-handle of silver, suitably engraved and mounted on ebony, which was presented to him by Mr. McInnes, of Manchester, representing the company. The company then proceeded to the Victoria Hotel, where they were entertained at dinner by the electricity company.

Scott and Mountain, Limited.—Amongst the contracts in hand at the Close Works, Newcastle-on-Tyne, we note a complete plant consisting of three engines and dynamos coupled, each of 250 h.p., together with switchboard, boosters, steam and exhaust pipes, feed heater, etc., for working the electric railway at Hill of Howth; complete transmission of power plants for the armour-plate department of the Cyclops Steelworks, Sheffield; the Lanarkshire Steelworks, Motherwell, N.B.; and Messrs. Richardson, Duck, and Co., Limited, Stockton-on-Tees; electric pumping plants for the Dalmeny Oil Company, near Edinburgh, and for Earl Rosslyn's Collieries, Dysart; electric haulage gear for the Broughton and Plas Power Coal Company, near Wrexham, and for the Consett Iron Company, Limited, Langley Park Colliery, near Durham. The firm are also supplying their combined engines and dynamos for Messrs. Taylor, Garnett, and Evans, Limited, *Manchester Guardian* Printing Offices. These engines are of the self-lubricating type, and are fitted with a valveless pump delivering oil under pressure to the bearings and all other working parts. We are informed that 3,000 h.p. of this type of various sizes is on order at the present time. The engines are made of either the compound two-crank type or tandem compound three-crank type, in sizes varying from 20 h.p. to 2,000 h.p. Messrs. Scott and Mountain have also recently completed an extension to the electric pumping plant at the Shillbottle Colliery, near Alnwick, as also an electric winding gear for the Glasdir Copper Mines, Dolgelly, together with two sets of their combined engines and dynamos for the Port Talbot Railway and Docks Company, South Wales.

Rochdale.—The minutes of the Tramway Sub-Committee, approved by the Town Council at their meeting last week, stated that Mr. Bennett (electrical engineer), accompanied by Mr. E. B. Petrie, appeared before the sub-committee on behalf of the Drake and Gorham Traction Syndicate, Limited, with reference to the proposed establishment of a light railway within the borough of Rochdale with connections to the surrounding districts, but the sub-committee declined to recommend the committee to accede to the application of the syndicate. A letter was received stating the terms upon which the Bury Corporation were prepared to insert a clause in their Bill now before Parliament to enable them to work the tramways between the Bury borough boundary and Heywood market place, and enquiring whether the Rochdale Corporation were prepared to enter into an agreement based upon similar terms for working the Rochdale and Heywood section of the tramways. It was decided to recommend that the gauge in future be the standard gauge of 4ft. 8½in., and that tramways on this wider gauge be laid along the existing routes to the borough boundary at Manchester-road, Oldham-road, Halifax-road, and Whitworth-road; and that new tramways connected with the existing routes be laid to the borough boundary at Milnrow-road, Edenfield-road, Rooley Moor-road, and Bury-road, and that loop connections be made along John-street and Molesworth-street, and round by the railway station between Drake-street and Manchester-road. It was also resolved to write to the urban district councils in the neighbourhood that the Corporation have decided to promote a Bill enabling them to extend and work tramways to the borough boundary, and to adopt the standard gauge of 4ft. 8½in. throughout; and stating that the Corporation would be pleased to receive their observations thereon.

PROVISIONAL PATENTS, 1899.

APRIL 4.

7041. Improvements in electric arc lamps. Gerald St. John Day, 64, Barton-arcade, Manchester.

7105. Improvements in apparatus for controlling the reversing mechanism employed in telegraphing and the like by means of electrical rays or waves. Axel Ocling and Carl Gustaf Georg Braunerhjelm, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Feb. 27, 1899, being date of application in Sweden.)

APRIL 5.

7144. A new or improved electric apparatus for automatically regulating the physical condition of gases and liquids. Heinrich Schultz, 102, Burdett-road, London. (Complete specification.)

7179. Improvements in long-distance electrical signalling. Daniel Vincent Riordan, 38, Chancery-lane, London.

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APRIL 6.

7264. Improvements in electric meters and accessories in connection with coin-freed and other electricity meters. James Readman, 73, St. Stephen's-road, Upton Park, London.

7277. Improvements in or connected with apparatus for measuring and recording electric currents. Hermann Aron and Aron Electricity Meter, Limited, 6, Lord-street, Liverpool. (Complete specification.)

7284. Improvements relating to telegraphic, telephonic, and like systems, and to automatic switching apparatus therefor. Léon Joseph Mathurin Dardeau, 11, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Oct. 10, 1898, being date of application in France.)

APRIL 7.

7321. Improvements in secondary battery plates, grids, and the like. William Alfred Gent, 23, Ivy-lane, Brockley, London.

7326. Improvements in electric telephony. Charles Adams-Randall, 63, Chancery-lane, London.

7339. Method of operating typewriting, composing, or similar machines by means of electromagnetism. Ernst Trowe, 70, Chancery-lane, London. (Complete specification.)

7345. Improvements in multiple-contact telephone transmitte s and the battery circuit or circuits relating thereto. Charles Adams-Randall, 63, Chancery-lane, London.

7354. Improvements in dynamometers. George James Gibbs, 18, New Bridge-street, Blackfriars, London.

7364. Improvements in or relating to means for controlling and indicating the supply of electrical energy. Henry Kunkelmann, Charles Emmanuel François, and César Réne Loubery, 111, Hatton-garden, London.

APRIL 8.

7371. Improvements in electric safety devices. George Keith Buller Elphinstone, 101, St. Martin's-lane, London.

7415. Improvements in electrical cooking apparatus. John B. Cary and Mary Cary, Veuve Delevy, 18, Southampton-buildings, Chancery-lane, London.

7416. Improvements in electricity meters and in prepayment mechanism for the same. George Hookham, 18, Southampton-buildings, Chancery-lane, London.

7427. A correcting transformer for simple or polyphase alternating electric currents. John Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (La Société Anonyme pour la Transmission de la force l'Electricité, France.)

7445. Improvements in electric switches. Patrick Hamilton, 16, Emperor's-gate, South Kensington, London.

SPECIFICATIONS PUBLISHED.

1898.

6058. Apparatus for transmitting motion to a distance by means of electrical energy. Siemens Bros. and Co., Limited. (Siemens und Halske, Aktien-Gesellschaft.)

6944. Method of and furnace for the continuous melting of glass by electricity. Becker and Schreyer.

7129. Means of generating electrical energy. Holmes, Holmes, and Holmes.

8274. Electric bells. Oppenheimer.

8319. Electrodes and the method employed for producing them. Krebs.

10618. Indicating and recording apparatus for use in connection with electric meters. Pillinger.

11302. Electrical switches. Brier.

11498. Holders for electric glow lamps. Gover and Proctor.

12438. Apparatus for indicating leakages or escapes of current from electric conductors. Kallmann.

13312. Electric incandescent lamps. Michaelson.

14399. Electric measuring instruments. Blackburn and Spence.

15100. Electrical influence machines. Pidgeon.

23820. Apparatus for measuring the phase difference of alternating currents and idle currents. Tuma and Kaldegg.

24833. Means for suspending electric motors on electrically-propelled vehicles. Short.

26619. Telephone switchboards or switching apparatus for telephone stations. Thompson. (Ahern.)

26789. Electrical incandescence lamps. Feeny. (Allgemeine Elektricitäts Gesellschaft.)

1899.

1208. System of conduits for the underground conductors of electric railways and tramways. Sterza.

1232. Process of, and means for, transforming electric currents. Thomsen.

2288. Accumulator plates. Ribbe.

3387. Trolley apparatus for use in connection with electric traction. Winslow.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1899.	Corresponding week 1898.	Increase or decrease.	Total receipts for half-year. 1899.	1898.
		£	£	£	£	£
Birmingham Tramway	April 8	4 504	3,762	+ 742	53,309	49 749
Blackpool and Fleetwood Tramroad	,, 8	602	—	—	3,123	—
Bradford City Trams	Feb. 5	145	—	—	6,733‡	—
Bristol Tramways and Carriage Co.	April 7	3,587	2,810	+ 777	—	—
City and South London Railway	,, 9	976	884	+ 92	16 251	15,826
Dover Tramways	,, 8	214	119	+ 95	2,110	1,514
Dublin U.T., elec. cars	,, 7	1,252	827†	+ 425	12,539	9,888†
Dublin S.D. Electric Tramways	,, 7	984	449	+ 535	9,067	5,552
Halifax Corporation Tramways	Mar. 29	312	—	—	10,712*	—
Liverpool Overhead Railway	April 9	1,674	1,539	+ 135	19,990	20,295
South Staffordshire Tramways	,, 7	923	609	+ 314	8,588	8,081

* Since June 30, 1898. † Including horse cars. ‡ Since July, 1898

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	24½-25½
Bournemouth and Poole Electric Supply, Limited, Ord.	10	13½-13¾
—— 4½ per cent. Cum. Pref	10	10¾-11¼
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	18¾-19¼
—— 6 p. c. Cm. Pf., 30,001-40,000 (all paid)	10	18¾-14¼
—— 5 per cent. Perpetual Debenture Stock	100	126-129
Brush Electrical Engineering, Limited, Ordinary	2	1¾-2¼
—— Non. Cum., 6 per cent. Pref.	2	1¾-2¼
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	102 105
Callender's Cable Company, Debentures	100	114-117
—— Ordinary	5	12½-13½
Central London Railway, Ordinary	10	9¾-10¼
——	8	7¾ 8¼
—— Pref. Half-Shares	3	3¾-4
—— ,, ,,	5	4¼-4¾
Charing Cross and Strand	5	10¾-11¼
—— 4½ per cent. Cum. Pref.	5	6-6¼
Chelsea Electricity Company	5	7¼-8¼
—— 4½ per cent. Debentures	100	114-116
City of London, Ordinary	10	16¾-17¼
—— ,, 90,001-100,000	10	16¾-17¼
—— 6 per cent. Cumulative Pref.	10	15-16
—— 5 per cent. Debenture Stock	100	124-129
City and South London Railway, Consolidated Ordinary	100	68-70
—— Ordinary	3	4¾-5¼
—— 4 per cent. Debenture Stock	100	133-135
—— 5 per cent. Pref. Shares	10	14¾ 15¼
—— ,, ,, ,, '96	10	14-15
County of London and Brush Prov. Elec. Light Co., Ord.	10	11-12
—— ,, ,, No. 80,001-40,000	10	11-12
—— 6 per cent. Cum. Pref.	10	14-15
Crompton and Co.	3	3¼ 3¾
—— 5 per cent. Debentures	—	98-101
Crystal Palace District, Ordinary 5 per cent. Stock	100	130-135
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2-2¼
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	97-99
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5¼-5¾
Electric Construction, Limited	2	2¼ 2¾
—— 7 per cent. Cumulative Pref.	3	3-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	103-106
W. T. Henley's Telegraph Works, Ordinary	10	25¼-26¼
—— 7 per cent. Preference	10	12½ 13¼
—— 4½ per cent. Debentures	100	113-115
House-to-House Company, Ordinary	5	8¾-9¼
—— 7 per cent. Preference	5	9-10
Imperial Tramways, Limited	6	24¼-25¼
India Rubber, Gutta Percha, and Telegraph Works	10	21¼-22¼
—— 4 per cent. Debentures	100	101-105
Kensington and Knightsbridge Ordinary	5	12¼-13¼
London Electric Supply, Ordinary	3	3¼ 4
—— 6 per cent. Pref.	5	6¾-7
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	105-107
Metropolitan Electric Supply, Limited, Ord., No. 1-62,500	10	17-18
—— ,, ,, No. 62,501-85,000	4	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100	117-120
National Telephone, Ordinary	5	4¼-5
—— 6 per cent. Cum. First Pref.	10	11-13
—— 6 per cent. Cum. Second Pref.	10	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	4¾-5¼
—— 3½ per cent. Deb. Stock, Red.	100	99-101
Notting Hill Electric Lighting Company, Limited	10	16¾-17¼
Oriental, Limited, 1879	1	1¼-1¾
—— £5 Shares	5	7¼-7¾
—— £4½ Shares, New	4½	6¼-6¾
Oriental Telephone and Electric Company	1	¾-1
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6¾-7
Royal Electrical Company of Montreal	1½	165-185
—— 4½ per cent. First Shares Mortgage Debentures	100	105-107
South London Electric Supply, Ordinary	3	3¼-3¾
St. James's and Pall Mall, Limited, Ordinary	5	17¾-18¼
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	35 39
—— 5 per cent. Bonds	100	106 108
Waterloo and City Railway, Ordinary	100	109-112
Westminster Electric Supply, Ordinary	5	15-16

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NOTES.

Electric Lighting Bill.—In the case of the Kensington and Notting Hill Electric Lighting Bill, which is the last measure before the Select Committee presided over by Sir W. Coddington, the opposition was withdrawn on Saturday. The Bill will therefore go before the Committee on Unopposed Bills.

Russian Companies.—The law relating to foreign firms and stock companies in Russia has been changed lately. While formerly the Government allowed foreign companies to trade in Russia only with the proviso that this permit could be cancelled at any time and without any reason being stated, it is now reported that permits given to foreign companies will in future carry with them rights equal to those enjoyed by similar corporations of Russian nationality.

Crystal Palace Engineering School.—This school of practical engineering will conclude its Easter term on Friday next, when a number of visitors have been invited to be present to hear announced the list of certificates for the past term which have been awarded by the examiners. Sir John Jackson, F.R.S.E., will occupy the chair in the lecture theatre of the school at noon on that day. Visitors will be admitted to view the workshops and laboratories of the school at 11 a.m.

Wheels and Pulleys.—Mr. Archibald Sharp, B.Sc., Wh.Sc., A.M.I.C.E., delivered a lecture before the Civil and Mechanical Engineers Society last night on the design of wheels and pulleys. In his lecture Mr. Sharp dealt most fully with the design of driving and non-driving wheels, bicycle wheels, and with the various forms of wood and steel pulleys for countershaft work. The last part of his lecture was devoted to the subject of flywheels, on which Mr. Sharp is an authority.

Mining Engineers.—A meeting of the members of the North of England Institute of Mining and Mechanical Engineers was held this week in the Wood Memorial Hall, Newcastle-on-Tyne. The chair was taken by Mr. W. Armstrong, and discussions ensued on coal-cutting machinery, with special reference to two types of electric coal cutters. Other papers brought before the meeting were on "Timbering of Iron Ore Mines in Cumberland and Furness," while Mr. T. L. Elwen read a paper on "The Glacial Deposit Wash in the Dearness Valley."

Borrowed Thunder.—In our last issue, under the head of "Electric Lighting," we referred to a lecture delivered by Mr. J. T. Shorrock, L.D.S., R.C.S., at Darwen. It was entitled "Electric Lighting in our Houses and Workshops." We find that the picturesque language used by Mr. Shorrock in his lecture is not original, but that it will be found practically verbatim in that excellent book written by Mr. Robert Hammond, entitled "The Electric Light in our Homes." We trust that in his lecture Mr. Shorrock gave due credit to his source of inspiration.

Institution "Journal."—We have received from the Institution of Electrical Engineers the April issue of the *Journal* of the Institution. In it there is recorded a continuation of the discussion on the three papers on "Rules for the Regulation of Wiring," and papers on "Electric Traction by Surface Contacts," by Miles Walker; and "Wireless Telegraphy," by G. Marconi. There also appears a record of the demonstration by A. A. C. Swinton on the Wenhelt electrolytic contact breaker; Prof. E. Wilson's paper on "The Induction Motor," and a communication by L. B. Stillwell entitled "Note on Standard Frequency."

London County Council Tramway Report.—Prof. A. B. W. Kennedy has just started for America in order to inspect the most recent tramway installations of that country. We understand that Prof. Kennedy is expected to return to England about the end of this month, and after that will undertake a Continental trip in order to complete a report to the London County Council on electric traction generally. This report, when completed, will be of the utmost value to the County Council, and we trust that this body will, in the interests of other local authorities in the United Kingdom, publish it broadcast.

Idle Provisional Orders.—A rumour is current to the effect that the Board of Trade proposes shortly to put pressure on those local authorities which obtain their provisional electric lighting orders and do not proceed to put them in operation. A fair number of such orders are now in existence which were granted in the early nineties, in order to prevent companies obtaining electric lighting powers in towns. It is still the custom to adopt this mode of opposition to companies so applying. If the rumour is correct, the Board of Trade will clearly state that unless the provisional orders are proceeded with in a certain definite time they will be revoked.

Colonial Telegraph Rates.—We understand that a meeting of some 20 members of Parliament will be held in one of the committee rooms of the House of Commons on the 25th inst. to consider a scheme to be submitted by Mr. Henniker Heaton, M.P., for cheapening Imperial telegraphic communication. At this meeting, to which prominent merchants interested in telegraphic communication with India, Australia, and South Africa will be invited, a proposal is to be made that the Governments of India, South Africa, Australia, and New Zealand shall hold a conference with the home Government with the object of reducing the present high cable rates, which for private messages are regarded as prohibitive.

A New Circuit-Breaker.—We have recently seen illustrations of a new expansion circuit breaker, manufactured by Messrs. McCarthy Bros. and Ford, of Buffalo, N.Y. The circuit breaker consists of an ordinary knife switch, which is held on by means of a trigger. This trigger is kept in position by a thin wire, through which the main current passes. The expansion of this wire when the current exceeds a predetermined limit is made to reach the trigger, and then the switch flies open. It is claimed that the time element introduced by the hot wire is a great advantage when the circuit breaker is used for electromotor work. In this case the sudden rush of current when the motor is switched on will not operate the switch, as is too frequently the case with the usual magnetic types of current interruptors.

Large Transformers.—The Niagara Falls Power Company has been indirectly responsible for the bulk of the experience of the manufacture in the United States of very large transformers. It is only recently that we had to chronicle the fact that the largest transformer order known had been given for use on their system, and now we learn that they have ordered no less than seven 2,500-h.p. transformers from the Westinghouse Company. These transformers will be of the same type as the four 850-kw. transformers built by the same company for the Cataract Power and Conduit Company about a year ago, and which are in use at Buffalo. The efficiency guaranteed for these transformers is over 98 per cent. at full load and also at half load, while at quarter full load it will be over 97 per cent. They will be used for raising the two-phase 2,200-volt current from the generators up to three-phase 4,400-volt current for supplying the Union Carbide Company.

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Camberwell Lighting.—The Board of Trade has not been able to induce the Vestry of Camberwell to agree to the County of London and Brush Provincial Electric Lighting Company increasing its high-pressure system from 5,500 volts up to 6,600 volts. The Vestry's argument is that the lower limit is sufficient for all the requirements of the company in their district, and that the extra 20 per cent. is being added simply to meet the convenience of other surrounding districts. While we are quite sure that the Vestry have solved the real reason for an increase, we cannot see that they are likely to gain anything from the opposition they are offering. They also oppose the adoption of the two-phase alternate-current system of electric distribution, and state that they would prefer to have the continuous-current system, in order that the company may give a supply on a system which is quite distinct from that adopted by the London Electric Supply Corporation.

The Dusseldorf-Crefeld Railway.—A new railway has recently been constructed from Dusseldorf to Crefeld, and it is especially designed for electric traction and high-speed working. The distance between the two towns is about 14 miles, and the line is in most places fenced off as an ordinary railway. The work has been carried out by Siemens and Halske, of Berlin. The electric cars run at an average speed of 25 miles an hour, and can easily get up to 38 miles per hour if required. In this case the motors are mounted direct on the axles of the bogies of the car, and all reduction gearing is thus avoided. Each car is driven by two motors of 40 h.p. The passenger accommodation of the car consists of 36 inside seats and 14 places on the platform. The cars used contain every requisite for comfortable travelling, and we understand that the line is likely to become a commercial success. In many respects it is not dissimilar to the electric railway between Blackpool and Fleetwood, which has achieved a great success in the two months in which it has been opened.

Alternate-Current Electric Fans.—We refer elsewhere to the small electric motors used on the 1899 types of fans in America. In regard to these motors when required for alternate-current types, special interest centres on the starting device. In this respect the *American Electrician* points out that the alternate-current induction motor pure and simple, when fed by single-phase currents, is non-starting—that is, it has no tendency to turn until it gets in motion. This is overcome in fan motors, as a rule, by putting in what are known as shading coils—that is, short-circuited copper strips around parts or corners of the poles. The currents induced in these give a magnetisation out of phase with that of the main body of the poles, thus giving a rotating field, which starts the motor in motion. Once up to speed, the armature or secondary gives the necessary cross-magnetisation, so that the starting coils are no longer necessary. As they cause a constant waste of energy they may be cut out, and in one motor at least they are connected with the switch in such a way that they are cut out in the running position and only closed while starting.

Institution of Mechanical Engineers.—The next ordinary general meeting of this institution will be held on Thursday and Friday next week (April 27 and 28) in the new home of the members at Storey's-gate, St. James's Park. Sir William H. White, K.C.B., F.R.S., will take the chair at 7.30 each evening. On Thursday the presidential address will be delivered, and on Friday a paper on "Evaporative Condensers" will be read by Mr. H. G. V. Oldham, A.M.I.M.E. In this paper, after pointing out the advantage of using evaporative condensers where a large supply of cooling water is not available, the author will discuss the general action going on in them. He will also consider the details of these and describe the principal types of air condensers which have been used during the past 26 years. Mr. Oldham will likewise take up the testing of such apparatus, and the advantage of the use of fans to increase the efficiencies of evaporative condensers generally. The paper should give rise to a most interesting discussion, and be worthy of careful study by all central-station engineers who are not blessed with an ample supply of water for condensing purposes. The annual dinner of the Institution of Mechanical Engineers has been arranged to take place at the Hotel Cecil on Wednesday next, the 26th inst., when a large and representative gathering is expected.

Rebuff to the London County Council.—The Kensington Vestry has made a rather caustic reply to a communication of the London County Council pointing out "that some few instances have occurred in which the Council have approved of plans for electric lighting works submitted by electric lighting companies, as to which works the local authorities concerned had afterwards raised objections or had imposed conditions not quite in accord with those imposed by the Council, and intimating that in order to secure, if possible, uniformity of action in future the Council had decided to give the local authority an opportunity of expressing its views upon the notices and plans before the Council's approval or disapproval was given to the works referred to therein." From what we have seen, the London County Council itself has been most unreasonable in raising objections to the proposed works of electric lighting companies, and most vestries have adopted a broader policy in such matters. We are, therefore, pleased to see that the Kensington Vestry consider it advisable to inform the London County Council that in this matter "they do not think that any useful purpose would be served by the adoption of the course proposed by them, but consider that the remedy is rather to be found in the termination of the present unnecessary overlapping jurisdiction under the Electric Lighting Acts."

Siemens Engineering Society.—On Wednesday last week the engineering society organised amongst the staff of Messrs. Siemens Bros. and Co., of Woolwich, held their annual conversazione in the Assembly Rooms at Charlton. This society, whose ordinary meetings are strictly confined to members of the staff, removes its bar against visitors on these occasions. Last week, for instance, a large number of past members were invited and welcomed by their old colleagues. The main assembly room and the small rooms at the back were filled with apparatus usually of scientific interest. These exhibits, though largely contributed by the firm, also included a number from outside sources. Amongst these we noted a particularly interesting arrangement, which was termed a pneumatic Wheatstone's bridge, used for determining the value of orifices for the admission of air into large chambers. The air passages and receivers are arranged just in the same way as the electric conductors of the Wheatstone bridge. The apparatus serving as a galvanometer bridged the opposite corners between the air resistances. Amongst the other exhibits, we noticed some excellent spectroscopic apparatus, and also Prof. Ewing's hysteresis curve tracer. The society had hoped to have on view the historic telegraph instrument which was supplied to General Gordon and recovered during the recent Soudan expedition. The proceedings were enlivened by an excellent orchestra, and also with some experiments with phonographs.

Electric Conduits and Disease.—The current number of the *Lancet* seriously debates as to whether electric

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conduits are not a possible cause of the spread of disease. It seems that a correspondent to the paper has pointed out that in the town where he lives the main cable supplying the current is laid in a 4in. pipe beneath the public foot path, with branch pipes for house connections, the ends of which are left open. The higher temperature inside the houses induces an indraught of air by these open pipes, and, as different houses vary in temperature and these pipes form a direct communication from house to house, so there is a circulation set up between one house and another, the current of air varying in velocity according to the range of temperature. In the case of houses warmed throughout by a hot-water system, the temperature may be as much as 25deg. F. higher than the external air, a condition which causes an influx of air of sufficient velocity to blow out a candle flame. In this way the infected air of a house where infectious disease is present might easily be drawn into other houses with serious results. The conveyance of small-pox by aerial agency is established, and it is conceivable that it could be conveyed from one house to another in the manner just suggested. There is the possibility of other contagious diseases being spread in the same way. Our contemporary adds that the preventive remedy is clear, and that the pipes should be plugged with insulating material when led into a house.

Electrolytic Conduction.—It has been suggested a number of times that interesting results might be obtained with a tube or trough containing an electrolyte and surrounding a transformer so that the electrolyte forms a complete circuit just like a short-circuited coil, in which currents are induced; in such a case alternating currents will flow through the electrolyte without the necessity of any electrodes. Mr. Behn-Eschenburg, in the *Zeitung fuer Elektrochemie*, describes briefly, with the aid of an illustration, some experiments made with such an arrangement. The article is condensed as follows in Mr. Carl Hering's digest: "A horizontal, rectangular trough was made to fit around the core of a transformer, and was filled with an electrolyte, which thus formed a short-circuited liquid coil in which currents were induced. Into this trough the terminals of a voltmeter were inserted at fixed distances, from which, knowing the current, the resistance could be calculated. Immediately above the trough was a single winding around the same core, the voltage of which was also measured, and this showed the total voltage which was induced in the trough of liquid. His experiments, which were only approximate, were made to find whether the resistances thus measured agreed with those measured in the usual way, and the experiments gave favourable results. The trough was made of wood, so as to be a non conductor. Besides the trough there was a single winding of a resistance wire which had approximately the same resistance as that of the liquid, thus enabling comparisons to be made with the resistance of the liquid and that of this wire. The results showed that comparisons could be made in this way, and that the behaviour of the liquid was like that of a solid conductor."

Dublin Tramways.—Mr. E. Kenneth Cambell sends a long letter to the *Financial Times* on the value of the hares of the Dublin Tramway Company. In answer to a letter from a gentleman who had raised a point as to whether the present market price of these shares was justified, Mr. Cambell quotes the usual arguments in favour of electric traction, and adduces most valuable facts from the experience obtained from those sections of the company's lines which have already been converted for electrical working. For instance, the Donnybrook and Phœnix section was opened up for electric traction at the end of January. During the 10 weeks which have elapsed since then the number of passengers carried per week has steadily increased from 100,000 to 146,000 for the week ending April 7. During the similar period last year the average number of passengers per week with horse cars was about 65,000. What, perhaps, is of more interest to the shareholders is the fact that with a reduction in fares of about 33 per cent., the revenue per week has increased from an average of £380 with horse traction, to £620 with electric traction. Even this average is not fair, as with horse traction the receipts were practically constant, while with electric cars the weekly returns have shown a steady rise from the beginning of February. Mr. Cambell proceeds to point out that not only have the number of passengers increased, and also the receipts, but that at the same time the cost of running per car per mile is very much reduced by the introduction of electricity. He then makes a calculation as to the effect of the entire conversion of the company's system, 84 miles in all, and concludes that in spite of the extra capital cost, 20 per cent. dividends should be earned in the near future.

Ammonium Amalgam.—An interesting communication on the general characteristics of ammonium amalgam is made to the *Chemischer Centralblatt*, 1898, ii., 853, which is abstracted as follows in the *Journal* of the Chemical Society: "In order to prepare ammonium amalgam and to measure the E.M.F. between a mixture of the amalgam with mercury and a strip of copper immersed in copper sulphate solution, the author uses a cell containing mercury and divided into two portions by a partition which dips into the mercury, but does not reach to the bottom of the cell. The ammonium amalgam, prepared by electrolysing a solution of ammonium chloride in one half of the cell, quickly diffuses into the mercury in the other half, and here the E.M.F. between the mixture and a copper electrode in a solution of copper sulphate is tested. Whilst, before the passage of the current the E.M.F. is only 0·16 volt, after it has passed for a few seconds it rises to 1·89 volts, but when the circuit is broken it falls quickly. Even when the froth formed on the surface of the mercury is brushed off, the E.M.F. still remains high. When dilute sulphuric or hydrochloric acid is used instead of ammonium chloride, the E.M.F. is only 0·1 volt, and with a solution of sodium chloride the E.M.F. only attains 0·62 volt in 12½ minutes, owing to the slow diffusion of the amalgam, for when crystals of the amalgam are transferred to the other portion of the cell, the E.M.F. rises to 2·146 volts. Potassium amalgam diffuses even more slowly than sodium amalgam. When ammonium amalgam is heated, its volume increases by an amount greater than that due to the expansion of the contained gases. The author concludes that an ammonium amalgam is first formed, and then decomposes into mercury, hydrogen, and ammonia."

Telephone Mains.—The following details, collected from the agenda of the Vestry of St. George-the-Martyr, Southwark, show generally the terms on which the National Telephone Company are prepared to remunerate local authorities in London for permission to lay their wires underground. The company has offered this Vestry 2s. 6d. a year for every exchange subscriber in the parish who would be supplied by the new underground mains. It also undertakes to provide and maintain free of charge a private line from the vestry hall to the depôt. We should also infer from what we know in other places that the National Telephone Company would make good all the damage done in opening up the streets. The Electric Light and Dust Disposal Committee have the matter in hand, and they report to the whole Vestry that they think the

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required permission should be given, provided that the Telephone Company will increase the proposed annual payment to 5s. per annum for each subscriber, and are also ready to provide a small telephone exchange at the vestry hall, with communication to the various stables and depôts, and also to the officers of the Vestry, the clerk, surveyor, medical officer of health, and other officials. They likewise ask that the work shall be superintended by the surveyor, and that the company shall pay the cost of such superintendence. The above terms do not seem to us to be reasonable, as if the Telephone Company repair and make good the streets after opening them up, we fail to see the moral right of the Vestry to the annual charge proposed, which would, of course, be borne by the telephone subscribers. We trust that when the Government Telephone Bill is brought before the House of Commons, full details will be given of the proposed arrangements by which the company shall have the right to put their wires underground, provided that they agree to allow inter-connections between their subscribers and those obtained by the Government exchanges. In this way the royalties proposed above would be saved.

Iron and Steel Institute.—The programme of arrangements in connection with the holding of the annual meeting of this institute at the Institution of Civil Engineers, Great George-street, Westminster, on Thursday and Friday, May 4 and 5, has been completed, and from this we gather that the first day's proceedings will include a meeting of the council, to be followed by a general meeting of members at 10.30 a.m., when the hon. treasurer (Mr. W. Whitwell) will present the financial statement for last year. The retiring president (Mr. E. P. Martin) will induct into the chair the president-elect (Sir William Roberts-Austen, K.C.B.), and an announcement is to be made that the Queen has graciously consented to accept the Bessemer gold medal for 1899, in commemoration of the great progress made in the iron and steel industries during her reign. The president will then deliver his inaugural address, after which the following papers are to be read and discussed: "The Gellivare Iron-Ore Mines," by H. Bauerman, F.G.S. (London); "Wellman Tilting Furnace," by A. P. Head (London); "Exploring for Iron Ore with the Magnetic Needle," by Prof. H. Louis, M.A., A.R.S.M. (Newcastle-on-Tyne); and a paper by Prof. J. Wiborgh, of Stockholm, on "The Use of the Hot Blast in the Bessemer Process." The annual dinner will take place at the Hotel Cecil in the evening. The following day (May 5) the selection of papers provided for discussion are: "The Diffusion of Iron," by Prof. J. O. Arnold and A. McWilliam (Sheffield); "Use of Blast-Furnace and Coke-Oven Gases," by E. Disdier (Bilbao); "Solution Theory of Iron and Steel," by Baron H. Jüptner von Jonstorff (Donawitz, Austria); "Theories and Facts Relating to Cast Iron and Steel," by Bertrand S. Summers (Chicago, Illinois); and a paper by D. Tchernoff, of St. Petersburg, on "The Manufacture of Steel Direct from the Ore in the Blast Furnace." In the evening Lady Roberts-Austen will hold a reception at the Royal Mint, Tower-hill. It may be mentioned that members intending to take part in the discussion can have copies of papers forwarded to them a week in advance by applying to the secretary.

A Comparison.—After visiting this country and America, Mr. W. Than, the chief mechanical engineer of the New South Wales Railways, recently returned to Sydney, where, if he did not exactly fall among thieves, he appears to have experienced what to most people is about as bad—he got into the hands of the newspaper interviewer. A representative of the Sydney *Daily Telegraph* saw Mr. Than, who was asked which of the systems of electric traction, particularly as applying to tramways, found the most favour in England and in the United States. His answer was that in the latter country, where this method of locomotion is in special favour, the overhead system is being superseded by the conduit system. He pointed out that in New York, where the conduit system is alone in operation, notwithstanding its great cost, it has been found so convenient, and, so far as the public are concerned, so simple, that it has been adopted quite regardless of the expenditure it entails. As regards other cities he adds that many of them, if they have not actually got electric traction, are now carefully debating the question, and, no doubt, as soon as local considerations allow, it will be put into operation. Continuing, he says: "In England, while this matter has been somewhat neglected up to the present, as compared with the United States, the people are waking up. Many of the towns have now got big schemes under consideration, and, as they have any amount of money, I have no doubt that, though a little slow in making up their minds, they will go ahead rapidly as soon as ever they decide. Several towns have already got a system, and in a short time England should show as much progress in this important regard as America. Since my first visit, eight years ago, I found that a very considerable advance has taken place in the States, both in regard to the improvements of machinery and to the extension of electricity as a motive power. Then, too, there has come about a greatly extended use of other methods for securing economy in working both railways and tramways. Altogether there is a vast and notable advance."

Cast-Welding Rail Joints.—It will be remembered that some months ago we described a novel method of obtaining high temperatures devised by Dr. Goldschmidt, in which he fused iron by mixing metallic aluminium with iron oxide. The ignition of this mixture turned the mass into metallic iron. The above process has recently been applied by the inventor to joining the ends of rails for electric tramways. The following abstract of a description of this process which appeared in the *Elektrotechnische Zeitschrift*, is taken from Mr. Carl Hering's excellent digest: "Dr. Goldschmidt applies his mixture to the joint in the two rails, which are first pressed tightly together from end to end. By the heat generated when the metal is cast around them, the expansion will press them still tighter together, producing what is claimed to be a weld across the whole cross-section, as was shown by means of tests. For making the joint, a mould of thin sheet metal is laid around the joint and surrounded on the outside by sand. A mixture of ordinary iron ore with aluminium is placed in the crucible and is ignited, after which more of the mixture is added until the crucible is full; this requires a few minutes. For a rail of large cross-section, about 7in. high, he states that 8¾lb. of aluminium is required. The top of the crucible will be covered with liquid corundum. The contents of the crucible are then poured into the mould around the rail, and it is said the liquid corundum first covers the rail with a thin coating, preventing the fused metal from 'injuring' the rail by getting in contact with it. The slag formed, which is corundum, may be saved as a valuable by-product. The whole process is very rapid and simple; three men will suffice, and no transportation of apparatus or machinery is required other than the clamps, the crucibles, and the raw materials. It seems that the crucibles require renewing frequently. Among the advantages of his method over the electrical welding system are that the heating of the iron around the joint is quite uniform, and there is, therefore, no danger of burning; moreover, the amount of heat

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can be accurately determined in advance from the mixture and quantity of the ingredients."

Electricity in the Italian Navy.—Giulio Martinez's fourth article to the *Electrical World* (U.S.A.) on the above subject gives a description of the various controlling devices which have been introduced into the Italian navy for operating the electric motors for power purposes, and particularly for driving the turrets of the heavy guns. In the ships to which the author refers, the largest turrets contain two 10in. 25-ton guns. These turrets are moved by two motors, the larger one having a capacity of about 16 h.p., and the smaller one of from 5 h.p. to 6 h.p. These motors are provided with powerful series windings and relatively small shunt excitation. There is no starting rheostat used in connection with the small motor. The large one is provided with an automatic rheostat consisting of a coil of copper wire wound on a closed magnetic circuit, and having a resistance of ·6 to ·8 ohm. This resistance is short-circuited at the proper time by an electromagnet connected across the brushes of the motor, set to act when the counter E.M.F. has reached a sufficiently high value. With the small motor it was found to be sufficient to make the series winding of a slightly higher resistance than would ordinarily be necessary. The small motor gears on to the spindle of a larger one by means of a worm and wheel, but this gearing can be drawn out of action by means of a magnetic clutch, when the larger motor is required to drive the turret over considerable distances. Under normal working conditions, with a large motor a speed of 7deg. per second is attained, and the slowest motion possible is ½deg. per second. By working the pressure switches by short jerks extremely small movements are obtainable, and the adjustment of the aim is very perfect and requires no special skill on the gunner's part. The main part of the connections and the motors are placed in the protected portion of the vessel, not even being near the movable parts of the turret. A five-wire flexible cord, easily replaced if injured, connects the interior of the turret with the apparatus. An advantage resulting from the use of the small motor is that it is possible to operate the turret machinery from the ordinary circuits, when it is desired to make sure that everything is in working order. The author gives a full diagram of the connections used with these turret motors.

High Voltages.—On the 29th ult. Prof. Elihu Thomson delivered a lecture before the New York Electrical Society on high-voltage electricity. He exhibited a number of brilliant experiments, and also had on view his novel application of the Planté rheostatic machine for the production of extremely high electrical pressures. Prof. Thomson covered the various methods of producing high voltages, and referred to the fact that transmission schemes were now using such high pressures that discharges took place constantly between the conductors. For instance, where 40,000 volts was employed, any conductors within 2in. of each other were liable to a sudden discharge; and even with much greater distances, at 50,000 volts a bluish discharge caused by leakage through the air began to take place. He explained that at these high potentials the capacity of the line wires played an important part in the actions. Referring to the methods of obtaining high voltages, Prof. Thomson gave an interesting *résumé* of a very probable explanation of the production of the electrical conditions causing lightning discharges. This consisted in the diminishing of the capacity of a system having an initial charge. For example, a film of varnish, or a thin sheet of rubber, in contact with a metal plate, and having a charge of very low tension, due to mere contact, becomes charged to a tension sufficient to cause a 1in. spark when removed from the metal—that is, when the capacity of the system, considered as a condenser, is decreased. A similar phenomenon takes place when similarly charged globules of moisture are brought into contact or near each other. The outer ones shield the inner ones, the charge of the system gathers on the outer layers, and, the capacity being increased, an elevation of voltage is the result. The old steam machine, or "hydro-electric generator," took advantage of this principle for its action. In the same way, an ascending current of warm air, having a definite electrification, enters a layer of moisture-laden air, which it condenses into minute drops, the whole taking a puffed or globular shape, and the voltage of its outer layers mounting up until it is sufficient to strike to earth in the form of lightning. Of course, the Wehnelt electrolytic interruptor was exhibited and described by the lecturer, who also had on view some high-frequency apparatus, as exemplifying the extreme method of raising voltage by varying the rate of change of current.

Electric Fan Motors.—The use of small electric fans in England for creating refreshing breezes in the dog-days is on the increase, but up to the present the business being done is only an infinitesimal percentage of that done in the United States. It is open to argument as to whether our conservative tastes, or the greater heat of America, is responsible for this fact. In the April number of the *American Electrician* no less than eight pages are devoted to the 1899 models of electric fan motors. These pages are replete with illustrations of the motors, which in many cases show clearly the mechanical parts. We gather from this article that the general trend of design is towards the abolition of cast iron in the magnetic circuit. In its place either forged magnets, or preferably magnets built up of wrought-iron or steel laminations, are used. In the new motors the general practice is to use either two self-adjusting bearings of phosphor-bronze, or else one long single bearing with the armature overhanging one end and the fan the other. We also gather from our contemporary's article that the question of enclosing fan motors has still to be settled. A large number of these motors are now enclosed, so that dust is kept out of the working parts, but in others these parts are left open to ensure ventilation and a ready inspection of the brushes and commutator. It seems that a great advance has been made in the lubrication arrangements in order to prevent oil being thrown out by the motor. Both ring and wick lubricators are being used in the newer types. Amongst the illustrations given we notice particularly that of the Westinghouse motor, in which the field laminations, together with the exciting coil, form practically a short cylinder. The motor armature is placed directly over the field coils on a vertical axis. In the alternating motor section for driving ventilating propellers near the ceiling we notice a very interesting gear for reducing the speed of the motors. In this case the motor is mounted on a spherical ball bearing, and drives a small friction pinion. This engages with two large leather-faced wheels on hinged inclined shafts. On the outer surface of these wheels the spherical enclosing case hangs, and to it are attached the fan blades. The motor armature runs at a high speed, turning the intermediate wheels at a moderate speed, while the outer case goes at a still lower speed. A large number of novel features have also been introduced in the supports for these fan motors to enable the blast to be directed in any given direction. These usually take the form of either a universal joint or else of a ball-and-socket arrangement. Now that fan motors are actually being manufactured in England by certain of our contracting firms we trust that they will push the use of their wares, and also be able to keep the home market in English hands.

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BOOTLE ELECTRICITY WORKS.

Councillor W. R. Brewster (mayor) has been a member of the Town Council since 1881, and has always taken a very active part in its affairs. At the time of his appointment as mayor he was chairman of the General Purposes Committee and deputy-chairman of the Health Committee. He takes special interest in the work of the latter committee, and was prominent in obtaining the erection of the Corporation hospital at Linacre and the refuse destructor works. The Mayor has also been for very many years a member of the West Derby Board of Guardians, which includes

MR. W. R. BREWSTER (MAYOR).

Bootle, and two years ago he was chairman of that body. He is still chairman of the Walton Workhouse Committee, that building being said to be one of the largest in England. For many years also he has served the town as an overseer of the poor. Mr. Brewster retired from business some years ago, and he, in fact, devotes the whole of his time to public affairs. His election as mayor was received with universal satisfaction, and he has devoted both time and purse to the duties of his office without stint, being greatly assisted therein by Mrs. Brewster, the mayoress.

Mr. Thomas Lodwick Miller was born at Liverpool on March 21, 1860, and is the son of the late Mr. Thomas Miller, of the firm of W. C. Miller and Sons, shipbuilders, Liverpool, and grandson of the late Mr. Edward McKeverigan, of the firm of Clayton and McKeverigan, shipbuilders, Birkenhead. In July, 1875, Mr. Miller was apprenticed for a term of five years to Messrs. Fawcett, Preston, and Co., Phœnix Foundry, Liverpool, passing through the various shops, and entering their drawing office in February, 1880, where he remained until July, 1888, during the later years being engaged as leading draughtsman, having charge of the hydraulic and pumping engine departments, both as regards design and the supervision of the carrying out of the work in the shops under the general manager. During this period he had a varied experience in the design and construction of marine engines, sugar-making and distilling machinery, including evaporating plants of single and multiple effect, gas-engines, air-compressors, and other works, and was also largely engaged in examining into and reporting on new inventions and conducting experiments with a view to their practicability. In July, 1888, Mr. Miller accepted the post of lecturer in engineering at

MR. T. L. MILLER, CONSULTING ENGINEER, BOOTLE.

University College, Liverpool, where he was responsible, under Prof. Hele-Shaw, D.Sc., for the equipment of the Walker Engineering Laboratories, including the design of the experimental engine and other special machines. In 1890, shortly after the completion of the Walker Engineering Laboratories, Mr. Miller resigned his appointment in order to devote the whole of his time to consulting work, since which time, in addition to his electrical work, he has been engaged in reporting upon schemes for the utilisation of water power, the inspection and testing of machinery and materials, the design and superintendence of construction of new plant and machinery, the conduct of arbitrations, and the giving of evidence in law courts and at Local Government Board enquiries. He has advised the Fleetwood Improvement Commissioners and the Hereford City Council on electric lighting matters, and is at present engaged by the Bootle and Barnsley Corporations, the Hoylake and West Kirby Urban District Council, the Committee of Visitors for the Rainhill Asylum, Lancs., and for the North Wales Counties Lunatic Asylum, Denbigh, and the West Derby Board of Guardians, and is also engaged on the Bootle tramways and several electrical transmission schemes. Mr. Miller is an associate member of the

COUNCILLOR J. A. MARK, CHAIRMAN OF COMMITTEE, BOOTLE.

Institution of Civil Engineers, a member of the Institution of Mechanical Engineers, and a member of the Institution of Electrical Engineers; and is the author of a number of papers on engineering subjects, amongst which may be mentioned "The Transmission of Power to a Distance," "The Efficiency of Gas-Engines," "The Application of Electric Motors for Power Purposes," "Factors of Safety," and "The Strength of Copper Pipes."

Mr. J. A. Crowther commenced his career as a civil engineer with the late T. Wigglesworth, Esq., highways surveyor to the city of Leeds. Under Mr. Wigglesworth's supervision, he gained an intimate knowledge of the construction and maintenance of over 300 miles of roads and streets of a very varied character, bridge construction, etc. After serving in this office for a period of eight years he was transferred to the office of the city engineer of Leeds, where he remained for a period of three years, and during this time was principally engaged in the extension and improvement of the sewerage system of the city. In May, 1889, he was appointed borough engineer and surveyor of Nelson, where he prepared and gave evidence at a large number of Local Government Board enquiries and for three Bills promoted in Parliament. He designed and constructed extensive sewerage and sewage disposal works for the town, and acted as resident engineer during the construction of a reservoir, etc., in addition to his other duties. In May, 1892, he was appointed borough engineer and surveyor to the county borough of Bootle, and has since that time devoted his entire services and experience in order to improve the sanitary and other works in the town

MR. J. A. CROWTHER, BOROUGH ENGINEER, BOOTLE.

These works include the designing and construction of a system of flushing the public sewers with salt (sea) water, refuse disposal by means of a 12-cell destructor, provision of the electric light, construction of tramways for electric traction, hospital extensions, laying-out of public parks and recreation grounds (£25,000 having been spent in the laying-out of one park 22 acres in extent), street improvements, design, construction, and ventilation of sewers, etc. He is an associate member of the Institution of Civil Engineers, member of the Society of Engineers, member of the Association of Municipal and County Engineers, and passed the examination of this association in 1886, member of the Sanitary Institute, and a member of several other scientific societies.

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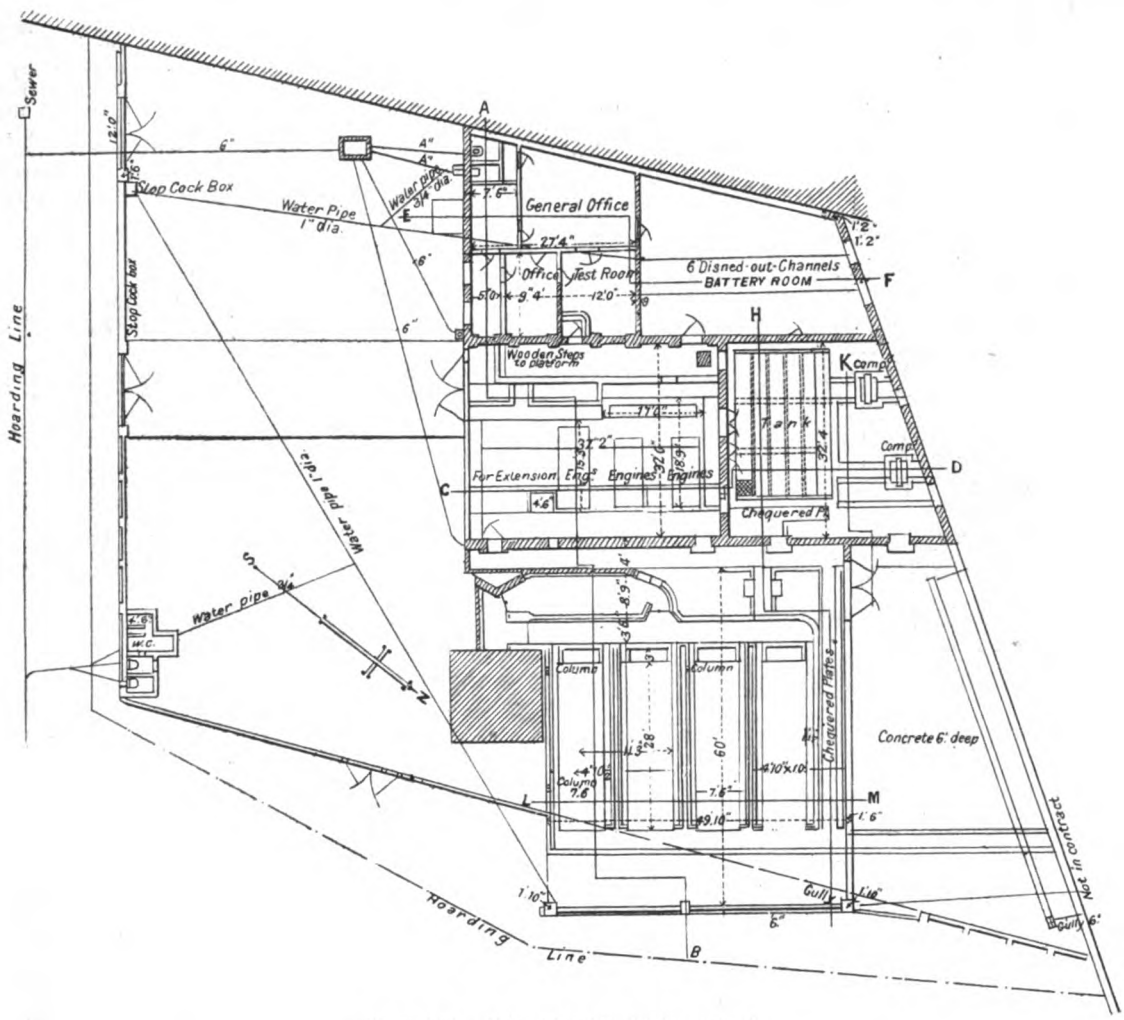
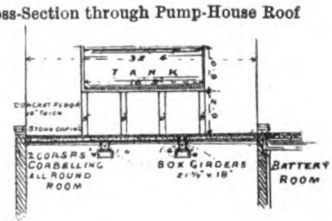
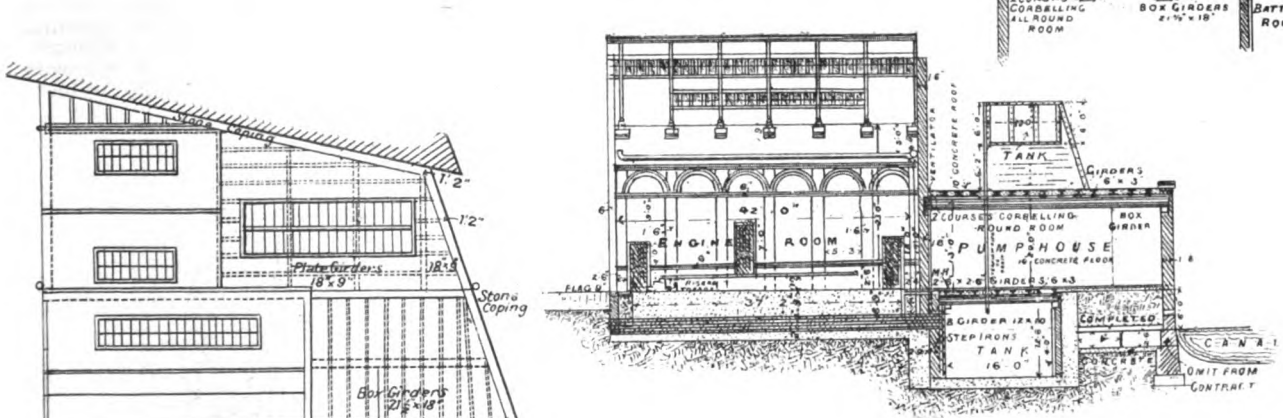


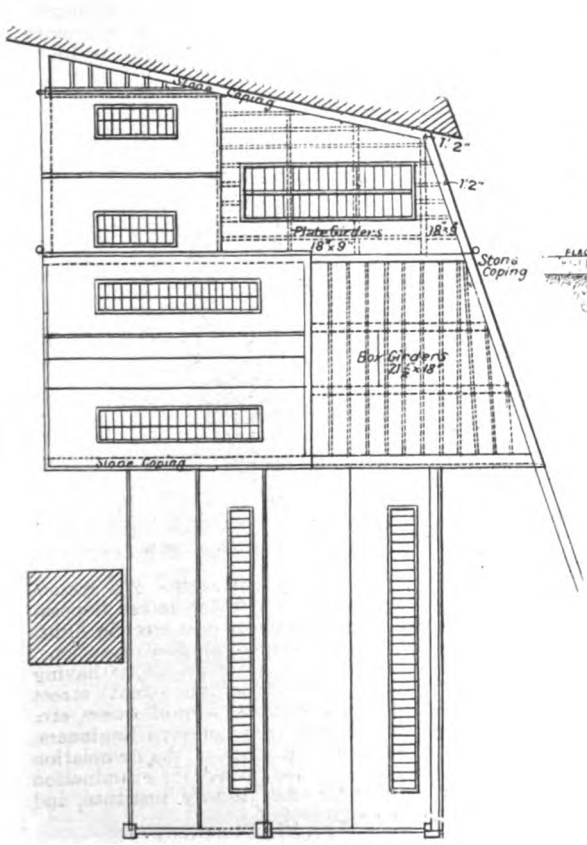
Ground Plan of the Electricity Works at Bootle

Cross-Section through Pump-House Roof

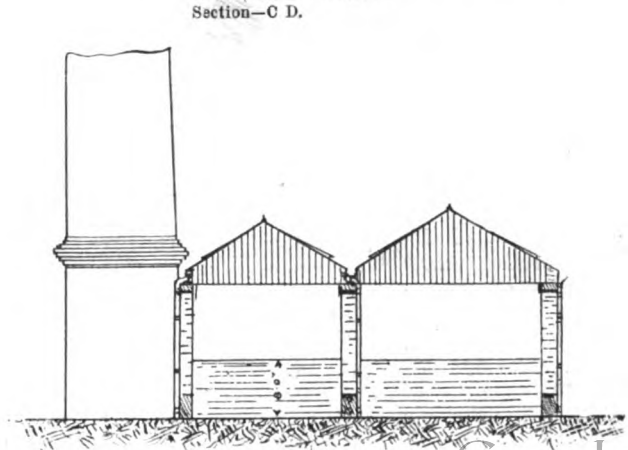




Section—C D.



Roof Plan of the Electricity Works at Bootle.



West Elevation.

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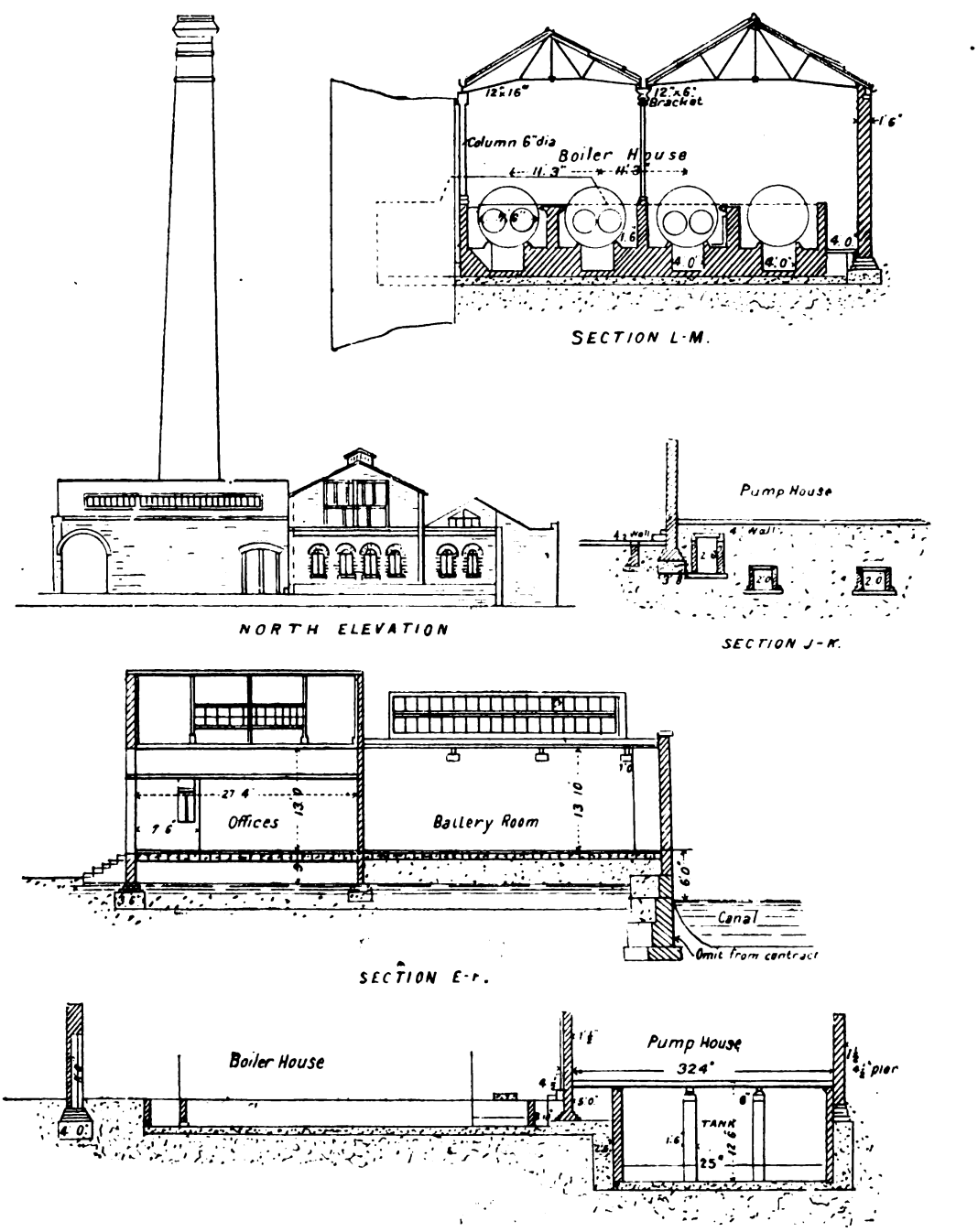
According to Baines, the value of the manor of Bootle at the time of the Domesday survey was 5s. 4d., which is equivalent in value to about £4 of present-day money. At the beginning of this century the population of Bootle-cum-Linacre was only 537, increasing in 20 years to 808, in 60 years to a little over 6,000, while at the close of this century the population cannot be much less than 54,000. Bootle has throughout the century been closely connected with Liverpool, principally in the earlier part, because the larger town obtained a considerable part of its water supply from the smaller town. Indeed, just a hundred years ago, after a century's discussion, two schemes were carried out for supplying Liverpool with water, one of these by the



Details of Electric Lighting Station at Bootle.

Bootle Water Company, which carried out plans authorised by an Act granted to Sir Cleave Moore so long back as 1708. Latterly—and its enormous growth is due to that fact—Bootle may be looked upon as giving an extension to the dock area of Liverpool and partly as a residential off-shoot of that city. Its latest work is the adoption and installation of electric light, showing that it eminently partakes of the spirit of progress shown by its giant neighbour. The town was incorporated in 1868. It has an area of 1,590 acres and a ratable value of over £477,000.

Historic.

As long ago as 1893 the authorities of Bootle were thinking of an installation of the electric light for the purpose of lighting the town hall and other public buildings, and at that time called in Mr. Miller to report, and the next year instructed him to prepare plans and specifications for such lighting. It was then intended to obtain steam for the electric light engine from the baths' boilers, the generating plant being placed in an engine-room provided at the baths. In 1894 the Corporation applied for a provisional order, and the Royal assent was given to this in July, 1895, soon after which instructions were given to Mr. Miller to report upon the steps necessary to put into force the order thus obtained. In order to make themselves familiar with the subject, the Watch Committee visited various towns, inspecting the electric light works therein, and early in 1897 the consulting engineer was instructed to prepare a complete scheme. This was done, and the Council adopted Mr. Miller's scheme in the middle of the year, and instructed him further to prepare complete plans and specifications so as to obtain tenders.

In 1898 the Corporation accepted the following tenders: buildings—Mr. Walter Musker, Bootle, £6,598; boilers, economiser, steam dynamos, condensers, condensing water pumps, balancing transformers, boosters, feed pumps, piping, and accessories—Messrs. Thos. Parker, Limited, Wolverhampton, £11,791; storage batteries—Chloride Electrical Battery Syndicate, Limited, £1,049; mains—

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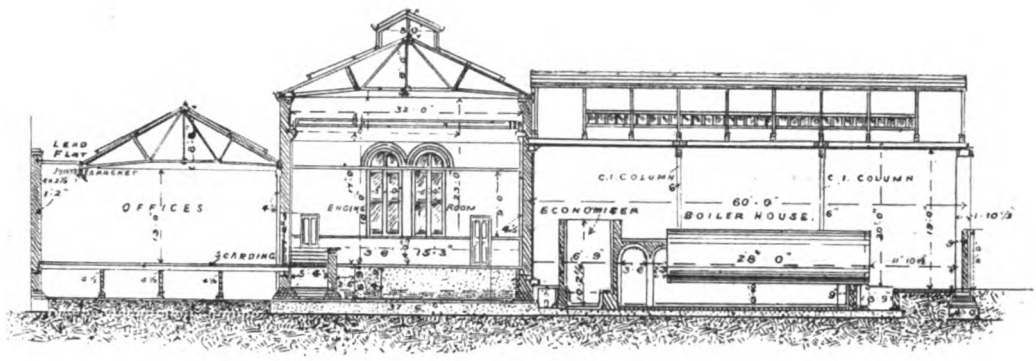
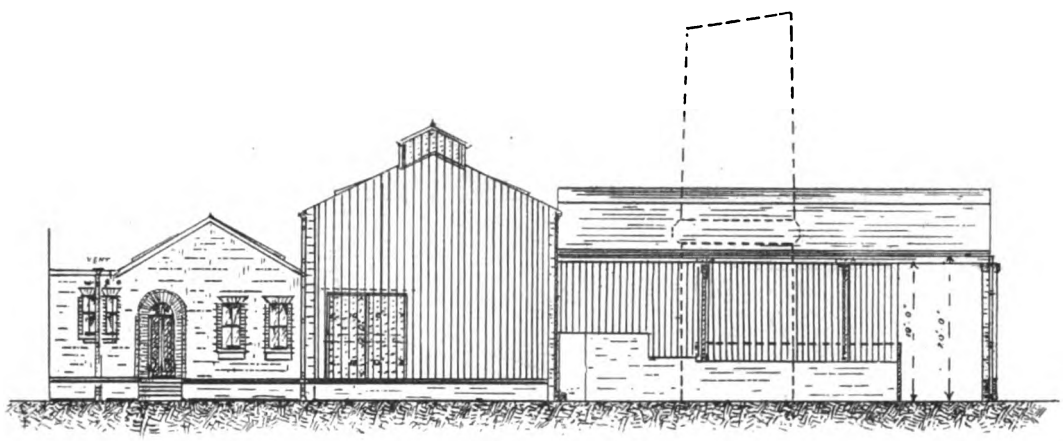
British Insulated Wire Company, £10,650—a total of £30,088.

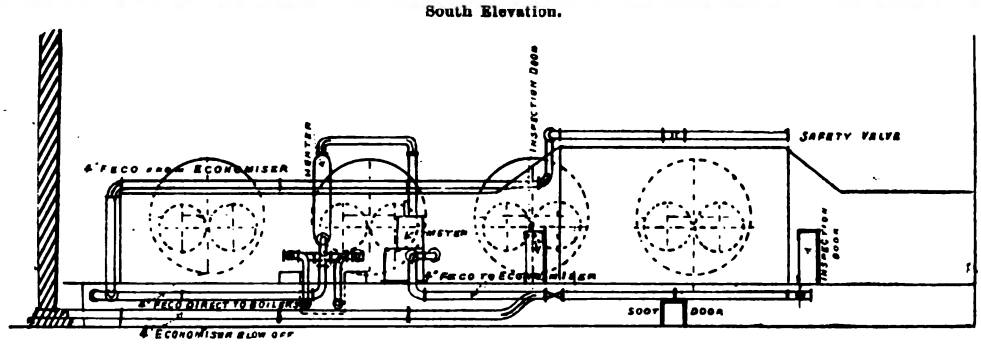
for same, the contract being placed with the British Insulated Wire Company, whose tender amounted to



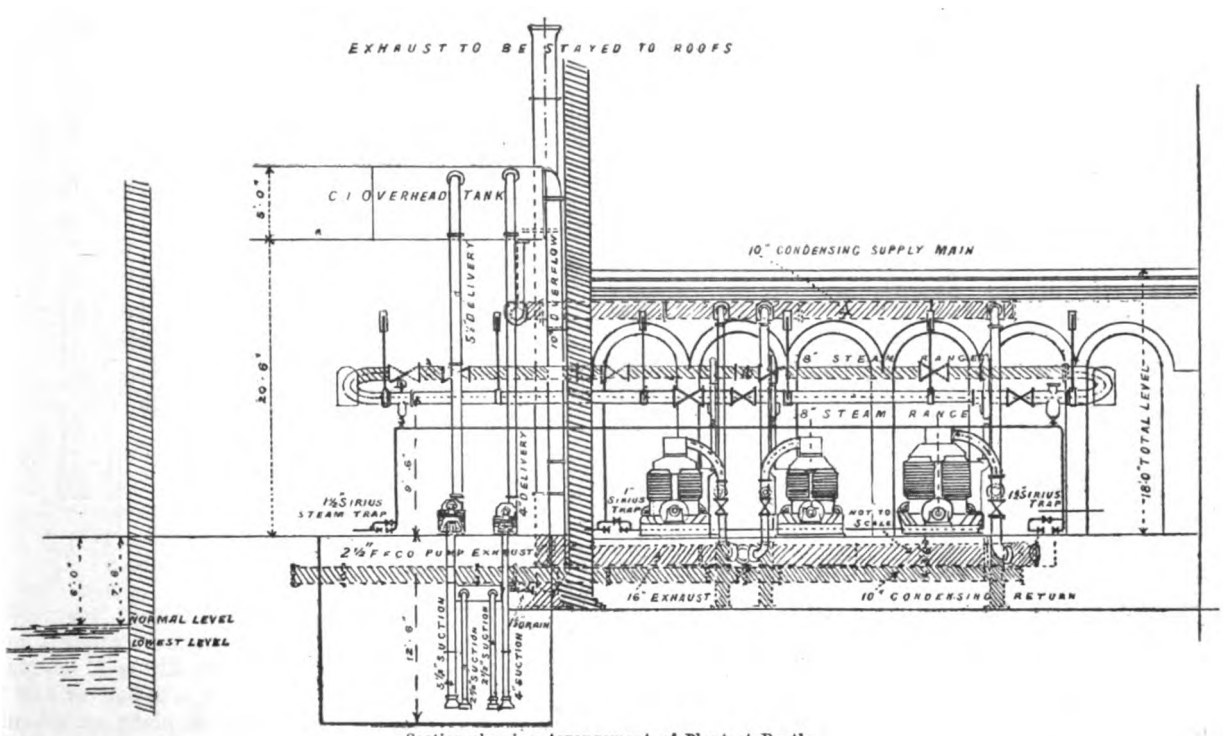
Longitudinal Section—A B.



South Elevation.



Section showing Pipes and Arrangement of Plant at Bootle.



Section showing Arrangement of Plant at Bootle.

Later in the year Mr. Miller was instructed to prepare specifications for public lighting and advertise for tenders

£2,600, which, with £3,250 authorised for extension of mains and public lighting, and £1,140 for meters, demand

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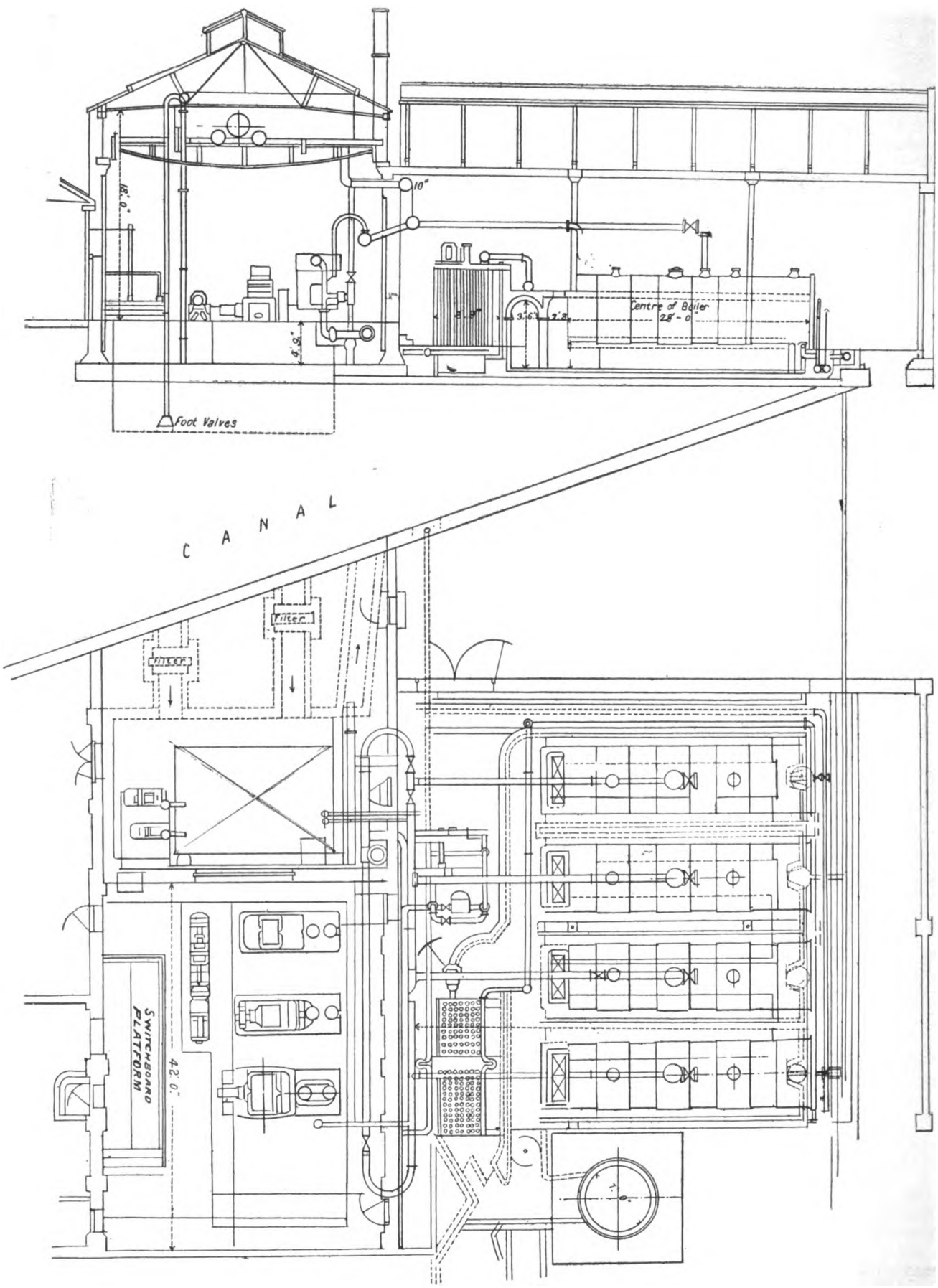
indicators, and service connections, brings the capital expenditure to £37,078.

Early in the current year Mr. Miller was instructed to report on the electrical equipment required, both at the



Plan and Section showing Arrangement of Plant at Bootle.

ment for Stanley-road and Strand-road lines, and £9,595 for Derby and Rimrose-road lines. Further reports on extensions of plant and mains were obtained, and the committee recommended the Council to make application to the Local Government Board for sanction to borrow £15,393 for new mains, £4,950 for extension of plant at the electricity supply works, and £7,195 for extension of public lighting, making a total of £27,538 for extensions. At the present time, before the opening of the electricity

electricity supply works and for the overhead construction and mains, but without cars, for operating tramways in Bootle by electricity. The report was adopted, and the Council decided to make application to the Local Government Board for sanction to borrow £13,436 for electrical equip-

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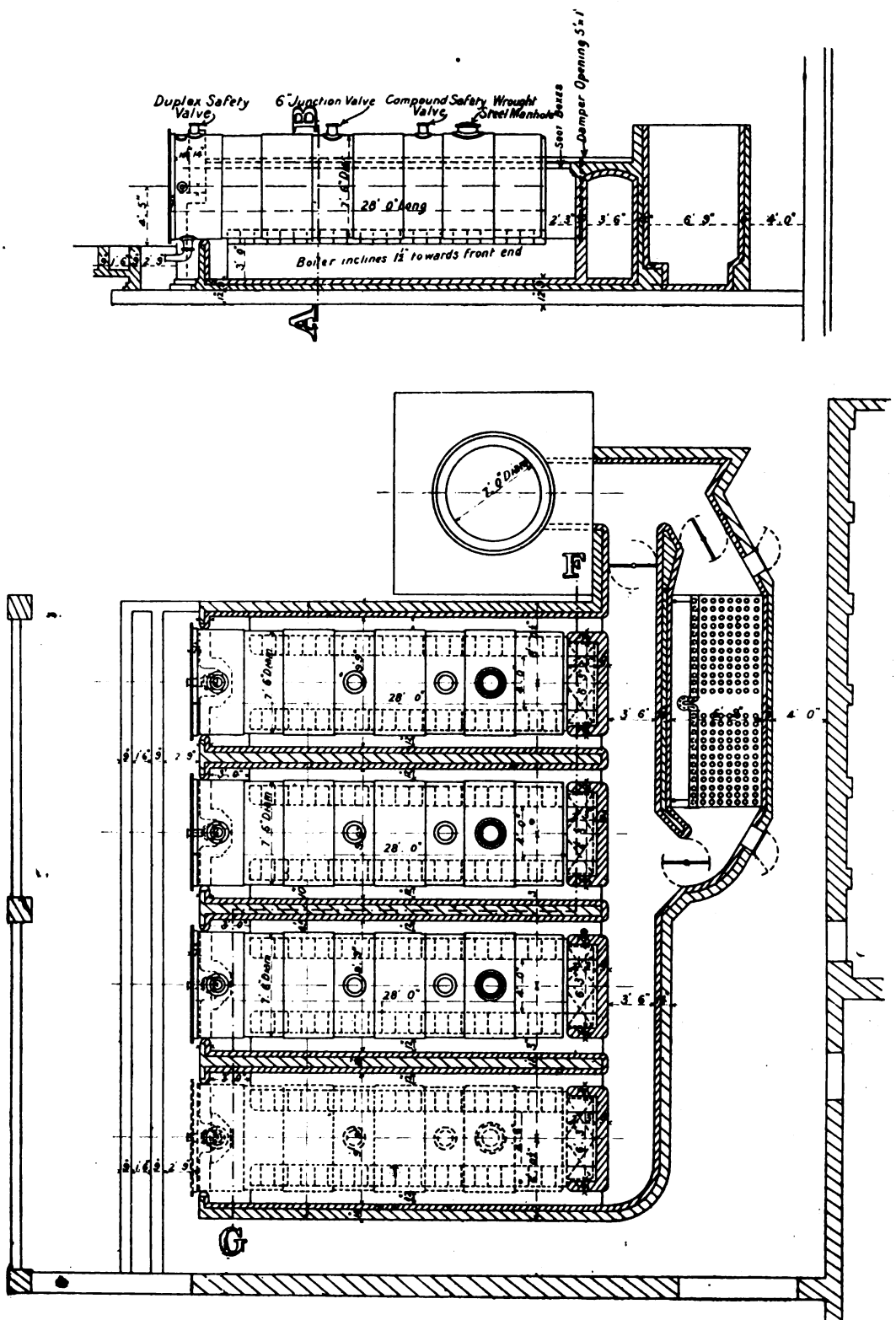
supply works, the demand for energy for lighting and power purposes is equivalent to about 7,500 lamps of 8 c.p. connected to the mains, which is about the full capacity of the station plant.

Site.

The electricity supply works are situated in Pine-grove, on the banks of the Leeds and Liverpool Canal, and adjacent to the Corporation destructor yard. Coal can be obtained direct from the canal, and there is an ample supply of water for condensing purposes. A glance at the accompanying map will show the position of the station.

Buildings.

The buildings have been designed by Mr. J. A. Crowther, A.M.I.C.E., borough surveyor, Bootle, the engine-room being 32ft. wide by 42ft. long, the boiler-house 50ft. wide by 62ft. long, the battery-room 33ft. average width by 56ft. average length, and the pump-room 32ft. wide by 32ft. long. All the buildings are on one floor, there being no second storey, and the end is temporarily fitted with corrugated iron to allow for extensions being readily made. The whole of the area is covered to a thickness of 2ft. with concrete, and the buildings are of a plain and substantial character, being built of common bricks, with red pressed brick dressings. The chimney is 7ft. internal diameter, 150ft. high, and rests on a bed of concrete 30ft. square by 6ft. thick. For a height of 25ft. above ground level the chimney is square, the remaining portion being octagonal.



Plan and Longitudinal Section of Boilers at Bootle.

System of Supply.

The supply is on the three-wire direct-current system, the pressure at consumers' lamps being 220 volts.

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EARTH CURRENTS AND ELECTRIC TRACTION.

On Friday evening Prof. A. W. Rücker, M.A., D.Sc., Sec. R.S., M.R.I., delivered a lecture at the Royal Institution on "Earth Currents and Electric Traction." Sir William Crookes presided.

Prof. RUCKER first referred to the electrical currents which traversed the earth's surface. In addition to these he had reason to believe that there might be, at great depths within the earth, currents of greater importance, to which the phenomena of terrestrial magnetism were due. Further, we had reason to believe that some currents might flow into the atmosphere, itself a seat of electrical phenomena. It was possible that currents might flow from earth to air, and from air to earth. But apart from all these there were other currents of considerable force which were distributed in the earth from dynamos, with the result that great electrical disturbances had taken place at some of the magnetic observatories; so that in reality, earth currents might be divided into two classes—natural and artificial. Natural currents might be divided into those which existed near the earth's surface, those which might flow at a considerable distance beneath the earth's surface; and those currents which flowed from earth to air, and from air to earth. He first considered the currents which flowed at a considerable distance beneath the earth's surface. At a depth of 10 or 12 miles we should come to a point where magnetised bodies would cease to be magnetic, as the increased temperature would be sufficient to destroy that property. He illustrated this annihilation of magnetic force by means of a piece of basalt, and pointed out that the argument, which would hold good in the case of iron, would also apply to the rocks in which iron or its oxides were found. A very interesting experiment made by Mr. Henry Wilde was referred to, in which an attempt was made to imitate the magnetic condition of the earth. A globe of about 18in. in diameter and containing a spindle around which iron was wound was inclined at a certain angle. There were really two sets of wires through which a current could be passed. The interesting and important thing was this, whether, when a small magnet was placed near this artificial globe, it would behave towards it the same as a magnetic needle would on the surface of the earth. But it was found that what on the artificial globe so formed the ocean parts had to be covered with a thin sheet of iron, and immediately there was obtained the most remarkable agreement between the model so constructed and the earth itself. In the course of further experiments there was thrown on a screen what he called a shell—an oblong piece of metal with a small magnet in the centre. Fine iron filings were indiscriminately scattered within and also outside this shell. The effect was that the enclosed filings immediately assumed magnetic lines, while those at the outside of the rim were still free and retained their original position. Conversely, when the magnet was placed outside the rim, the filings all around it arranged themselves into magnetic lines, while those enclosed remained perfectly free, and, of course, unchanged in position. The magnetic curve lines of both hemispheres of our earth were shown on the screen and described, and the lecturer proceeded to enquire into the existing differences of magnetic matter under the seas and on land. If there was such a thing as an iron shell round the earth, then there might at once arise a suggestion as to the nature of meteoric iron. But on inspecting the great Australian meteorite in the British Museum, he found that this showed no magnetism at all except that due to our earth's induction. The same held with a number of the smaller meteorites he had tested also at South Kensington. He experimented with a large piece of meteoric iron which had been lent to him. On testing this with a sensitive magnetic needle, the same result was apparent, the attractive force being still due to our earth's induction. Terrestrial magnetism was one of the most backward of the sciences. We did not really know why the earth was magnetised. Speaking of artificial currents and their danger to magnetic observatories, and to a less extent to colleges, he said the disturbances caused by these were first noticed in America, where the lines for electric traction were first laid down very roughly, with the result that large earth currents were allowed to disturb the neighbourhood. He showed by means of a diagram the disturbances that were caused by the South London Railway, and another diagram indicated those noticed at Greenwich. The promoters of several electric railways had already agreed not to used earthed returns on their lines. He believed that the insulating of the return wire had introduced additional cost and difficulties in the construction of the railways and tramways in question. In the case of the tramways running in the neighbourhood of Kew, it had been arranged to put the return conductor overhead, and to have two trolleys to collect the current instead of one as formerly. In spite of the ready way in which the promoters of the tramways had met the observatory authorities, the next year or two would be a very anxious time with observatories. Observations had been made at Kew now for something like 40 years, and to remove this observatory from the neighbourhood would be a national disaster. Another point he referred to was the possibility of currents flowing from the air to the earth and from the earth to the air. It had been suggested that there was a great system of electrical distribution due to this phenomenon, and that the aurora was connected with it. Of late the question of the determination as to the heights assumed by the aurora had entered upon another phase, but the actual measurement of these heights was open, as he showed, to grave doubts. In conclusion, he alluded to the attempts which were about to be made to add to our magnetic knowledge in the southern hemisphere by the expeditions of England and Germany, both of which would work together, though they would take different routes.

INSTITUTION OF ELECTRICAL ENGINEERS.

The Hissing of the Electric Arc.

RESUMED DISCUSSION.

(Continued from page 404.)

At the Institution of Electrical Engineers on Thursday evening, the 13th inst., the discussion was resumed on Mrs. Ayrton's paper on "The Hissing of the Electric Arc."

The **President** (Mr. J. W. Swan, F.R.S.) was in the chair, and having announced that it had been arranged to hold the next annual meeting of the Institution on Thursday, May 25, he invited discussion on Mrs. Ayrton's paper.

Prof. Fleming, in resuming the discussion, referred to the large amount of valuable matter the paper had afforded for discussion, and to the investigations which had taken place with a view of deciding the difficult problem which gave the title to Mrs. Ayrton's paper. Essentially the phenomenon of the arc consisted of the conduction of a current through a column of vapour. Suppose they accepted as a provisional hypothesis or suggestion that in the arc they had electrolysis of carbon vapour going on. He wanted to suggest for one moment that the velocity of the negative carbon ions was much greater than that of the positive. The result would be that they would have an accumulation of negative carbon ions near the positive pole, and that this would have the effect of creating resistance. Having followed up the hypothesis still further, he went on to remark that he had found by employing a vibrating mirror that the hissing arc was intermittent in light emission. The process going on in the normal arc, according to his own view of the matter, would be something like this—that electrolysis was taking place in the arc, that the rushing of the ions towards the crater would cause by impact a high temperature, which would provide the necessary fuel or material by the production of carbon vapour. That was one view which might be taken of the causes at work when an arc was started. But in addition to this, he thought that such a theory would explain in some way the formation of the mushroom on the carbon when the hissing began. Having advanced further arguments to account for the hissing, he remarked that Mrs. Ayrton, in her paper, had not gone into such matters as negative resistance and E.M.F., which entered into the region of hypothesis. He concluded by adding a hearty word of congratulation to the author for the singularly philosophical, elaborate, and careful paper she had placed before the Institution.

Captain Abney, on being invited to speak, said that although he had done a great deal of work in connection with the arc lamp, he could not claim to have entered at all into that field of investigation which Mrs. Ayrton had so ably penetrated. Unfortunately, he was debarred from hearing the paper read. He very much regretted this, and he would also very much have liked to see the beautiful experiments shown. He was, however, afforded the great pleasure of reading the paper, which showed, he thought, an ideal method of carrying out an investigation, for the subject

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was carried on from point to point most clearly, and no one could have come to any other conclusion but that the author's deductions were primarily right. The hissing of the electric arc had been of, he might almost say sad, interest to him. He came to the conclusion that a certain voltage was requisite, and so on; but he had the displeasure, long before Mr. Trotter brought forward that quotation of the arc, of being intimately "bothered" with it in his experiments. The way in which he was bothered was this: by means of a spectroscope he threw an image of the carbon points upon a screen, but it happened that the patch of light obtained used to oscillate. He found there was a definite rotation of something, and that what was happening was evidently taking place in the arc light itself. The slit of the spectroscope was diminished to a certain point, and then the various colours were beautifully exemplified on the screen. By means of a pinhole the image of the carbon points was produced, and thus they had the service of the prism and the whole phenomena exemplified in an interesting way on the screen. He hesitated to say whether the rotation was 450 times a second or minute, he forgot which. All he could say was that at the time immediately before the hissing there was the phenomenon to be seen which Mrs. Ayrton had described so well in her paper, and which led one to conclude that this might be due to oscillation. The hissing most frequently accompanied the rotation, which was excessively annoying to him with the experiments he was conducting. There was another point. He would like Mrs. Ayrton at some time to throw a monochromatic image on the screen and watch it. Having explained the method by which this might be done, he went on to describe the phenomenon which was noticed when the hissing began. Directly they had the hissing, there was a new phenomenon, and there was a blend surrounding the carbon point quite different from the violet. They had a yellow glow, which was very different from the violet flame, that was a compound of carbon and oxygen. It was a higher compound of carbon, oxygen, and perhaps of hydrogen. They could see this flame appear and disappear at their own sweet will by causing the carbons to hiss. He had a good many photographs showing all these effects, which formed a very interesting study.

Prof. Ayrton said during the discussion of the paper before Easter, Dr. Thompson criticised a statement he made on a previous occasion. His statement was that if they were dealing with normal arcs and kept the potential difference between the carbons constant, then, when they parted these slightly so as to lengthen the arc, they increased the current and did not diminish it, as they might *à priori* have been led to expect. To this statement Prof. Thompson took exception, and said that what the speaker ought to have stated was this: that with normal arcs, if they drew the carbons apart and wished to keep the potential difference between them constant, it was necessary to alter the outside conditions so as to increase the current. Now, it appeared to him (Prof. Ayrton) that this was a distinction without a difference. It was like the question of whether, in dealing with electric motor-cars, the motor was in front of the car or the car in front of the motor. In fact, Dr. Thompson's criticism might have been made just as well with respect to the ordinary statement about the flow of electricity over a wire; though he (Prof. Ayrton) did not wish it to be regarded that a current through an arc was exactly the same as a current through a wire. Supposing they had got two arcs of different lengths, and they desired the potential difference between the carbons to be, say, 55 volts in each case. There were millions of outside conditions for E.M.F. and resistance which would enable them to have 55 volts with the shorter arc, and there were millions of conditions which would enable them to have the same potential difference with a longer arc. If they had the two together, they must no doubt select conditions—outside conditions—which would enable them to have their 55 volts in each case. Exactly the same applied to a wire. If they wished to maintain a certain potential difference between the ends of a wire, made of lead, for example, so that it could be stretched, there were millions of ways in which they could do this. His point was, however, that if they stretched the wire and kept the potential difference constant, the current went down, whereas in the case of the arc, the length of which was increased, it went up. Another pointed criticism was in reference to what Captain Abney had just referred to—namely, the slow rotation of the bands which might be seen on the carbon crater before the arc hissed. Dr. Thompson had said that he thought this phenomenon had been pointed out by Mr. Trotter. Now, the curious part of it was that in Mr. Trotter's paper before the Royal Society and in the account given in a contemporary, no reference whatever was made to this slow rotation. [**Prof. Thompson** said what he referred to was contained in the account of a lecture.] After further criticisms, Prof. Ayrton said he would not delay them in referring to methods which Mrs. Ayrton used in carrying out her experiments, which to him had been very striking. One method, however, which he could recommend to the notice of students—they were all students more or less—was the one she adopted of studying the known by searching amongst the unknown—that is to say, a method of acquiring knowledge, not from books, of which she always herself said she was perfectly ignorant), but by studying, by careful observation, by carefully regarding every small phenomenon, and by pondering over all this, which was far better than the passing of any number of examinations or the coaching from any number of text-books.

Mrs. Ayrton, in replying, thanked all those who had criticised her for the very kind manner in which they had done this, and she thanked everyone for the extremely warm way in which they had welcomed her paper. With regard to the question by Prof. Thompson as to what she meant by the hissing of the arc, she remarked that the arc made a great many noises, and hissed under all sorts of conditions. Sometimes it made a noise like a kettle just about to boil, but the hissing of which she spoke was that which was accompanied by the fall in the difference of potential. This seemed to her the most curious circumstance which attached to the hissing of the arc, and it was that hissing alone that she was trying to explain. Having dealt with the points raised by Mr. Mordey, whom, however, she was sorry she could not help in accounting for the presence of the dark band of an alternating current, she proceeded to examine other questions and opinions. With reference to the opinion that the hissing of the arc was disruptive, as suggested in a letter which Prof. Blondel had been so kind as to send her—that it was caused by particles of carbon being torn off, she did not agree with that idea, as she did not think the potential difference was sufficient to allow of such tearing off. With regard to Prof. Fleming's hypothesis, she did not quite follow him as to why the negative carbon should receive a supply of carbon ions in the manner suggested. This was not her idea at all, but it was much too late to go into her theory that evening. The so-called "mushroom" did not always take place with a hissing arc—only with a short hissing arc. Having referred to the rotation of the arc, she said she was extremely interested in what Captain Abney had mentioned, and she would try it, especially as he found a distinctive flame when the hissing took place. Mrs. Ayrton was greeted with loud applause as she resumed her seat.

The **President** said it was the first paper they had listened to from Mrs. Ayrton, but he sincerely hoped it would not be the last. He thought they were all the more indebted to her for communicating this to them, as she was not a member of the Institution. They had not the honour of numbering amongst them any lady members, but he did not know that there was any legal disability to bar ladies from becoming such, and he hoped they might yet look forward to Mrs. Ayrton being a member of the Institution.

A cordial vote of thanks having been passed to her by acclamation, Messrs. W. Duddell, A.I.E.E., and E. W. Marchant, A.I.E.E., contributed their experiments on alternate-current arcs by aid of oscillographs, the discussion being adjourned until April 27.

FORTHCOMING EVENTS.

FRIDAY, APRIL 21.

Physical Society.—At 5 p.m., "Effect of a Solid Conducting Sphere in a Variable Magnetic Field on the Magnetic Induction at a Point Outside," by Mr. C. S. Whitehead, M.A. Demonstration of Richards's Method of Standardising Thermometers, by Mr. R. A. Lehfeldt, D.Sc.

Institution of Civil Engineers.—At 4 p.m., Redelivery of Prof. Ewing's Lecture on "Magnetism."

Crystal Palace School of Practical Engineering.—At 12 noon, announcement of list of certificates awarded by the examiners.

North-East Coast Institution of Engineers and Shipbuilders.—At 7.30 p.m., at Sunderland, "Shop and General Establishment Charges in Engineering Works, and their Relation to Costs and Estimates," by Mr. W. E. Cowens.

TUESDAY, APRIL 25.

Institution of Civil Engineers.—At 8 p.m., annual general meeting of corporate members, to receive report of the council, and to elect council and auditors.

WEDNESDAY, APRIL 26.

Society of Arts.—At 8 p.m., "Coal Supplies," by T. Forster Brown.

Institution of Mechanical Engineers.—Annual dinner at the Hotel Cecil.

THURSDAY, APRIL 27.

Institution of Electrical Engineers.—At 8 p.m., "Experiments on Alternate-Current Arcs by Aid of Oscillographs," by W. Duddell, Wh.Sc., and E. W. Marchant, B.Sc., Associate, conclusion of discussion. "Capacity Measurements of Long Submarine Cables," by J. Elton Young, M.I.E.E.

Royal Institution.—At 3 p.m., "The Atmosphere," by Prof. Dewar, M.A., LL.D., F.R.S., M.R.I.

Institution of Mechanical Engineers.—At 7.30 p.m., ordinary general meeting and president's address.

FRIDAY, APRIL 28.

Royal Institution.—At 9 p.m., "Some Features of the Electric Induction Motor," by Prof. C. A. Carus Wilson, M.A., M.I.C.E.

Institution of Mechanical Engineers.—At 7.30 p.m., "Evaporative Condensers," by Mr. Harry G. V. Oldham, A.I.M.E.

Personal.—Mr. W. C. P. Tapper, who was for nearly five years one of the chief assistants at the Brighton electricity works, has now been appointed resident electrical engineer to the Whitechapel District Board of Works to carry out the electric lighting of that district under Mr. A. Wright.—Mr. Furness, of Mutley, Plymouth, has been appointed resident electrical engineer to the Devonport Town Council.

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TO CORRESPONDENTS.

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ANANIAS SUPERSEDED.

The historic gentleman whose name appears above would find no occupation if he revisited this mundane sphere. The gentlemen who send special telegrams from various parts of the civilised world to the daily papers have entirely occupied the position so long held by the above-named gentleman. The contents bills of the daily papers will always indicate the enormity of the whopper in the paper when the subject is electrical and the subject-matter from the "special correspondent" somewhere abroad, for the size of the headline in the bill is directly proportional to the sensationalism of the statement. Every prominent name among electricians is exploited in turn, so that there is no favouritism. At one time it is Edison who is going to destroy whole countries, if not continents, at the touch of a button; at another time it is Tesla who will harness a balloon skyward and astonish Marconi; at another time it is Marconi, whose successes are said to have caused a drop in cable shares of several points; then an Hungarian with an unpronounceable name was to present us with a far-seeing apparatus, and so on. Of course, it may some day be possible for apparatus evoluted from Marconi's or some other initial wireless system to supersede cables, but at present such supercession is only within the purview of dreamland—it is neither practical nor possible with the apparatus as at present indicated. There is a very large and useful scope for Marconi's or some similar system, but the scope is somewhat outside—if not altogether so—the ordinary run of telegraphic work. There is very little doubt but that the innocent holders of cable shares have been frightened by the rather sensational accounts of Marconi's successful experiments, but while we can congratulate that gentleman upon his success, we must warn shareholders in cable companies that their property is in no immediate danger. It would be far more nearly jeopardised in certain directions by the successful laying of a Pacific cable, but this event is not of to-morrow, for, according to Mr. Chamberlain, the suggestion is still under consideration. After the numerous successful efforts by special correspondents it is distressing to find that the *Chronicle* has started a sensation which is open to the plea of being two years too late. This last little joke is from Austria, and is recorded in Tuesday's *Chronicle*. It is to the effect that "Herr Pollak is able on the same telegraphic line to wire sixty thousand words an hour." Unfortunately for the *Chronicle*, the Americans have been in that field before. Thus, in 1897, Messrs. Crehore and Squiers presented a paper to the American Institution of Electrical Engineers on their synchronograph. With this instrument they succeeded in their laboratory in transmitting signals at the amazing rate of three thousand to four thousand words per minute, or one hundred and eighty thousand to two hundred and forty thousand words per hour. Before this the *Chronicle's* special correspondent must shrink abashed, or rather the editor of our esteemed contemporary should do, as he is responsible for the ink-splashing. We acknowledge,

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however, that the above speeds were reduced when trials on practical lines were made, but the inventors carried out extensive trials in England at the end of 1897, which were described by them in a report to the Postmaster-General of the United States. With a loop from London *via* York and Leeds, back to London, some six hundred and sixty words were transmitted per minute, or practically forty thousand words per hour, while the speed was much curtailed by the construction of the apparatus available for signalling. Apart, however, from Messrs. Crehore and Squiers's developments, speeds higher than those named by the Austrian correspondent are easily obtainable with Wheatstone instruments on short lines.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

A FAULTY DYNAMO.

SIR,—Will you kindly explain through the correspondence of your valuable weekly paper what fault there is in a compound dynamo (100 volts 20 amperes), which, when started, takes about three minutes to excite, and then rise to 100 volts, which voltage it will keep for about five minutes, and then gradually fall away. The machine has been carefully tested before and after running and is found perfect. A new armature has been tried with the same results.—Yours, etc., A. E. B.

April 18, 1899.

[Our correspondent does not make it clear whether any current was taken from the dynamo or how much the voltage dropped after five minutes. If the fall is considerable on open circuit, he would do well to test the resistance of the shunt circuit both before and after running. An exact record of what actually happened and the results of the suggested test should enable a correct diagnosis to be made.—ED. *E. E.*]

ELECTRICAL MOTOR CARRIAGES.

SIR,—There seem to be so many obstacles to the ultimate firm establishment, and apparently inseparable from the early life of a new industry (such as the adverse state of the law, the over-sanguine inventor, and, lastly, the professional company promoter), that those who are most interested in the matter, and one who has largely contributed to the years of labour necessary in making the electrical vehicles a practical success, take all these things as a matter of course. But when a gentleman of the standing of Sir David Salomons states (assuming that he has been correctly reported in the *Royal Magazine* of this month) that the electrically-propelled carriage is an impossibility, it is to be pardoned if the remark is not allowed to pass unchallenged. And one is almost inclined to think that it was made without due consideration, as was the case when the same gentleman, in estimating the cost of propulsion by electricity a year or so ago, based his calculations on the cost of electric current at 4d. per unit, whereas at that very time it was to be obtained in London at 1d. per unit!

That one does not see many self-propelled carriages on the streets here is not evidence that they are unpractical. Our natural caution in adopting new ideas and our love of horses are enough to account for this, although, as a lover of horses myself, one of the last uses I would put a horse to would be the hauling of a tramcar or an omnibus; and I think that many of the horses one sees in cabs are fit subjects for anyone's compassion, and the sooner their use is rendered unnecessary by the introduction of electricity the better.

In spite of the long start which the automobile movement has had on the Continent, and in view of the fact that is only during the last two years or so that one was allowed to run a motor on the street here at all, it is a very significant fact that the principal system of electrical vehicles which has been adopted in Paris is of English origin.

The argument which Sir David is reported to have used when discussing the "inutility" (*sic*) of electrical motors, "it is as if one should go for a fast drive and expect the horses to gallop along with a load of passengers as well as a dozen sacks of coal," is not to the point, and one is tempted to remark that the horses would go very fast indeed if they had no load at all to carry. But why Sir David should try to prove the matter by wishing to carry accumulators (represented by the sacks of coal) in a horse-drawn vehicle, I fail to understand, for when we carry a set of accumulators in our electrical vehicle we do not want to carry horses, but do without them.

In conclusion, I can only say that, regarding the weight of an electrical carriage, it is now quite possible to produce one capable of carrying two persons for a 40-mile journey, the total weight of the carriage being under 12cwt., at a cost for electric current of 2s., and an annual expense for renewal of accumulators of £20.—Yours, etc.,

C. OPPERMANN.

The Automobile Club, S.W., April 17, 1899.

THE ELECTRIC LIGHTING OF CALCUTTA.

Messrs. Crompton and Co. are responsible for a large amount of the pioneering work in connection with electric lighting in India. The works they have equipped at Calcutta, which have just commenced to supply, are the latest outcome of their pioneering enterprise. The history of the undertaking does not concern us so much at present as the fact that the electricity works are now ready to supply, but the preliminary work has not been easy. In fact, the firm has done a great deal in inducing the Indian Government to grant electric lighting concessions on the lines of our provisional orders. The works at Calcutta belong to the Calcutta Electric Supply Corporation, Limited, and Messrs. Kilburn and Co., of Calcutta, will take the active management of the technical affairs of the company in India.

The buildings erected for the company are well designed and of ample size, as can be gathered from the above rough dimensions. Thus, the boiler-house is 42ft. by 88ft., the engine-room 43ft. by 88ft., while the shaft is 6ft. 6in. diameter inside and 150ft. high. The fact that the station is in India is emphasised by the following extracts from the building specification: "The concrete of the foundations is to consist of five parts of khoa, mixed with one part of the best ghooting lime and one part of Surki No. 1." Again: "The mortar to be composed of Surki No. 1 and best ghooting lime for the foundations, and Sylket lime for the superstructure, in the proportions of 2 to 1."

When, however, we come to the engineering details, there is no doubt about the English character of the materials and the general design of the arrangements. Thus three water-tube boilers are installed, each capable of evaporating 7,500lb. of water at 180lb. pressure. The feed pumps are all electrically driven, and are of the three-throw vertical type. Crompton motors are used to drive these pumps, and we were privileged to see one of the sets under trial at Chelmsford last year. The station is situated in the centre of the town, where condensing water is not obtainable, so the exhaust pipe is continued up the inside of the shaft. The generating plant now erected consists of two 60-i.h.p. engines, coupled to two 19-kw. dynamos at 220 volts; two 180-i.h.p. engines, coupled to 114-kw. dynamos at 440 volts; two large engines capable of indicating up to 360 h.p., and coupled to two 224-kw. dynamos, are now being erected. All the dynamos are of Crompton and Co.'s make, and are of the two-pole type. The higher-voltage machines can all give voltages up to 550 volts if required. The engines used are of the Willans type, the larger sizes having three lines of cylinders.

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Two batteries of Tudor accumulators have been provided, each consisting of 120 cells. The capacity of each cell is 420 ampere-hours on a 10-hours' discharge.

The mains form no inconsiderable portion of the contract, on account of the great length of the town. In this respect the company has been well advised, as they have laid mains the full length and width of the town, and thus can supply over a very large area. Three systems of mains are used. The first is the well-known Crompton culvert system with strained bare copper, which is employed wherever possible. Elsewhere the underground mains are laid in wood casings of teak or pinkado, and filled in solid with a mixture of sand, Stockholm tar, and resin in the proportion of 166, 20, and 14.

In a few of the outskirts overhead wires are allowed, and in this case iron poles are used to support wires of

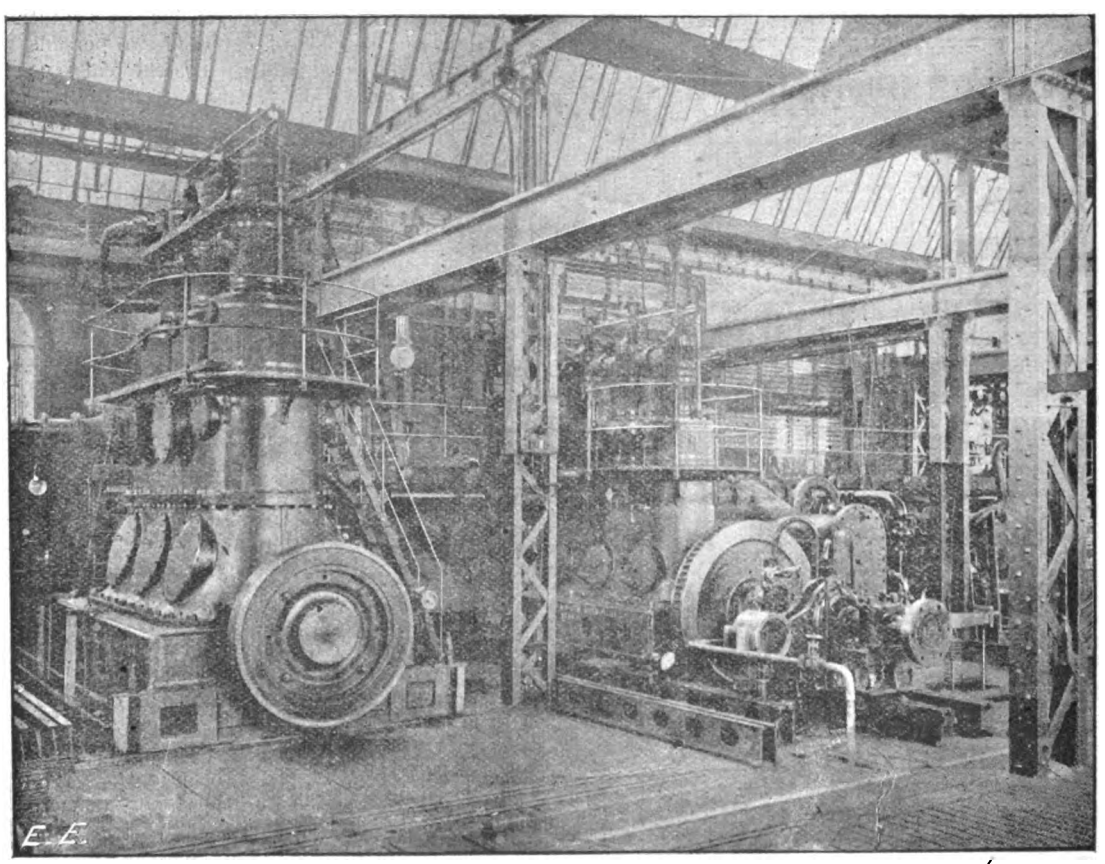

FIG. 1.—View of Messrs Willans and Robinson's Testing Department, showing the 1,200-h.p. Engine.

·082 square inch sectional area. Ten feeders are provided, and so designed as to give about 10 per cent. drop at the assumed full load, corresponding in all to some 500 kw. The standard size of the mains used for distribution purposes in the centre of the town is ·062 square inch by ·0125 square inch by ·062, while smaller sections are employed further out. On the aerial lines lightning arresters are attached at points 440 yards apart.

We trust in due time to be able to give photographs and plans of the work, but in the meantime must congratulate Calcutta on having an electric supply. It seems that electric fans are booming in the city, as cooling breezes in the offices in the town are worth their weight in gold at certain seasons of the year.

A 1,200-H.P. WILLANS ENGINE.

We were invited last week by Messrs. Willans and Robinson, Limited, to see the largest engine they have yet made, erected in their testing department, and running round at no load. We gladly availed ourselves of this offer, and proceeded to Rugby on Thursday, the 13th inst. The other attraction, apart from this large engine, was one of the 3 R type, whose normal load is 370 b.h.p., running on a Froude water-brake.

To commence with the large engine, which is shown on the left-hand side of Fig. 1, and is called the 3 V type, this engine is designed to give a maximum of 1,200 i.h.p. continuously when running at a speed of 230 revolutions per minute. The engine's most economical load is 1,000 i.h.p., and it is also capable of maintaining on emergency a load of 1,500 i.h.p. The engine we saw on Thursday week was the first of this size the company has made, and is to go to Liverpool to work the electric trams. In consequence of this, the valve gearing of the engine is so connected to the governors that a very ready response is made to sudden demands for power. The size of the engine can be gathered from illustrations Figs. 1 and 2, and from the fact that it was deemed necessary at first to have a second platform round the top of the steam-chest. The automatic expansion gear connected to the governor may be briefly explained as follows: In the first place, the governor is in this size arranged with a vertical axis, being driven by bevel gear off the main shaft. The governor rod from these governors is made to act direct on the throttle valve when the load is light. As soon as, however, the load increases to a point which demands an increase in the length of stroke before the steam is cut off, a three-way valve connected with a steam relay comes into play. This relay consists of a horizontal cylinder, seen in Fig. 2, in which is a piston arranged to actuate the cut-off gear in the top of the steam-chests. The extent of the motion depends on the ratio between the pressure in the steam-chest and the boiler pressure or the atmosphere. In this way the steam-chests are always connected to one side of the piston, and the other side is connected to either the boiler pressure or the atmosphere by means of the three-way valve on the governor rod. The arrangement for varying the cut-off is that which has been adopted for some years by Messrs. Willans and Robinson, and consists of a sleeve with spiral ports which rotate round the piston trunks, these latter having spiral ports in the opposite direction. In addition to this automatic variation of the cut-off, a further gear, which can be seen in Fig. 1, is added, by which, in the event of a sudden load, high-pressure steam is admitted into the low-pressure cylinders. With the exception of these alterations, the engine is practically the same in detail as the ordinary Willans type. The accurate way in which it is balanced is shown by the fact that it was running light

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at full speed of 230 revolutions per minute without any holding-down bolts.

The smaller engine, of the 3 R type which, we saw at work on the Froude brake, is capable of giving 585 b.h.p. on an emergency load. With the brake as we saw it arranged, the maximum load obtainable was about 350 h.p. This brake can be seen in Fig. 2. The force pump at the right-hand side of the illustration, is used to provide water at 60lb. pressure per square inch through the valve and pipe seen at the left-hand side, into the brake chamber. The brake consists of two parts, one keyed to the shaft and revolving with it; the other part is supported on the shaft, but prevented from revolving by the brake-arm, which is weighted. These two parts are provided with recesses in opposite directions. In this way a water-churn is

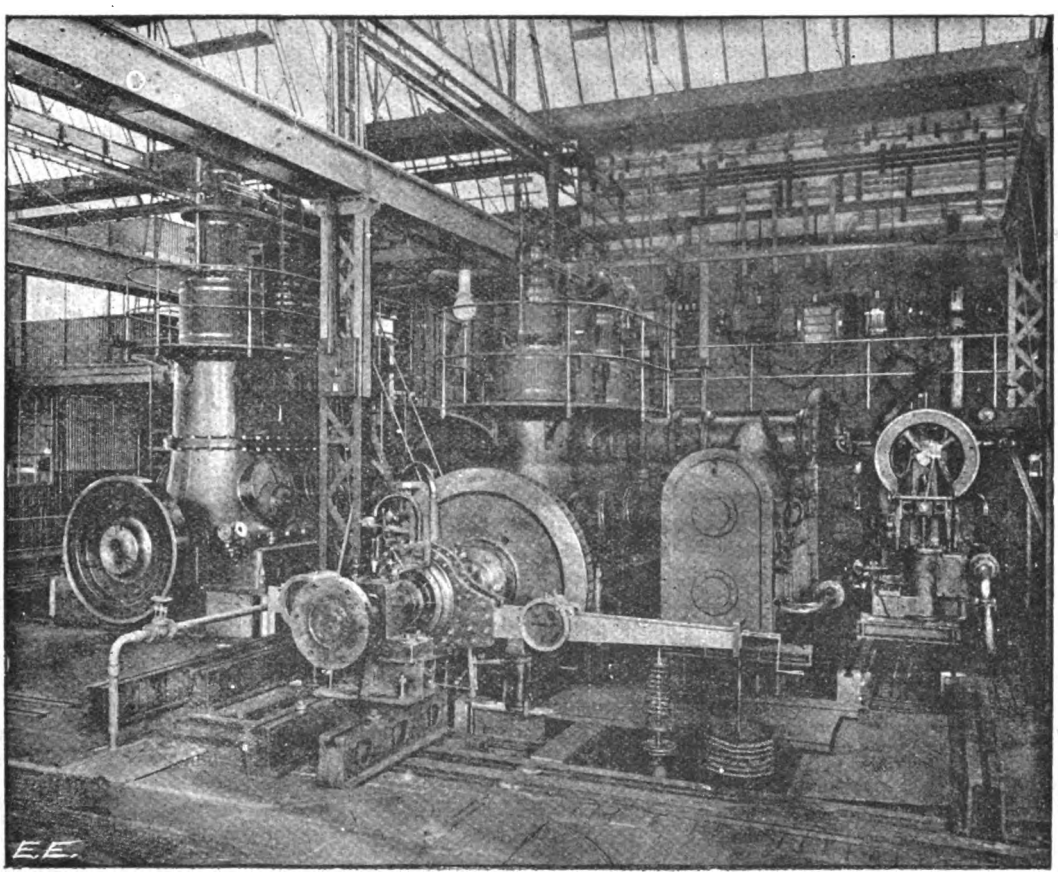

FIG. 2.—View of the Froude Brake coupled to a 370-h.p. Willans Engine.

obtained. The horse-power absorbed depends upon the amount of water actually in the braking chamber. The water escapes along the shaft, but we were not quite clear as to why more watertight glands could not be used to prevent this to some extent. Naturally, if the water was entirely confined in the chamber, unpleasant effects due to heating would arise. While we admire this addition to the equipment to Messrs. Willans and Robinson's testing-room, which enables large engines to be tested at the works without having the dynamos delivered at Rugby, we could not but reflect how much more convenient the dynamo is as an absorber of power when accurate measurements are required.

After these engines had been inspected an adjournment was made for lunch, when a few speeches were made. Mr. Mark H. Robinson was in the chair, and asked those present to drink the health of the new baby. He explained that when Mr. A. Bromley-Holmes, of Liverpool, placed the order with the firm for the first of these 1,200-h.p. engines they decided at once to put in hand all the templates, gigs, etc., for the production of the engines in quantity. Although the expense of these was great, the advantage of so doing was amply justified by the fact that they had now 16 of these engines on order. Of these, eight were going to Liverpool, six to Edinburgh, and two to Glasgow for electric lighting and traction work. Mr. Robinson also stated that this new engine was not to retain its position as the largest of the Willans type for long. The firm were making a 2,500-h.p. engine for the Paris Exhibition of next year. Parts of this large engine were already in the shop, and he hoped that it would ably represent the English practice of dynamo driving. After the toast had been drunk, Mr. W. A. Chamen, the electrical engineer of Glasgow, proposed a vote of thanks to the firm for the kind invitation to see the engine in question. He referred in very complimentary terms to the good work being turned out by the firm, and in this he was supported by Mr. Willock, the deputy convener of the Electric Lighting Committee in Glasgow. In reply, Mr. Robinson said that his firm and other English firms had been spurred on by American competition, and that they were quite prepared to compete in engine building with their foreign rivals. When judged on their engineering merits, English builders would be able to hold their own.

TELEPHONES.*

BY JOHN GAVEY.

(Continued from page 476.)

In the year 1864, the Universal Private Telegraph Company reintroduced the use of these switches for providing connection between subscribers to their private wire telegraph system so as to place them in direct communication with each other, and what was virtually a telegraph exchange was established by them. The system was subsequently extended by the Post Office to several towns in Great Britain. On the establishment of the first telephone exchanges in this country, the Edison Company started with a switch of the fixed bar and plug type just referred to, whilst the Bell Company introduced a board in which flexible cords, connected to plugs, were used for joining through the circuits. This was the direct progenitor of the modern system of switching.

A telephone switching installation comprises the following apparatus at the exchange: (1) an indicator, by means of which the attention of the operator is called when a subscriber desires to communicate; (2) a jack, or switch spring, to which a subscriber's line wires are connected;

* Paper read before the Society of Arts on April 12.

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(3) plugs, for insertion in the jacks, and connecting cords containing conductors, by means of which connection is established between any two subscribers; (4) speaking and ringing keys and other subsidiary apparatus, the use of which appears in the description of a modern switchboard. [Specimens of each class of instrument exhibited.] Each subscriber is, of course, provided with a complete telephone, an electric bell, by means of which he can be called, and some means of actuating the exchange indicator (1) when he desires to communicate.

The operation of telephone switching on small exchanges is a simple one. When the shutter of an indicator drops, the operator inserts one plug of a connecting cord into the corresponding jack, and by depressing a speaking key brings her telephone into the circuit. She ascertains the requirement, inserts the second plug of the cord into the jack of the subscriber who is wanted, depresses a ringing key which actuates the bell of the second subscriber, and the latter, on answering, finds himself in communication with his correspondent. [Apparatus exhibited.] The calling up of the exchange has been effected in various ways. In one, the most common, the subscribers are provided with a small magneto machine, set in motion by a cranked handle. The turning of this handle drops the exchange indicator. [Illustration.] In others, primary batteries have been used. Again, a system known as the "Law" or "call-wire" system has been tried. In this an independent circuit extends from the exchange to a certain number of subscribers, each call circuit serving from 40 to 60 persons. It terminates in a telephone at the exchange, at which an operator is listening continually. To obtain attention, a subscriber depresses a special key on his local telephone, which switches it into the call circuit, and if no one is speaking, he makes his wants known. If another subscriber be using the call circuit, the former waits his turn. The operator, on hearing his requirements, makes the necessary connections as before, the subscriber releases the "call key," and his telephone is thereby cut out of the call circuit and restored to his speaking circuit, on which he listens till he hears his corresponding answer. Finally, in the Post Office a system was designed, under the instructions of Mr. Preece, by which the removal of the telephone from its suspending hook actuated the indicator at the exchange, and this method has now been adopted, and, with certain modifications—which will be described later—it promises to become the standard type of working in the United States.

When the conversation is finished, the reverse operations are performed. If the call is originated by ringing, a brief ring is repeated, and this drops a second indicator shutter which is bridged in the connecting cords, and which is an instruction to the operator to disconnect the two circuits. With the "call" system instructions to sever the connection are conveyed on the call wire, and, finally, with the Post Office system the restoration of the telephone to the hook sends an automatic signal to the exchange, which indicates the close of the conversation. Where a special operation is necessary to ensure the severance of a connection much difficulty occasionally arises through a subscriber omitting to ring or call off; hence, under these conditions, other subscribers who wish to speak to either of the two who are joined through are told that he is engaged, and much discontent and trouble have arisen from this cause. The advantage of a system which abolishes this special operation and substitutes an automatic signal on the hanging up of the telephone is obvious.

So long as exchanges were of limited size, these simple types of switching readily met all requirements, but as the number of subscribers increased, and the switchboards grew to such dimensions that several operators had to be employed, a difficulty arose in making connections between circuits beyond the reach of a single operator. This was at first met by providing what are termed office junction circuits between each operator and all the others, but as the system became more extensive the number of these junctions and the difficulty of manipulation increased to such an extent as to render this method of working impossible. To meet this difficulty the multiple board was designed. This board is divided into sections, usually of such a size as to provide space for seating three operators, and on each section appear the local jacks and indicators of a number of subscribers, varying from 200 upwards, according to the average number of calls dealt with daily. In addition, however, to these local jacks and indicators, all the circuits of the whole of the remainder of the subscribers to the exchange are attached to a series of jacks fixed on the upper panels of the section, so that each operator is in a position to connect any one of the local subscribers, for whose calls she is responsible, directly to any other subscriber on the exchange. It is, however, evident that before a subscriber connected to a local section is joined through to any other subscriber, it is necessary to ascertain that the latter is not connected through at another section of the board to a third subscriber, and this is ascertained in a very ingenious manner. On the face of each jack is a metallic socket, and resting on this socket is one of the springs of the jack itself. These springs and sockets are so connected that on the insertion of a plug into a subscriber's jack, at any section of the board, the socket spring is moved into contact with a stud that connects a battery with the whole of the sockets of the jacks which serve that particular circuit. If a subscriber who is wanted is engaged, the fact is indicated to any operator in the exchange by a click in her telephone when she touches with the tip of the plug to which her telephone is for the time being connected the socket of his jack on her section. If she hears no click, she assumes that the subscriber is disengaged, and connects him through to the calling subscriber.

The early types of multiple boards were extremely costly, and they were subject to many defects, which led to the introduction of other systems, which were designed to cheapen the service and to improve the working. This again put the advocates of the multiple system on their metal, with the result that the modern multiple board, as at present manufactured, appears to meet, within its capacity, most of the requirements of a thoroughly efficient telephone system. I propose to describe briefly the latest form of multiple board, designed by the Western Electric Company, which embodies the most recent developments of American practice. First, the Post Office system of automatic "calling" by the removal of the telephone from its hook, and automatic "clearing" by the restoration have been adopted: but the progress of modern discovery has placed at the command of telephone experts improved methods of which they have availed themselves. Thus, small electric incandescent lamps, worked by relays, have been substituted for the necessarily somewhat cumbersome drop indicators previously used in most exchanges. These incandescent lamps can be placed in any position, vertical or horizontal, and they take up such little space that they can be fixed in the exact localities in which their indications are most readily observed, instead of having to be placed, as in the older boards, at a considerable distance from the jacks and cords with which they are worked. Thus there is no need for hesitation or thought on the part of the operator, whilst trying to connect in her mind a distant signal with the particular operation to be performed, for each lamp indicator is in immediate proximity to the jack or plug, as the case may be, which has to be used. Under each subscriber's local jack at the exchange is placed one of these incandescent lamps, which is normally dark, but which acts as the subscriber's calling signal. On the keyboard, and close to each of the connecting cords and plugs, are two similar lamps, the use of which is indicated in the following description of the *modus operandi*: On the removal of the subscriber's telephone from the hook the calling lamp immediately under his jack at the exchange lights, and the operator, without a moment's hesitation, inserts a disengaged plug into the jack. The insertion of this plug extinguishes the "calling lamp," and the operator presses the speaking key forward and simply says "Number." On receipt of the reply from the calling subscriber, the second plug of the pair is used, in the first place, to test the line on the multiple of the subscriber wanted, and then, if the latter be disengaged, for insertion in that subscriber's jack. This action lights the lamp nearest the operator on the keyboard. She reverses the speaking key for a brief interval, and this has the effect of ringing the bell of the subscriber wanted. On his removing the telephone from its hook the front

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lamp is extinguished, the two subscribers are in correspondence, and the operator is made aware, by the lamps ceasing to glow, of the fact that her work for the time being is complete. Should either subscriber hang up his telephone, as is sometimes done while searching for information, one only of the keyboard lamps lights, but no notice is taken of this unless it should remain in that position for an undue period. When, however, the conversation is really finished, and both subscribers restore their telephones, both keyboard lamps light, and this is an absolute signal to withdraw the connecting plugs, which action is followed by the extinction of the keyboard lamps. If the subscriber wanted is engaged or fails to answer, the operator says to the originating subscriber either "Busy" or "Does not answer," and on the latter restoring his telephone, the lamp on the keyboard furthest from the operator lights, and she withdraws the plug. It will be observed that the speaking in the course of manipulation is reduced to a minimum. When there is nothing to prevent an immediate connection, only one word is uttered by the operator, and this is increased to two when the connection cannot be made. [Switches exhibited in work.]

(To be continued.)

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

159. In an arc lamp how should the regulating coils be wound (*a*) when the lamp is required for parallel working, (*b*) when it is to be used for series working?—P. T.

160. Describe, with sketches, the best form of automatic cut-out you know of for an arc lamp.—S. W.

ANSWERS.

Question No. 154.—Define the terms indicated horse-power, actual horse-power, nominal horse-power, brake horse-power, and electrical horse-power. Explain their respective units, and their relation one to each other. Also what is meant by the electrical and commercial efficiency respectively of a dynamo?

[A large number of correct answers have been received to this question, and there is very little difference between the first dozen answers. We have decided to print the following three, classing them as equal.—ED. *E. E.*]

Answer to No. 154 (*awarded 7s. 6d.*).—This question, although not enumerating *all* the terms in use to express horse-power, indicates the variety which does exist. The term "horse-power" was first introduced by Savery and adopted by Watt, and the value which he assigned to it has been retained—namely, 33,000 foot-pounds per minute. The foot-pound, of course, is the unit of work, being equivalent to the work done in raising a weight of 1lb. through a vertical distance of 1ft. Watt found by actual experiment that an average horse could do 22,000 foot-pounds of work per minute, and to this figure he added 50 per cent. in order, it is said, to give his customers good value.

The indicated horse-power is the power (or amount of work done per minute) in the cylinder or cylinders of an engine in foot-pounds, divided by the unit of horse-power, 33,000. The indicated horse-power depends upon the mean steam pressure, piston area, length of stroke, and number of strokes per minute, and does not take into account the proportion of power used in the engine itself. The indicated horse-power is calculated by means of the well-known formula:

$$\text{I.H.P.} = \frac{\text{P L A N}}{33{,}000},$$

where P = means effective pressure (as obtained from the indicator diagram);
L = length of stroke in feet;
A = piston area in square inches;
N = number of strokes per minute.

The actual horse-power or brake horse-power are synonymous, and refer to the available horse-power at the crankshaft or flywheel of an engine. The term "effective horse-power" is also used with precisely the same meaning. The actual, brake, or effective horse-power is the indicated horse-power minus the power absorbed in the working parts of the engine. This latter value can only be ascertained by experiment, but may be taken as 25 per cent. in the case of condensing engines, and about 13 per cent. in the case of high-pressure engines.

Nominal horse-power is a term also instituted by Watt as a convenient method of reference for his various sizes of engines. In those days, however, the steam pressure was practically uniform—about 7lb. per square inch—and consequently size had an important bearing upon power. With the variety of increased pressure now in use this term has become insignificant, and should certainly be altogether abandoned. It is retained by some makers of agricultural steam-engines and gas-engines. Nominal horse-power may be taken as $\frac{1}{6}$ i.h.p.

The electrical horse-power of a dynamo is the horse-power given out or available at the terminals of the dynamo. It is sometimes specified as the external horse-power, and corresponds to the brake horse-power of an engine. It is obtained by dividing the output in watts at dynamo terminals by 746, the number of watts equivalent to 1 h.p. Thus, external electrical horse-power

$$= \frac{\text{E.M.F. at terminals} \times \text{external current}}{746}.$$

Similarly, internal electrical horse-power

$$= \frac{\text{E.M.F. in armature} \times \text{armature current}}{746}.$$

(This corresponds to the power absorbed in working an engine.) The sum of these quantities give us the total electrical horse-power (corresponding to the indicated horse-power of an engine.) The electrical efficiency of a dynamo is the ratio of the external electrical horse-power to the total electrical horse-power. The commercial efficiency of a dynamo is the ratio of the external electrical horse-power (or the power available) to the horse-power supplied to the armature shaft for driving.

It may be interesting to mention the existence of still another term of horse-power. The term "normal horse-power" was introduced by the North-East Coast Institution of Engineers and Shipbuilders, and is used by them on trial trip tests. After assuming certain conditions with regard to design, etc., they obtain the value of the normal horse-power for both boilers and engines thus:

$$\text{N.H.P.} = \text{D}^2 \sqrt[3]{\text{P}}\ \text{S} \text{ (for engines)};$$

$$\text{N.H.P.} = \frac{\text{H} \sqrt[3]{\text{P}}}{16} \text{ (for boilers)};$$

where D = diameter of low-pressure cylinder in inches;
P = working boiler pressure;
S = stroke in inches;
H = heating surface in square feet.

N.H.P. of engines and boilers conjointly:

$$= \frac{(\text{D}^2 \sqrt[3]{\text{S}} + 3\ \text{H}) \sqrt[3]{\text{P}}}{100}.$$

In America a practical standard of horse-power is measured by 30lb. of water evaporated per hour, at a pressure of 70lb. per square inch above atmosphere from 100deg. F. per horse-power.—A. M. O.

Answer to No. 154 *(awarded 7s. 6d.)*.—Nominal horse-power as understood by Watt was both a measure of the commercial value of an engine and of the power it might be expected to develop in ordinary work. He found that a horse when yoked to a whin-gin averaged 17,600 foot-pounds when walking and 26,000 foot-pounds when

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trotting. As it was the horse he had to compete against with in the adoption of his engine, he took as a safe figure 33,000 foot-pounds. The pressure on his piston was 7lb. to the square inch, and he fixed his piston speed $= 128 \times \sqrt[3]{\text{stroke}}$, so that his formula for nominal horse-power was (area of piston in inches $\times 7 \times 128 \times \sqrt{\text{stroke}}$) $\div 33{,}000$. Gradually, however, as it became possible to construct boilers to supply steam at higher than atmospheric pressure, and engines to run at higher speeds, the powers developed by engines considerably exceeded their nominal horse-power. Watt's rule was altered from time to time by various persons, but they never obtained general acceptance, being without any proper scientific basis, and owing to the great advances made in engineering construction nominal horse-power is now entirely obsolete. The 33,000 foot-pounds of Watt is, however, still retained as a basis of calculation for English horse-power—*i.e.*, 1 h.p. will lift 33,000lb. 1ft. high (at London) in one minute. All the rules which have been brought forward for nominal horse-power from time to time are quite useless for scientific purposes, and they only give very imperfect estimates of the relative value of different engines. By Watt's rule, speed and pressure were constant values, whereas either one may be altered without material alteration in commercial value.

Indicated horse-power takes into consideration area, speed, and pressure, and may be defined as the measure of work done in the cylinder, as shown by the indicator diagrams, and is equal to (area of piston in square inches $\times$ mean pressure in pounds square inches $\times$ feet travelled by piston per minute) $\div$ 33,000 foot-pounds. Of course, with single-acting engines, travel of piston = stroke $\times$ revolution; with double-acting engines, twice this amount; with engines having more than one cylinder the indicated horse-power of each is determined separately, and the sum of these is the indicated horse-power of the engine.

Actual horse-power has no definite meaning. Sometimes indicated horse-power is referred to as actual horse-power; sometimes indicated horse-power + power absorbed in friction of indicator and connections, and often the actual output is referred to as actual horse-power, whether electrical, pumping, brake, or otherwise.

Electrical horse-power is the actual output of a dynamo, and is = (volts $\times$ amperes) $\div$ 746. Here 746 is the watts (slightly more than) equivalent to 33,000 foot-pounds, calculated from the erg (absolute unit of work C.G.S. system) 1 watt = 10,000,000 ergs per second = 0·738 foot-pound per second; 1 foot-pound = 13,540,000 ergs per minute; therefore 1 watt = $\frac{1}{746}$ h.p.

The French *force de cheval*, *cheval vapour*, or metric horse-power = 542·5 foot-pounds per second = 735 watts, or 0·987 h.p

Brake horse-power is the actual work done by an engine at the pulley, flywheel, or coupling, as the case may be, and is calculated from the basis of 33,000 foot-pounds. There are various forms of brakes for testing purposes, each having its own formulæ, but time does not allow me to particularise even one or two forms. Brake horse-power is the actual output of an engine over and above the power absorbed to overcome friction and other losses in the engine itself.

As to the relation of indicated horse-power, brake horse-power, and electrical horse-power to each other, these will, of course, differ according to the efficiencies of the engine and dynamo. But as an instance of a modern central-station set, let us suppose the indicated horse-power to be 300 non-condensing, then you may reasonably expect to get 276 b.h.p. under same conditions, or if this engine be coupled direct to a dynamo you could reasonably expect to get 253 e.h.p. under same conditions. This would be allowing 8 per cent. drop in engine and 9 per cent. drop in dynamo, and there are plenty of engines and machines doing this nowadays.

The electrical efficiency of a dynamo is the ratio of the useful energy to the total energy. The commercial efficiency of a dynamo is the ratio of the useful energy or output to the power actually absorbed in being driven. The former takes into consideration the current used for magnet coils, the resistance of armature and magnet coils, etc., from calculations according to type of dynamo. The latter also takes into consideration power absorbed by belts, journals, etc.—F. R. S.

Answer to No. 154 (*awarded* 7*s.* 6*d*).—Power in its engineering sense is a term used to express the co-relation of expended energy and the time in which it is engendered; in other words, a rate of doing work. The engineering unit of rate of doing work is the horse-power, which represents an expenditure of 33,000 foot-pounds of energy in one minute.

The indicated horse-power of an engine is ascertained by multiplying together the average steam pressure (P) per square inch of piston, the area (A) of piston and the velocity of piston in feet per minute (number of steam strokes $\times$ length of stroke = N $\times$ L), and dividing by 33,000 to bring it to engineering units of power. Or in symbols,

$$\text{I.H.P.} = \frac{\text{P L A N}}{33{,}000}.$$

The indicated horse-power of an engine, therefore, is the actual power developed in the cylinder, and therefore, when compared with the actual or brake horse-power as found by experiment, it forms a very reliable guide to the merits of its performances. To find the average pressure on the piston, it is necessary to take indicator diagrams and calculate it from them in the familiar manner.

The actual or brake horse-power of an engine is the power actually available for doing work at its pulley. It is equal to the indicated horse-power—the power lost in friction, etc., in the mechanical structure of the machine. In a good modern simple non-condensing engine the brake horse-power may be equal to anything up to 75 per cent. of the indicated horse-power. Owing to the complicated paraphernalia of pumps, shafting, and propeller which have to be driven in a marine engine, it is very much less, usually about 50 per cent. of the indicated horse-power.

Nominal Horse-Power.—This is a term which, though still retained in a few classes of machines, such as those for agricultural purposes, is gradually, and very rightly, getting into disuse. It is one of the few legacies of Watt which we could very well get on without—it merely gives in a round-about manner the approximate effective area of the piston of an engine for which it is quoted. In Watt's days the standard average steam pressure was 7lb. per square inch, and the average piston speed 220ft. per minute. This being assumed one could easily calculate, knowing the diameter of the cylinder, the nominal horse-power—a number which in those days would approximate very closely to the indicated horse-power. In a modern high-pressure engine, to designate it by its nominal horse-power would give no definite idea of its power—it would, in fact, be very much less than its indicated horse-power. The term, however, is happily nearly extinct. It is better for every reason to express the diameter of the cylinder in inches.

Electrical Horse-Power.—Electrical power is measured in units which are called kilowatts. A current of one ampere flowing under a pressure of one volt does work at the rate of one watt. For the same reason as mechanical engineers use horse-power instead of foot-pounds per minute, the electrical engineer uses the kilowatt in preference to the watt.

Units.—A current of one ampere flowing under a pressure of one volt for one minute does one joule, or ·7474 foot-pound, of work. That being known, it is easy to calculate the numerical relation between an electrical and a mechanical horse-power; they are as 1·34 to 1, or 746 watts = 1 h.p.

The *Electrical Efficiency* of a dynamo is the numerical relation that the energy given out at the terminals bears to that actually generated in the armature of the machine. This efficiency (which is usually very high—98 to 99 per cent. being attainable in the best examples) is given for all kinds of dynamos by dividing the energy given out at the terminal by itself + the C^2 R or heat losses in the armature and fields. The three following formulæ give the efficiencies of shunt, series, and compound dynamos:

Series— $$\frac{C \times E}{C \times E + C^2 (R_a + R_s)}.$$

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Shunt—

$$\frac{C \times E}{C \times E + \frac{E^2}{R_{sh}} + \left(C - \frac{E}{R_{sh}}\right)^2 \times R_a}.$$

Compound—

$$\frac{C\,E}{C \times E + C^2\,R\,S + \frac{E^2}{R_{sh}} + \left(C - \frac{E}{R_{sh}}\right)^2 . R_a}.$$

Where C = current at 'bus bars;
E = E.M.F. at 'bus bars;
R_a = resistance of armature;
R_s = resistance of series coils;
R_{sh} = resistance of shunt coils.

The *Commercial Efficiency* takes into account not only the C^2 R losses, but also all those losses due to friction, eddy currents, hysteresis, armature reactions (such as due to partial demagnetisation of fields by interaction of armature coils outside polar embrace), sparking at brushes, etc., and all the other thousand and one losses which tend to differentiate between the power actually put in at the pulley of the machine and the energy actually got out at the 'bus bars. To find it from the equations given above scientifically with any accuracy would be impossible, but formulæ, empirical, no doubt, but very accurate, are known to those who are accustomed to their manufacture in standard patterns and sizes. Assuming, however, that a certain definite number of watts (W) are lost otherwise than in C^2 R losses in the machine, the *commercial efficiency* may be found by adding W to the denominator of the fraction obtained for the electrical efficiency of the unit under consideration. The commercial efficiency of a series dynamo, therefore,

$$= \frac{C \times E}{C\,E + C^2\,(R_a + R_s) + W}.$$

—H. F.

THE FULHAM TENDERS.

The following is Mr. F. H. Medhurst's report to the Electric Lighting and Dust Destructor Committee on the tenders for the electric lighting works:

I have most carefully examined all the tenders sent in, and I have already sent in a statement in which all the tenders have been analysed. I do not, therefore, in this report intend to repeat that statement and analysis, though in what follows I shall frequently refer to them.

In the first place, an examination of the statement to which I have referred clearly shows that the reasons why the General Electric Company have sent in the lowest tender is that their tender for the work in connection with the river pipes is by far the lowest. As the whole contract is out of all proportion, much more important than this particular section of it, I am very strongly of opinion that the river pipe work should be eliminated from all the tenders, and that a comparison between them should then be made. The Vestry might, with advantage, ask for fresh tenders from four or five of the principal firms who make a speciality of this kind of work, and the section should, I think, be taken out of the contract for electrical equipment altogether, because, if it be allowed to remain in, we are face to face with a totally unjust basis on which to compare the tenders.

With the river pipe section eliminated, we have the following figures:

Brush Company	£44,782	0	0
General Electric Company	44,968	7	10
British Insulated Wire Company	45,024	8	6
Johnson and Phillips	46,702	6	0
Ferranti, Limited	47,339	17	2
Fowler and Co., Limited	48,773	2	6

The Brush Company state in their letter accompanying their tender that they are not prepared to adhere to the "penalty" clause, as stated in the specification; and, as one of the main advantages in having one contractor for the whole job is that you have a substantial firm guaranteeing the punctual performance of the whole contract, I am of opinion that the Brush Company's tender is disqualified owing to their non-compliance with the condition to which I have referred. With the Brush Company disqualified, the next lowest is that of the General Electric Company of £44,968. 7s. 10d. In analysing the tenders, it occurred to me that it would be interesting to ascertain what the result would be if the contract was split up into two, and if everything except the cables were given to one contractor, and the mains or cables given in a separate contract.

If Section IX.—*i.e.*, mains—be treated as a separate contract, and Section III.—*i.e.*, river pipes—be eliminated for the present, we have the following figures for the remainder of the work:

Johnson and Phillips	£29,862	0	0
General Electric Company	30,159	0	0
Brush Company	30.255	14	11
British Insulated Wire Company	30,771	10	0
Ferranti, Limited	33,086	18	10
Fowler and Co.	34,294	16	8

Now, taking Section IX. separately, we have the following figures:

Ferranti, Limited	£14,252	18	4
British Insulated Wire Company	14,252	18	6
Fowler and Co.	14,478	5	10
Brush Company	14,526	5	1
General Electric Company	14.809	5	6
Johnson and Phillips	16,840	6	0

I have carefully checked all the schedules, and I find that the British Insulated Wire Company have made a mistake in their total, which should stand at £14,152. 18s. 6d., thus making their tender the lowest.

Now, if we add the amount of the lowest tender for plant—*i.e.*, Johnson and Phillips, for £29,862—to the lowest tender for mains—*i.e.*, the British Insulated Wire Company, for £14,152. 18s. 6d.—we have a total of £44,014. 18s. 6d. The lowest tender, including mains, but eliminating river pipes, was that of the Brush Company, and, as they have disqualified themselves, the lowest practicable tender was that of the General Electric Company for £44,968. 7s. 10d., so that by splitting the whole scheme into two contracts there is a direct saving to the Vestry of just over £950—a saving which, in my opinion, ought to be made. The contractors for the mains cannot possibly clash with the contractors for the remainder of the work, because the two will be carrying out their operations at different parts of the parish, and in a different manner. Both contractors are sufficiently large to enable the Vestry, in case of delay, to levy a very considerable weekly fine of 1 per cent. per week, which, even on the amount of the cable contract, amounts to a considerable sum. There is not much more trouble in dealing with two contractors than in dealing with one, though there is a great deal more trouble in dealing with six or seven contractors than in dealing with one.

Messrs. Johnson and Phillips have tendered for steam turbines, and they are the only firm that have done so. I gave contractors considerable latitude in the specification I have prepared with a view to enabling them to tender for the type of engine which they themselves considered to be absolutely the best under the circumstances. The output, the efficiency—in a word, the performance—were most carefully specified, but I wished the Vestry to get the very best possible value for the money it was spending, and, therefore, I did not too rigorously insist upon matters of minor detail. The steam-turbine is working successfully in many town lighting installations in London and in the provinces. It is as efficient as, and less expensive than, any other type of steam-engine working condensing and with superheated steam, and as Messrs. Johnson and Phillips have taken upon themselves the responsibility of guaranteeing its performance in accordance with the terms of the specification issued to them, I have no hesitation in recommending you to accept Messrs. Johnson and Phillips's tender for everything except the mains, and the British Insulated Wire Company's tender for the mains. I should advise you to allow me to issue fresh specifications to four or five selected firms for the river pipe work, and to let that part of the job be tendered for afresh, separately. This will occasion no delay in the completion of the whole scheme, because the remainder of the contract will take much longer to carry out than the laying of river pipes for the condensers. I may mention that the adoption of steam-turbines will result in a saving of at least £1,200 to £1,500 in foundations for the engines. Messrs. Ferranti, Limited, tendered alternately for supplying engines of their own manufacture at a reduction of £2,921 in the engine section. I have recently seen engines of Messrs. Ferranti's design working most successfully, and I consider that, next to the tender of Messrs. Johnson and Phillips, Messrs. Ferranti's alternative tender, which would bring their price from £33,086. 18s. 10d. down to £30,165. 18s. 10d., is the most favourable.

The following is the statement referred to in the above report (where no sub-contractor is given the plant is the firm's own make):

Pipes.

General Electric Company, Limited £3,121 0 0
Sub-contractors.—Hopkinson and Co., Alley and Maclellan, Stewart and Clydesdale, Holden and Brooke, A. C. Wells and Co., J. J. Royle.

Brush Company, Limited 3,139 0 0
Sub-contractors.—Hopkinson and Co., Alley and Maclellan, Stewart and Menzies, Holden and Brooke, Berend and Co., Edwards and Bardes.

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Ferranti, Limited £2,850 5 0
Sub-contractors.—Hopkinson and Co., Glenfield and Co., Babcock and Wilcox, Holden and Brooke, Wells and Co., Stewart and Menzies.
Johnson and Phillips 3,246 0 0
Sub-contractors.—Hopkinson and Co., Glenfield and Co., Stewart and Menzies, Babcock and Wilcox, Holden and Brooke, Wells and Co.
Fowler and Co., Limited 2,703 0 0
Sub-contractors.—Hopkinson and Co., Glenfield and Co., Stewart and Clydesdale, Holden and Brooke, Wright and Co., Berend and Co.
British Insulated Wire Company, Limited 2,880 0 0
Sub-contractors.—Hopkinson and Co., Glenfield and Co., Stewart and Menzies, Babcock and Wilcox, Holden and Brooke, Wells and Co.

Condensing Plant.

General Electric Company, Limited £2,024 0 0
Sub-contractors.—Korting Bros., W. G. Jons, Alley and Maclellan, Stocks and Co.
Brush Company, Limited..... 2,189 15 1
Sub-contractors.—Korting Bros., W. H. Allen and Co., Alley and Maclellan, Bailey, Pegg, and Co., Thorncliffe Ironworks.
Ferranti, Limited 2,480 17 0
Sub-contractors.—Korting Bros., J. and H. Gwynne, Parker or others, Glenfield and Co., Babcock and Wilcox.
Johnson and Phillips..... 2,439 0 0
Sub-contractors.—Korting Bros., Gwynne and Co., Babcock and Wilcox.
Fowler and Co., Limited 1,831 0 0
Sub-contractors.—Korting Bros., Jackson, Blake and Knowles, Staveley Iron Foundry.
British Insulated Wire Company, Limited 2,214 0 0
Sub-contractors.—Korting Bros., J. and H. Gwynne, Johnson and Phillips, Glenfield and Co., Babcock and Wilcox.

River Pipes.

General Electric Company, Limited £750 0 0
Sub-contractor.—Stocks and Co.
Brush Company, Limited 2,500 0 0
Sub-contractor.—John Aird and Co.
Ferranti, Limited 2,000 0 0
Sub-contractor.—Not certain.
Johnson and Phillips..... 3,225 0 0
Sub-contractor.—J. Aird and Son.
Fowler and Co., Limited 2,042 0 0
Sub-contractor.—G. Munday and Sons.
British Insulated Wire Company, Limited 6,500 0 0
Sub-contractors.—Kirk and Randall, but probably British Insulated Wire Company, Limited.

Steam Alternators.

General Electric Company, Limited £13,603 0 0
Sub-contractors.—Musgrave, General Electric Company, Willans and Robinson.
Brush Company, Limited..... 12,255 0 0
Sub-contractors.—Mirrlees, Watson, and Co. (for exciter engines), Brush Company, Limited.
Ferranti, Limited 15,824 0 0
Sub-contractors.—Willans and Robinson, Bruce Peebles or Parker, Limited, Yates and Thom, and own make.
Johnson and Phillips..... 12,124 0 0
Sub-contractor.—C. A. Parsons and Co.
Fowler and Co., Limited 17,229 0 0
Sub-contractor.—Belliss, for exciter engines and own make steam alternators.
British Insulated Wire Company, Limited 14,483 2 6
Sub-contractors.—Musgrave and Co., General Electric Company, Limited, Willans, Johnson and Phillips.

Switchboards.

General Electric Company, Limited £1,896 0 0
Sub-contractor.—Ferranti, Limited.
Brush Company, Limited 2,228 2 6
Sub-contractors.—Various high-class firms for instruments.
Ferranti, Limited (less connections) 1,807 2 6
Johnson and Phillips..... 1,736 0 0
Fowler and Co., Limited 2 705 5 0
Sub-contractors.—Nalder and Elliott Bros.
British Insulated Wire Company, Limited 1,660 0 0
Sub-contractors.—Johnson and Phillips, Verity's, Elliott Bros., or others.

Softening Plant.

General Electric Company, Limited £1,295 0 0
Brush Company, Limited..... 1,295 0 0
Ferranti, Limited 1,295 0 0
Johnson and Phillips..... 1,462 0 0
Fowler and Co., Limited 1,360 0 0
British Insulated Wire Company, Limited 1,575 0 0
W. G. Atkins is the sub-contractor for each firm.

Crane.

General Electric Company, Limited £398 0 0
Sub-contractor.—Higginbottom and Mannock.
Brush Company, Limited 379 10 0
Sub-contractor.—Marshall, Fleming, and Jack.
Ferranti, Limited 399 0 0
Sub-contractor.—Spencer and Co.
Johnson and Phillips..... 452 0 0
Sub-contractors.—Chatteris Engineering Company, Limited.
Fowler and Co., Limited 440 0 0
Sub-contractor.—Stothert and Pitt.
British Insulated Wire Company, Limited 398 0 0
Sub-contractor.—Higginbottom and Mannock.

Mains.

General Electric Company, Limited £14,809 5 6
Sub-contractors.—Henley's and British Insulated Wire Company, Limited.
Brush Company, Limited 14,526 5 1
Sub-contractor.—British Insulated Wire Company, Limited.
Ferranti, Limited 14,252 18 4
Sub-contractor.—British Insulated Wire Company, Limited.
Johnson and Phillips..... 16,840 6 0
Fowler and Co., Limited 14,478 5 10
Sub-contractor.—British Insulated Wire Company, Limited.
British Insulated Wire Company, Limited 14,252 18 6

Transformers.

General Electric Company, Limited £1,743 0 0
Sub-contractor.—Johnson and Phillips.
Brush Company, Limited..... 2,169 10 0
Ferranti, Limited 2,351 0 0
Johnson and Phillips..... 1,835 0 0
Fowler and Co., Limited 1,970 0 0
British Insulated Wire Company, Limited 1,600 0 0
Sub-contractors.—Johnson and Phillips, or British Thomson-Houston Company.

Arc Lamps.

General Electric Company, Limited £3,452 5 6
Sub-contractor.—Johnson and Phillips.
Brush Company, Limited..... 3,968 7 0
Sub-contractor.—Crompton and Co.
Ferranti, Limited 3,512 15 10
Sub-contractor.—Johnson and Phillips.
Johnson and Phillips..... 3,596 0 0
Fowler and Co., Limited 3,492 6 6
Sub-contractor.—Johnson and Phillips.
British Insulated Wire Company, Limited 3,303 10 4
Sub-contractor.—Crompton and Co.

Disinfector.

General Electric Company, Limited £1,476 6 10
Brush Company, Limited..... 1,480 10 4
Ferranti, Limited 1,470 18 6
Johnson and Phillips 1,672 0 0
Fowler and Co., Limited 1,468 5 2
British Insulated Wire Company, Limited 1,406 15 2
Defries is the sub-contractor for each firm.

TOTALS.

General Electric Company, Limited £45,718 7 10
Brush Company, Limited..... 47,282 0 0
Ferranti, Limited 49,339 17 2
Johnson and Phillips 49,927 6 0
Fowler and Co., Limited 50,815 2 6
British Insulated Wire Company, Limited 51,524 8 6

The committee have recommended the Vestry to accept the lowest tender—that of the General Electric Company, Limited, whose price is £44,968. 7s. 10d., subject to the design of their dynamos being deemed satisfactory.

COMPANIES' MEETINGS AND REPORTS.

ORIENTAL TELEPHONE AND ELECTRIC COMPANY, LIMITED.

The directors in their report for the year ended Dec. 31, 1898, state that the revenue account shows a balance to credit of £10,955. 3s. 9d. transferred to profit and loss. Including the sum of £964. 8s. 3d. brought forward from 1897, and after deducting £2,858. 8s., the amount of interim dividend paid in November last, there remains £9,061. 4s. for disposal. The directors propose to deal with this sum as follows: to pay a final dividend of 8d. per share, free of income tax, making 5 per cent. for the year, to transfer £2,000 to reserve, and carry forward £1,344. 8s. With regard to the Indian subsidiary companies, the Bombay Company has again paid 6 per cent. for the year, whilst the Bengal Company has paid 5 per cent., as against 7 per cent. for the previous year, carrying forward Rs.20,000 as a precautionary measure

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against possible temporary outlay. The Telephone Company of Egypt has declared its usual dividend of 6 per cent. on its preferred shares. The company has recently entered into an agreement with the Government of Egypt to continue the Government telephone service for a period of 25 years from Jan. 1 current. Its business in general progresses favourably. The China and Japan Telephone Company has paid its debenture interest, but its accounts for the past year have not yet been audited. They point, however, to a larger surplus than in previous years. With a view to improving the telephone service at Shanghai, which would have involved a large expenditure of money, the directors of that company, through its local manager, approached the Council of the Shanghai Settlements some years ago in order to obtain, if possible, a prolonged term of concession so as to justify the outlay. The Council has now decided to grant a 30 years' concession, but has invited tenders by public advertisement. The directors of the China and Japan Telephone Company have sent in a tender, but the result so far is not known. The electric lighting branch of the Company's business shows a small surplus, which has been carried meantime to a suspense account to provide for expenses in connection with a change of management now being proceeded with in Calcutta.

NATIONAL ELECTRIC FREE WIRING COMPANY, LIMITED.

An extraordinary general meeting of this Company was held at the offices, Charing Cross-road, on Wednesday.

Mr. R. Stewart-Bain presided, and said the meeting was called for the confirmation of the following resolution passed on the 24th ult.; "That the name of the Company be and it is hereby altered from the National Electric Free Wiring Company, Limited, to the National Electric Wiring Company, Limited." He now moved a resolution to that effect.

This was seconded by **Mr. W. R. Davies** and carried.

The proceedings then terminated.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY.

The report of the directors for the half-year ended Dec. 31 last, to be submitted to the half-yearly meeting on 26th inst., gives the gross receipts for the half-year as £290,431, against £275,142 for the corresponding period of 1897. The expenses, including £26,045 for cost of repairs to cables and expenses of ships, were £100,086 (£102,845), leaving a balance of £190,345. Deducting £4,699 for income tax, £31,921 for interest on debentures, debenture stock, and contribution to sinking fund, etc., the net profit for the half-year amounts to £153,725, which, with £10,723 brought forward, shows an available balance of £164,448. One quarterly interim dividend of 1¼ per cent. has been paid for the half-year, and another of like amount is now proposed, making a total dividend of 5 per cent. It is also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year 1898. The balance of £51,948 has been transferred to the general reserve fund. During the half-year £56,806 has been spent in gradually renewing weak portions of the Company's system. Having been advised that, according to international law the United States are bound to take over the obligations which Spain entered into with the Company in regard to telegraphic communication in the Philippines, the necessary representations have been made through diplomatic channels to the Government of the United States on the subject. Owing to the insurrection in the Philippines, the Company were for a short time compelled to close all their stations in the islands of Panay, Negros, and Cebu, and to withdraw the staff to Manila. The Panay-Negros cable has since been reopened for public traffic, and by arrangement with the Government of the United States the Company's Manila-Capiz cable has been extended to Ilo-Ilo direct, thus making the latter communication independent of the unsatisfactory land lines between Capiz and Ilo-Ilo.

ANGLO-ARGENTINE TRAMWAYS COMPANY.

The report of the directors for the year 1898, to be presented to the meeting on 28th inst., states that the receipts for the year were £240,846, as against £212,602 in 1897. The working expenses were £168,410 (£155,768). The net profit was £72,436 (£56,834), and this added to the amount brought forward, £1,634, makes a total of £74,070. Deducting interest on debenture stock, £13,800, and interim dividend (1s. 6d. per share), £19,500, an available balance of £40,769 (£26,135) is left. Out of this the directors recommend a dividend of 2s. 3d. per share, free of income tax, absorbing £29,251; reserve fund, £10,000; £1,518 is to be carried forward to the next account.

LEGAL INTELLIGENCE.

POWELL v. THE EASTERN TELEGRAPH COMPANY, LIMITED.

In this action, heard in the Queen's Bench Division before Mr. Justice Wills and a special jury, Mr. William Frederick Powell, of 27, Cathcart-hill, Junction-road, N., sought to recover damages from the defendant company for wrongful dismissal and arrears of salary due to him.

Mr. Rawlinson, Q.C., and Mr. H. Tindal Atkinson appeared for the plaintiff; and Mr. Witt, Q.C., and Mr. Roskill were for the defendant company.

The plaintiff, who had been in the service of the defendants since 1879, entered into a written contract with them in 1891 for five years' service at home or abroad. Under this he was entitled to three months' notice if the defendants wanted to terminate his engagement. Under one of their rules, after five years of uninterrupted service abroad the employé became entitled to four months' furlough at home on full pay. In 1893 the plaintiff was sent to Gibraltar and subsequently to Alexandria, where he stayed till last year. While at Alexandria his health failed, and he suffered from dyspepsia and insomnia. Consequently, having completed five years of service, he applied for four months' furlough in accordance with the rules, which was duly granted. This leave expired on Sept. 6. His health not having improved during his holiday, he consulted Dr. Peyton, of Newport, where the plaintiff's father resided, and he advised him that he was not in a fit state to go abroad. The plaintiff thereupon asked to be transferred temporarily to an English station. The company then sent their own doctor to examine him. Accordingly the defendants' doctor saw the plaintiff and prescribed for him, and the plaintiff returned to his home at Newport. On Sept. 7 he received a letter from the secretary of the company intimating that his leave had expired, and the company's doctor having reported him fit for duty he was to proceed at once to Gibraltar. He thereupon sent to the defendants his own doctor's certificate to the effect that he was not in a fit state to leave England. The company replied that they could only accept their own doctor's certificate, and, after some further correspondence, the plaintiff declined to enter into a fresh agreement for five years, and was on Oct. 10 dismissed from the company's employment.

Dr. Peyton, of Newport, Monmouthshire, said he attended the plaintiff in September last, and in his opinion he was not fit to do work, either at home or abroad, as he was suffering from acute dyspepsia and insomnia.

For the defendants, **Dr. Arthur Cæsar**, acting medical officer to the Eastern Telegraph Company, was called. He said he saw the plaintiff on Sept. 2 and 5, and he complained of dyspepsia and insomnia. Witness, however, was of opinion he was in good health, and thought he was quite fit for duty when he examined him.

Evidence was also given that the original rules, as supplied to the plaintiff in 1891, had been amended, and it was provided that privilege leave was only granted on condition that the employé returned to his station for a further period of service, and the company reserved to itself the right to recover the amount of salary paid to an employé on leave should he fail to return to his station on the expiration of his leave. It had been found necessary to make this new rule, as clerks had been in the habit of taking their four months' furlough on full pay and then declining to return to their stations abroad. A copy of the rule was posted up in the office in Cornwall while the plaintiff was there, and it was suggested that he knew the rule, and as he declined to contract for a further period of service, the defendants were justified in dispensing with his services.

The jury found that the order given to the plaintiff to go to Gibraltar was an unreasonable one, and that he did not know of the new rule which required employés on coming home on furlough to enter into fresh agreement for service with the company.

On these findings judgment was given for the plaintiff for £112, the amount claimed.

BRADFORD AND LEEDS LIGHT RAILWAY ORDER.

An important appeal came before Sir Courtenay Boyle at the Board of Trade on the 19th inst.

The Power and Traction Company proposed to make a light railway, 5½ miles long, between Leeds and Bradford, but, both towns objecting to an independent company coming within their boundaries, the Light Railway Commissioners sanctioned only a mile and a half, which would connect the two towns with the proposed extensions of tramways. Both Leeds and Bradford have Bills in Parliament this session to make lines practically to take the place of the light railway, but Bradford has agreed to purchase the order and make the line if it is sanctioned by the Board of Trade.

Mr. Pembroke Stephens submitted, on behalf of Leeds, that the proposed line connecting the three miles of tramways of Leeds by a mile and a half loop line joining on to two miles of tramway of Bradford could not be a light railway, but a tramway, which ought to be sanctioned by Parliament under the Tramways Act, and not under the Light Railways Act.

Mr. Balfour Browne, Q.C., said if such schemes as this had to be sanctioned by Parliament, with its consequent expense, then the Light Railways Act would be no use.

Sir Courtenay Boyle asked if there was a precedent for a municipality making a tramway out of its own boundary.

Mr. Balfour Browne replied that only on Tuesday a committee of Parliament had sanctioned Glasgow Corporation making seven or eight miles of tramway outside its own boundary.

Sir Courtenay Boyle said the questions raised were too important for him to decide on that occasion. They would have to be carefully weighed by the Board, and he would inform the parties when a determination of the points had been arrived at.—*The Times.*

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Ealing.—The District Council require tenders for two boilers and a complete set of steam-pipes.

Salford.—The Electric Light Committee invite tenders for concentric lead-covered cables by 28th inst.

Grimsby.—The Council have decided to place a motion on the agenda paper inviting tenders for the electric lighting scheme.

Harrogate.—The Electric Light Committee are requiring a large amount of 3in. iron piping for mains, and 2,000 tons of coal.

Reigate.—The Town Council are prepared to receive tenders for the supply and erection of various electric plant. Tenders by May 1.

Edinburgh.—The Corporation are prepared to receive tenders for a 12 months' supply of coal, carbons, and pipes. Tenders by April 24.

London.—The County Council invite tenders for the supply for one year from July 1 of engineers' goods and electrical stores. Tenders by 24th inst.

Epsom.—The Urban District Council are prepared to receive tenders for the supply and erection of various electric plant. Tenders by 12 o'clock noon on May 8.

Belfast.—The Electric Committee are prepared to receive tenders for laying conduits, building junction boxes, and laying cables. Tenders by 12 noon on April 27.

Newport (Isle of Wight).—The Committee of Visitors of the County Asylum invite tenders for the supply of a combined engine and dynamo. Tenders by April 29.

Darlington.—The Corporation invite tenders for the supply and delivery of various plant, together with the fixing of the same, at their electric generating station. Tenders by May 8.

St. Marylebone.—The Guardians invite tenders for electric light wiring and fittings for the new front blocks of their workhouse, Northumberland-street, W. Tenders by 10 a.m. on May 8.

Hull.—The School Board invite tenders for an adequate installation of the electric light at their central higher-grade school and school of science in Brunswick-avenue, Beverley-road. Tenders by 25th inst.

St. Pancras.—The Vestry are prepared to receive tenders for supplying and fixing additional plant at the Regent's Park electricity works, comprising dynamos, engines, etc. Tenders by 12 o'clock noon on May 16.

Poplar.—The Board of Works invite tenders for engine and pump room equipment and all electrical plant in the works except the battery, boiler-house equipment, battery and battery stands, and public street lighting. Tenders by 10 a.m. on April 25.

Bolton.—The Bolton Corporation invite tenders for the work required in laying the tramway rails in Lostock and Horwich. Specification, etc., may be obtained from the borough surveyor, Mr. W. H. Brockbank, Town Hall, Bolton. Tenders by May 1.

Morley.—The Corporation invite tenders for the wiring and fittings required at their public baths, Fountain-road, Morley. Specifications, etc., may be obtained from the architects, Messrs. Holtom and Fox, on payment of a deposit of £1, which will be returned on receipt of a bona fide tender. Tenders by 4 p.m. on 26th inst.

Dundee.—The Dundee Gas Commissioners invite tenders for the excavation, brick and mason, carpenter and joiner, slater, plumber, plaster, and iron work of roofs of additions to electric lighting station, Dudhope-crescent-road. Particulars may be obtained from Mr. William Alexander, city architect. Tenders by 27th inst.

Almodovar del Campo (Spain).—Tenders are invited for the installation of electric light and the working of same for 20 years. The deposit is £100. The annual income is estimated at £400 Tenders may be addressed to the Ministerio de la Gobernacion, Madrid, or to the municipal authorities at the above place, province of Ciudad Real, by May 5.

West Ham.—The County Borough Council invite tenders for two 1,500-i.h.p. engines, two 800 kw. alternators and exciters, or two 800-kw. 1,500-i.h.p. steam alternators and exciters. Specification, etc., may be obtained from the Borough Electrical Engineer, Abbey Mills, West Ham, on the deposit of a £5 Bank of England note, which will be returned on receipt of a bona fide tender. Tenders by 4 p.m. on April 25.

Hampstead.—The Vestry invite tenders for the supply, delivery, and erection of electrical plant, including steam alternators and engines, switchboard panels, boilers, feed-water heaters, vertical steam feed pumps, exciter, water-softening plant, air pump and condenser, Green's economiser, and overhead travelling crane. Particulars may be had of Mr. A. P. Johnson, vestry clerk, to whom tenders must be sent by 12 noon on May 18.

London, S.W.—The Vestry of St. Mary, Battersea, invite tenders for the supply and erection and the carrying out of work in connection with the electric lighting of the parish to specifications as follows: (Specification No. 1) feeders, distributing mains, and arc light leads, including laying and jointing; (2) water-tube boilers; (3) steam dynamos and engines. Specifications, etc., may be obtained from the Vestry Clerk, at the Municipal Buildings, Lavender-hill, S.W., on payment of £3. 3s. for each specification, etc., which sum will be returned after the receipt of the specification, etc., accompanied by a bona fide tender. Specifications and drawings can also be seen at (but not obtained from) the office of Prof. Alex. B. W. Kennedy, 17, Victoria-street, Westminster. Tenders by 12 noon on June 7.

Blackpool.—The Tramway Committee invite tenders for the taking up of the tramway line and conduit and the relaying of new tramway lines on the carriage drive between Church-street and Adelaide-street. Specification, etc., may be obtained from Mr. J. Wolstenholme, borough engineer, St. John's Market-buildings, on deposit of £1, which will be returned on receipt of a bona fide tender. Tenders by noon on 24th inst.

Southampton.—The Corporation of Southampton invite tenders for the reconstruction of about 1¾ miles of tramway on the Shirley route. Specifications, etc., may be obtained and plans inspected on or after 30th inst. at the offices of the consulting engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of £3. 3s., which will be returned on receipt of a bona fide tender. Tenders before noon on May 2.

Perth.—Applications will be received at the City Council Office from persons desirous of applying for a concession for the installation and working of a system of electric lighting for the municipal buildings and streets of the city of Perth, as well as house-to-house lighting. Conditions of contract and full particulars may be obtained on application to the Agents-General for Western Australia, 15, Victoria-street, Westminster, London, or Gordon and Gotch, St. Bride-street, Ludgate-circus, E.C. Tenders by May 2.

Egremont.—The Wallasey Urban District Council invite tenders for the supply for 12 months from June 30 of the following stores required for the use of the gas, water, and electrical works: paper-insulated concentric cables, oils, lead and wrought-iron pipes, cast-iron main pipes, cotton waste, meters (gas, water, and electricity), lamp columns and lamps, main switches, and cut-outs. Particulars, etc., may be obtained at the Gas and Water Engineer's Office, at the Works, Great Float, near Birkenhead. Tenders by 24th inst.

RESULTS OF TENDERS.

Bolton.—The Electricity Committee have accepted the tender of Mr. R. W. Kenyon for the supply of electric casings and coverings.

Winchester.—The City Council have accepted the tender of Messrs. E. H. Gudgeon and Co., of Lewisham, at £98. 17s. 9d., for electric light installation at the Guildhall and clock tower.

Basingstoke.—The tender of the National Telephone Company, Limited, for an electric call bell system, at the sum of £65, has been accepted subject to the company maintaining same for 12 months.

Southampton.—The Corporation have accepted the tender of Messrs. Lankester and Sons, Limited, at £599. 15s., for the works and fittings in connection with the electric supply to the isolation hospital.

Newquay.—The Directors of the Atlantic Hotel have accepted the tender of H. Jenkin for erecting an engine-house in Beacon-terrace; Wilson and Co., St. Austell, for electric light installation for the hotel.

Southampton.—The Corporation have accepted the tender of the Leeds Steelworks Company for the supply of 1,200 tons of rails and fishplates required for the reconstruction of the tramways at £7. 5s. per ton.

Derby.—The Corporation have accepted the tender of H. Vernon, Derby, for the works in excavations, foundations, engine-bed, and retaining wall in connection with extensions to the electric lighting station, Derby.

Gloucester.—We referred last week to the acceptance of the tender of the British Insulated Wire Company, Limited, for the contract for public lamps. We are now informed that the tenders for this section of the work are still under consideration.

Lynn.—The Town Council have received the following tenders for the supply of meters: Aron Meter, £5. 10s.; Thomson-Houston, £5. 6s.; Ferranti, £5. 5s.; Long Schattner, £4. It was decided to order 50 Ferranti and 20 Long Schattner meters.

Morley.—The following tenders have be accepted: Mrs. Naylor, covering accumulator-room floor with lead, £35. 10s.; Electrical Engineering Company, for an alternate motor dynamo and direct-coupled plant, £148. 10s.; Anti-Vibration Incandescent Gas Company, Bradford, 12 sets of incandescent fittings, £6.

Beckenham.—The Electric Lighting Committee have received the following tenders for dust destructor: Manlove, Alliott, and Co., Nottingham; W. F. Mason and Co., Manchester; Goddard, Massey, and Warner, Nottingham; Beaman and Deas, Victoria-street, S.W.; and Horsfall Furnace Syndicate, Leeds.

Coventry.—The Corporation have received the following tenders for the various works required in extension of the buildings of the electricity works, Sandy-lane:

Kelley and Son, Foleshill, near Coventry (accepted)...	£1,843	7	6
I. Isaac and Sons, Foleshill, near Coventry	1,941	1	5
C. H. Barber, Bishop-street, Coventry	1,993	0	0
C. Garlick, Far Gosford-street, Coventry	2,221	0	0
C. G. Hill, Much Park-street, Coventry	2,793	3	1

Burton.—The Town Council have received the following tenders for wrought-iron roofs and other ironwork at the electric light works: W. C. Holmes and Co., Huddersfield, £687. 0s. 11d.; J. Tildesley, Willenhall, £685; Cross and Cross, Walsall, £655; E. Cockney and Sons, Limited, Frome, £557. 7s. 9d.; Filer and

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Wildbore, Burton, £538. 8s.; Gough and Felgate, Burton, £529. 18s. 8d.; Westwood and Wright, Brierley Hill, £496. 8s. (accepted).

Barking.—The Urban District Council have received the following tenders for the supply and erection of plant:

Sunderland Forge Company (accepted)	£945
Bruce Peebles and Co. (Alley and Maclellan engine)	975
Foote and Milne	1,002
Mavor and Coulson	1,002
Foote and Milne (larger engine)	1,030
General Electric Company	1,058
Mavor and Coulson (larger engine)	1,168
Brush Electrical Engineering Company	1.226
Bruce Peebles and Co. (Willans engine)	1,247
Scott and Mountain	1,255
Musgrave (British Thomson-Houston dynamo)	1,374
Musgrave (Mather and Platt dynamo)	1 396
Brush Company (100-kw. set)	1 424
McClure and Whitfield	1,490
Electric Construction Company	1,546
G. Wailes and Co.	1.612
Willans and Robinson (Crompton dynamo)	1.657
Crompton and Co. (Willans engine)	1 790

BUSINESS NOTES.

Islington.—The extension of the public electric lighting is under consideration.

Lowestoft.—The plans for the proposed electric light station have been approved of by the Council.

Garston.—The Council's provisional order is being transferred to the Garston District Electric Lighting Company.

Bolton.—An application has been made to the Corporation for the supply of electric current to Smithfield, Lostock.

Aveling and Porter.—Messrs. Aveling and Porter, Limited, propose to extend their wharf at Strood-intra, Rochester.

Shrewsbury.—The Lighting Committee have decided to spend £4,139 for extension of the Corporation's electrical works.

Camborne.—Copies of the draft provisional order of the Camborne electric lighting have been served on the clerk.

Mile End.—The Vestry are instituting enquiries with a view of combining a dust destructor with their electric supply scheme.

West Ham.—A deputation from the Town Council has visited the systems of electric traction and electric lighting in Glasgow.

Manchester.—The estimates passed by the Tramways Committee for the ensuing year contain an item of £3,000 for sample electric tramcars.

Armagh.—The electric light engine at the asylum has been condemned, and is to be removed immediately. Another one will probably be purchased.

Teddington.—The District Council have resolved to apply to the Board of Trade for a provisional order for the supply of electricity to the district.

Wallsey.—Mr. R. H. Bicknell, C.E., has held an enquiry into applications of the Council to borrow £10,000 for the purposes of electric lighting.

Ross.—The Urban District Council are discussing the proposed application by private gentlemen of the town for a provisional order for supplying electric light.

Plymouth.—It is expected that the electric lighting works will be finished in about a month. The electrical engineer gives August as the date for the installation of the electric traction.

Camberwell.—The Guardians have had placed before them estimates for a new hospital. The estimate of the architect, Mr. Edwin T. Hall, for cost of all buildings includes £10,000 for electric plant.

Llanwrst.—In the notice *re* electric supply station in our issue of the 14th inst, it was reported that the dynamo was supplied by the Electrical Supply Company, instead of by the Electrical Company, Limited.

Grimsby.—Mr. McKenzie, the district manager of the National Telephone Company, has been asked to submit a scheme, sanctioned by his company, with reference to placing their wires underground.

British Columbia Electric Railway Company.—The preference share registers will be closed until the 30th inst. for the preparation of warrants for the interest on the 5 per cent. preference shares, payable on 1st prox.

Whitehaven.—The electrical engineer has been authorised to inspect the systems adopted in other towns, and to report on the repairs and renewals necessary to the private supply conductors, with an estimate of the cost of the work.

Maidstone.—At a special meeting of the Urban District Council a report and recommendation respecting the proposed scheme for providing electric light and a refuse destructor for the borough was referred back to the committee.

Salisbury.—The Salisbury Electric Light Company having entered into a contract with the National Electric Free Wiring Company, Limited, London, the latter company have commenced operations and opened a temporary office at Town Mill, Salisbury.

Huddersfield.—The Electric Lighting Committee have passed a resolution expressing their appreciation of the valuable assistance rendered by Sir James T. Woodhouse, M.P., for the part he had taken in bringing about the defeat of the General Power Distributing Company's Bill.

Bridgend.—At last week's meeting of the Urban District Council a letter, stating the terms upon which the English Industrials, Limited, Manchester, offered to take over the electric lighting order from Bridgend, was read and referred to the Finance Committee.

Walsall.—The Electric Lighting Committee have resolved to allow additional discounts for current: where the total yearly consumption reached 10,000 units, but not 15,000 units, 10 per cent.; where the total yearly consumption reached or exceeded 15,000 units, 12½ per cent.

Scarborough.—A letter from the Drake and Gorham Electric Traction Company, Limited, proposing an arrangement with the Corporation for the laying down and working of electrical tramways in the borough, has been referred to the Electric Tramways Sub-Committee to report upon.

Eastern Extension, Australasia, and China Telegraph Company, Limited.—The 473 debentures which were drawn by lot on April 11, 1899, will be paid off at par on July 1 next at Messrs. Barclay and Co., 54, Lombard street, E.C., after which date interest on them will cease.

St. James's and Pall Mall Electric Light Company.—The amount of electricity sold by the Company for the quarter ended March 25 is stated at 1,161,987 units, estimated to produce £21,061, as against 1,016,642 units which produced £20,036, for the corresponding period of last year.

Devonport.—At the last meeting of the Borough Council it was decided to proceed with the lighting of all the main roads in the outer wards by electricity forthwith. The capital outlay will be £7,000. It was further resolved to ask the electrical engineer (Mr. Furness) to bring up a report.

Ripley.—The District Council have appointed a committee to consider the advisability of the Council making its own gas or electric light, and distributing the same to Ripley and the adjacent villages, and a motion to apply for a provisional order to enable the Council to do so has been carried.

Removals.—Messrs. Sax, Slatter, and Co., Limited, electrical engineers and contractors, have removed to Foresters' Hall, Clerkenwell, E.C.—Mr. Godfrey Evans, civil and electrical engineer, has removed to Queen's-chambers (adjoining General Post Office), Queen street, Nottingham.

Carlisle.—In response to applications the Electric Committee have decided to extend the cables at an estimated cost of £674. The engineer has been instructed to obtain additional plant to the extent of £384, and to have fittings fixed for lighting the electric light station at a cost not exceeding £130.

Hackney.—The Vestry have received a communication from the Board of Trade stating that the application of the County of London (East) Electric Lighting Company would not be proceeded with. The Vestry will now proceed with their scheme for supplying the district with electricity.

Northampton.—A contract for free wiring has been sealed between the supply company and the National Electric Free Wiring Company, Limited, London. The Free Wiring Company have already commenced operations, and opened temporary premises at the electricity works Angel-lane, Northampton.

India.—The Viceroy has sanction the construction of 550 miles of tramway railways, with a gauge of 2ft. 6in., in the districts north and south of the North-West Provinces. A Laffan cable from New York announces that the Indian Government have ordered 45 locomotives from Philadelphia for the Indian mining districts.

Heckmondwike.—The Electric Lighting Committee are unanimously in favour of the adoption of an electric lighting scheme for the town, in accordance with plans prepared by Mr. Hawtayne, of London. Notice has been given of a proposal that the scheme be adopted, and steps taken for submitting it to the ratepayers.

Aberdeen.—Four arc lamps are to be erected at Queen's Cross at a cost of £130. It has also been arranged to light College-street by electricity. A letter from the National Telephone Company proposing that the Corporation should grant facilities, under the usual restrictions, for the laying of underground wires, is before a committee.

Stockport.—Messrs. McClure and Whitfield have received the order from the Corporation for their extension plant of two 140-kw. dynamos at 500 volts, with spare armatures, to be direct-coupled to Willans and Robinson engine. The first plant, consisting of three 56-kw. Mersey-Willans combinations, has now been completed some time.

Great Northern Telegraph Company, Limited, Copenhagen. The directors state that the net receipts for the year 1898, including the amount brought forward, were £378,723. After payment of debenture interest and interim dividend, £295,972 remains, out of which an extra dividend, making 12½ per cent. for the year, is proposed, leaving £61,417 to be carried forward.

Gateshead Tramways Bill.—Mr. J. W. Lowther has officially reported to the House of Commons from the Select Committee on Unopposed Bills on this Bill that the committee had examined the allegations contained in the preamble and amended the same so as to make it consistent with the provisions of the Bill as passed by the committee, and found the same as amended to be true.

Newcastle.—In the event of the Tramways Bill passing through the House, Mr. Charles Hopkinson is to be appointed chief superin-

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tendent engineer. It is also proposed to appoint an assistant superintendent engineer, at a salary of £500 per annum. The report of Mr. Laws, the city engineer, will come before a special meeting of the Tramways Committee to be held for that purpose.

Tunbridge Wells.—The Corporation having entered into a contract for free wiring with the National Electric Free Wiring Company, Limited, London, the company have opened temporary premises at Bedford House, Mount Zion, during the building of a permanent showroom. We are informed that several installation orders are already in hand, including motors for printing works, etc.

Electric Timber Seasoning and Preservation Company, Limited.—This Company has been registered, with a capital of £150,000 in £1 shares (60,000 of which are preference), and the object is to adopt and carry into effect certain agreements for the acquisition of the business of a timber merchant, and generally to carry on the business of electricians and electrical engineers, etc.

Mexborough and Worksop Electric Lighting Orders.—On Tuesday the Bills confirming the Mexborough and the Worksop Electric Lighting Provisional Orders came before Mr. Campion, one of the examiners of private Bills, for proofs of compliance with the Standing Orders of Parliament. These being satisfactory, the Bill was ordered to be reported to the House of Commons for second reading.

Poole and District Electric Traction Company, Limited.—This Company has been registered with a capital of £100,000 in £10 shares, and the object is to carry into effect an agreement between the British Electric Traction Company, Limited, and the Bournemouth, Poole, and District Light Railways (Electric) Company, Limited, and others, to carry on the businesses of electrical engineers, carriers, etc.

Barmouth.—The Board of Trade have, in consequence of the representations of the Council, refused to grant a provisional order for the lighting of the town by electricity applied for by Mr. David Davies. They have informed the Urban District Council that in the event of the Council applying for such an order they would withhold the right to the Council of transferring its powers under the order to any private individual or firm.

Appointments Vacant.—Vacancies occur in the staff of the electric light departments in Belfast, Keighley, and King's Lynn. The Corporation of Sheffield invite applications for the appointment of a mains superintendent at a salary of £250 per annum. There are also vacancies for a switchboard attendant, a works manager, and a man experienced in the making of electric detonators for blasting fuses, particulars of will be found elsewhere.

Fuel Economisers.—Competition has been rife amongst the makers of feed-water heaters for the large order that has recently been placed by the East End Electric Railway Company for the new electric power station, New York. We understand that the universally known Green's economiser was the successful competitor. This is an important order, amounting to about 10,000 tubes, and is probably the largest of this kind that has ever been given out by one single company.

Sheffield.—The *Sheffield Daily Telegraph* believes that the next sections to be taken in hand by the Tramways Committee for electric traction will be Brightside and Heeley. The precise time for beginning the work will depend on the progress made with the sections now in hand—namely, Ecclesall-road, Intake, and Pitsmoor. Some time ago the committee decided to use the American bell-punch in the collection of fares. The instrument was brought into operation for the first time yesterday.

London Gazette.—Adjudication: April 11—(1) James Stephen Blackwell, electrical engineer, described as one of the partners in the firm of Charles and Blackwell, trading as the Central and Engineering Company; and (2) James Edwin Stott (trading as James E Stott and Co.), electrician, Huddersfield. The unsecured liabilities amount to £598. 13s. 7d.; the gross liabilities are £731. 1s. 3d. The assets, after payment of the sum of £22. 7s. 8d., are estimated to realise £274. 17s. 1d., leaving a deficiency of £323. 16s. 1d.

Halifax.—The great success which has attended the sections of electric tramway has resulted in applications for numerous extensions. A service to Stump Cross, from whence the remaining distance to join the Bradford tramways at Shelf is a comparatively easy section, is suggested, but the Corporation cannot construct this section until the new bridge at Godly is finished, the contracts for which have just been let. The Illingworth and Pellon sections will be those opened next. The tram receipts are already averaging some £300 per week.

Edinburgh Corporation Bill.—The Select Committee of the House of Commons presided over by Sir J. Kitson is considering the Edinburgh Corporation Bill. It is proposed by the Bill to authorise the Lord Provost, Magistrates, and Town Council of Edinburgh to erect and maintain a municipal hall, to provide increased facilities in connection with their electric lighting undertaking, to construct works and tramways, to acquire lands, and to control wall advertising. The only parts of the Bill which are opposed are those relating to the municipal hall and the right to control wall advertising.

St. Marylebone.—Notice of motion was given for last night's meeting of the Vestry as follows: "That inasmuch as it is now indefinite as to when the electric lighting of the main streets of the parish may be extended, the cost being prohibitive, it be referred to the Works Committee to ascertain the cost of lighting the main roads with the Nos. 2 and 4 Welsbach gas-burners in their new design, the same as in use at Camberwell and Lambeth, whereby, at no increase of cost, three times the light is obtained, and bring up a report to the Vestry thereon."

Harrogate.—Tenders are to be invited and submitted to the next meeting of the Electric Lighting Committee for 60 or 70 tons of 3in. iron piping in which to lay the new trunk mains from the works to the town. Tenders for about 2,000 tons of coal are to be advertised for and submitted to the next meeting, and a suitable shed is to be provided at the works for storing coal. Several posts are to be converted into the electric light standards. Two additional 25-kw. transformers have been ordered from the British Electric Transformer Manufacturing Company, Limited.

Ayrshire.—The County Council have adopted a minute of the Ayr Tramway Bill Sub-Committee, stating that they were of opinion that in consideration of the Corporation binding themselves to complete the tramway both to Prestwick and Alloway within four years from the passing of the Act, and to have a certain specified service with Prestwick and Alloway, the District Committee should agree to the extension of the period within which the District Committee are entitled to acquire the tramways within their district from seven years, as stipulated in the Act, to 21 years.

Finchley.—The clerk and surveyor of the Urban District Council have been authorised to take such steps as they may consider necessary for promoting a scheme of light railways under the Light Railways Act between the boundary of the district with Hornsey, in the Archway-road, to Totteridge-lane, and that application for an order enabling the Council to construct light railways be made to the Light Railway Commissioners in May next, and that in his discretion the clerk be authorised to instruct Mr. Forbes to act on behalf of the Council in carrying out this proposal.

Perth (W.A.).—Since March 10, the work of constructing the first of the electric tramways, and also the car-house, has been in active progress. Mr. Cooke, the engineer for the company, is confident of completing the first set of lines by July next. The rails and sleepers—the former being 84lb. to the yard—are very solid, and when the wood-paved part of the street is reached the rails are to be further increased in solidity to 94lb. The car-house will have a depth of 207ft. by 65ft. At present 75 men are engaged in laying the lines, and with the car-house the company give employment to over 100 persons.

Bangor.—At a special meeting of the City Council the recommendations of a special meeting of the Lighting Committee, that in lieu of the guarantee, which has caused so much discussion, the signed agreement and verbal promises to take electrical energy from the Corporation to the extent of nearly 60,000 units, should be accepted, that works be erected, that the report of the engineer be adopted, and that tenders amounting to £13,052 be approved, were agreed to. The Council will apply to the Local Government Board for power to borrow £4,500 with which to erect the destructor, and £2,000 for the purchase of electric meters and extra mains.

Dorking.—The Finance Committee having considered Mr. Trentham's report, pointed out that he himself made the following summary thereof—viz.: (1) that electric lighting could not be expected to pay the Council the first year, that it might the second, but certainly would the third, if carefully designed and managed; (2) that a site in Station-road would be a very convenient situation; (3) that on account of the great extent of the roads to be lighted, public lighting alone would not pay. He further stated that he estimated the cost of the capital expenditure connected with the electric lighting scheme at £19,833. The question now stands adjourned for two months.

Yeadon.—At the annual meeting of the Yeadon Urban District Council on Monday the suggestion to ask the Leeds Corporation to extend their tramways system to Guiseley or Menston came up for discussion, Mr. G. W. Teale proposing that the other local councils be asked to appoint a deputation to wait upon the Tramways Committee. After discussion it was decided to invite the Councils of Horsforth, Rawdon, and Guiseley to a joint meeting to formulate a scheme for serving the district with tramways. The clerk was instructed to get information as to whether the provisional order for electric lighting obtained by the Yeadon Council in 1894 is still in operation.

Catalogue.—From the catalogue of Messrs. J. H. Heathman and Co., fire-escape makers, 2, Endell-street, London, W.C., we gather that the London County Council having decided to confine the fire-protection duties to the members of the Metropolitan Fire Brigade, and having therefore withdrawn the constable fire-escapes from the stations of the metropolitan police, they have taken the constable fire-escapes from the London County Council and now offer them for sale at reduced prices. A number of London brigade manual fire-engines are also offered at half cost. The catalogue contains details of fire-pumps, force-pumps, hose, stairs, fire-resisting doors, extension ladders, and other fire and life-saving appliances.

Taunton.—The report of the Electric Lighting Committee, adopted at the last meeting of the Town Council, stated that the erection of the new plant at the works was approaching completion. The lamp connections during the past quarter were equivalent to 1,390 8-c.p. lamps. One 4-h.p. motor was also connected. The question of immediately putting in a steam condenser at the works was receiving the committee's consideration. The committee proposed to report on this subject at a special meeting of the Council as soon as they had obtained an estimate of the cost. The committee recommended that the Municipal

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Electrical Association be invited to visit Taunton during their visit to Bristol in June next.

Morecambe.—The electric light works were opened on June 29, 1898. There were then 66 public lamps connected until the end of July, at which date the first private consumer was switched on. On March 31 this year 200 applications for current for lighting purposes had been received. At that date the number of consumers was 154, incandescent lamps connected 2 595, incandescent lamps equivalent to 8 c.p., 5,335. Number of private arc lamps 32, the total number of private lamps equivalent to 8 c.p., 5,835. With respect to public lighting, the number of arc lamps was 104; gas lamp pillars converted into incandescent lighting, 85; incandescent lamps, 143. The total (equivalent) number of 8-c.p. lamps, both private and public lighting, was 7,674.

North-West London Railway.—Mr. Balfour Browne, for this Company, on Wednesday explained to a Select Committee of the House of Commons presided over by Mr. Jeffreys a scheme for the construction of an underground electric traction railway, four miles in length, between the Marble Arch and Cricklewood, with stations at the Marble Arch, Edgware-road, Kilburn, Brondesbury, a point a little farther north, and Cricklewood. The capital power asked was £1,500,000, with borrowing powers of £500,000; and the line, which was to have double tunnels, was estimated to cost £1,065,183. In the result the committee passed the preamble, deciding unanimously to allow a return fare of 2½d., a single fare of 1½d.; the intermediate fares to be 1½d.

Maidenhead.—The following report has been prepared by the Electric Lighting Committee: "The committee have very carefully considered Messrs. Burstall and Monkhouse's report, and make the following recommendation—viz.: 'That Messrs. Burstall and Monkhouse be retained as consulting engineers with instructions to prepare plans and estimates to be furnished for the information of the Local Government Board; further, that the town clerk be directed to apply to the Local Government Board for sanction to borrow a sum of money for carrying out the scheme; also that the engineers be requested to prepare in addition to the plans and estimates a specification of the proposed works, and that tenders be invited for executing such works, which tenders shall be submitted to the engineers for their report.'"

Glasgow.—A Lords' Committee on the 18th inst. passed the preamble of the Bill promoted by the Corporation of Glasgow to extend its tramway system to areas outside the municipal boundary. The Corporation have come to an agreement with the Corporation of Paisley to acquire the tramway undertaking three years hence when it falls to be purchased by the Paisley Corporation, and the Corporation of Glasgow will work not only the Paisley system but also the line of tramways running through the county of Renfrew, and connecting Glasgow with the Paisley system. Chief Officer Paterson, of the fire brigade, has submitted to the Watching and Lighting Committee a proposal for the erection of a large number of additional fire-alarms throughout the city. The instruments are made and maintained by the department, and the wires by the National Telephone Company, whose contract with the Corporation expires in October.

Ealing.—Tenders are to be invited for two boilers and a complete set of steam pipes. When any barrel piping is required local tenders are to be obtained for the same The stokers at the electricity station will receive an additional 2s. 6d. per week, it having been decided to discontinue the "bonus" system. At the last meeting of the District Council it was proposed: "That in view of the fact that the Middlesex County Council have now admitted the county necessity for a system of tramways, this Council appoint a committee to negotiate (*a*) with the Middlesex County Council so that the tramway lines in Ealing may be laid at the same time as the wood pavement; and (*b*) the London United Tramways Company as to the terms on which they would be prepared to construct and work such lines." An amendment that the motion should be deferred till the Council heard the result of the incorporation application was carried by nine votes to six.

Belfast.—The town clerk (Sir Samuel Black) has placed before the members of the City Council the following statement, prepared by himself, with regard to the proposed municipalisation of the tramways:—Rough estimate of value of tramways as they may be purchased in 1908: 37 miles of single line at £4.000, £148,000; 130 cars at £100, £13,000; 1,040 horses at £20, £20,800; harness and stable fittings per horse, £5,200; stable and buildings, £50,000; fixed price of goodwill, £2,000—total, £239 000. If now purchased at price of the day: capital of the company, 24,600 shares, £246,000; premium at present price, £8, £196,800; debentures, £60,000—£502,800; being an addition on estimated value of £263,800; conversion and electric power, £350,000—total, £852,800; interest and sinking fund thereon (30 years) at £5. 2s. per cent., £43.492; depreciation on electric expenditure at 10 per cent., £35,000; loss of rent, £5,000—requiring a net profit yearly till 1907 of £83,492.

Richmond (Surrey).—The following resolution was lost by the Mayor's casting vote at the Town Council's meeting last week: "That efforts be made to hold a conference consisting of four representatives from each of the following authorities—viz, the Richmond Main Sewerage Board, the Barnes District Council, and the Richmond Town Council—with a view to consider and report as to the practicability and desirability of establishing a system of electric tramways or light railways throughout the two districts in combination with a scheme of dust destruction, sludge destruction, and electric light supply, public and private, under the management of the Main Sewerage Board or a special joint committee appointed for the purpose." A clause in the agreement between the Council and the electric lighting company (1891) provides that the company should have the sole right of supplying public or private electric light, and that the Council should use their utmost endeavours to prevent any other company from supplying electric light in the district.

Middlesbrough.—A special meeting of the Middlesbrough Corporation Streets Committee was held on Tuesday to consider the tramway extensions in the borough. The tramway company is applying under the Light Railways Act for extension not only through portions of the borough to Eston and South Bank, but along Dock-street to the docks. The surveyor recommended a double line throughout. The width of the street varies from 16ft. 2in. to over 20ft., one side being a blank wall. After various divisions had been taken, the motion for a double line was lost, but a second for a double line where it was over 19ft. and single line under was carried. No line at all is to be allowed down Bridge-street East. The Borough Surveyor called the committee's attention to the fact that several tracks for which permission had been obtained were not yet completed, and the town clerk was instructed to draw the attention of the company to the fact, notifying that the Council would apply for the penalties. It was also decided to ask the company to light the stopping places on the route.

Lynn.—Prof. Robinson has been authorised to obtain from Messrs. Spagnoletti and Crookes an estimate for the wiring and fittings required for lighting the theatre and to report thereon. The report of Prof. Robinson as to the progress of the works states that the three-ton crane has been erected and satisfactorily tested. The 10 ton crane is nearly completed. The small engine has been erected. The rest of the work under this contract is being pushed forward. Two dynamos have arrived, but the erection will be deferred until the engine-house is more finished. The material for the batteries has arrived, and Messrs. Siemens are proceeding with the mains. The wiring of the town hall and offices is proceeding satisfactorily. A plan is being prepared for wiring the theatre, and a specification for wiring the technical institute. When the committee of the corn exchange have decided to light, tenders will be advertised for. An offer from Mr. R. Wardale, the lessee of the theatre, to pay 7½ per cent. per annum on the outlay provided it be not charged as extra rent, but for use of electric fittings only, has been accepted. Prof. Robinson has been authorised to proceed with the contracts for the necessary lamps and brackets in the north district.

"Vril" Electric Launches.—We have received from Messrs. Laing, Wharton, and Down, Limited, 82A, New Bond-street, W., a well-got-up descriptive list of the "Vril" electric launches which they are exploiting. This company has laid down a complete plant for launch and boat building at St. Helens, Isle of Wight, and are open to supply electric launches of varying sizes and draught without delay. In the list now before us illustrations of a number of sea-going launches, some of which have been built for the admiralties of foreign countries, are shown. We understand from the list that these boats have been accepted by the Board of Trade as fulfilling all the conditions necessary for a ship's lifeboat, and they certainly are more suitable than steam launches in cases of emergency, provided the accumulators are kept in good order. The company has also arranged charging stations at West Cowes so that the launches can be quickly supplied with electricity in that district. The firm make a special point of the accumulator boxes they use, and which are so designed as to be quite acid-tight. Besides the fact that the lids are easily removable for inspection, special attention has been devoted to the terminals and to the connections.

Electrical Company, Limited.—We have received from this Company, which has its offices at 122, Charing Cross-road, W.C., their price-list for lampholders, in which some rather novel features are shown. Apart from the ordinary type of bayonet and screw socket lampholders which are in regular use, we notice a new line of holders to ensure that the lamps used in them will be of a specified candle-power. These holders, we fancy, are of American design, and are arranged specially for installations in which a charge is made at so much per lamp per annum, and where the consumption is not registered by meter. In search cases, the length of the central contact of the lamp is varied for different candle-powers, and at the same time tubes are placed in the lampholders which prevent lamps of high candle-power making contact in the holders installed for lower candle-power lamps. In this way the Company is secured against fraud on the part of the consumers. We also note in this catalogue one or two cheap devices for temporary wiring, which will find favour where they are allowed by the insurance companies, and also a series of holders for use for lamps in very damp places, or even under water. These latter holders are neatly arranged, and should be of great service in mining work where water is met with.

Richmond (Yorks).—At the meeting of the Town Council last week a report by Mr. Campbell Swinton was received with reference to the projected undertaking to supply electric light to the town by the Corporation. Mr. Swinton stated that from what he had ascertained it was probable that for eight months in the year water equivalent to 150 h.p could be obtained, but for the remaining four months not more than 40 h.p. In order that the Corporation might be in a position to supply electricity at 6d. per Board of Trade unit, which was equivalent to 3s. 9d. per 1 000ft. for gas, and at the same time cover all expenses, including interest on the capital borrowed for the purpose and sinking fund, he thought it would be necessary to have 3,000 lamps installed. If carried out in a proper manner, the works would involve an outlay of £7,000. Then consumers would have to bear the cost of wiring their houses

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for electric light, and have to provide necessary lamps and fittings. He suggested a canvass of the town to see whether it would be possible to get 3,000 lamps installed, though in a general recommendation he advised the Council to wait a few years before embarking on the project, pointing out that the plant and fittings would then probably be much cheaper than at present. The committee hope to be in a position to bring forward a scheme at the next meeting.

Baker-street and Waterloo Railway.—The Great Central Railway Company have withdrawn their opposition to the above railway's Bill. The Select Committee of the House of Commons of which Mr. Jeffreys is chairman on the 19th inst. resumed the consideration of the Baker-street and Waterloo Railway Bill. The estimate per mile was stated at £575,000, that for the Central London Railway £585 000 per mile, the Great Northern and City at £652,000, the North-West London £485 000, and the Great Northern and Strand £502,000. Mr. W. R. Galbraith, C E., joint engineer of the Waterloo and City Railway, with Sir Benjamin Baker, joint engineer of the present scheme, stated that the estimated cost of the works on the original railway was £1 090,000. Adding to this £215,000 for equipment. £100,000 for parliamentary, engineering, and law charges, £160,000 for interest during construction, and £50 000 for working capital, the amount was £1,615,000. The whole authorised capital was only £1 766,000, so that even if the corporation could issue the whole at par their profit would be only 10 per cent., and this did not include the cost of the additional station at Charing Cross. There was never a publication of the prospectus of the company. The case was then adjourned, the Chairman stating that the committee would like to have some further information as to the financial proposals of the Bill.

Southampton.—The Electric Lighting and Tramways (Joint) Committee have presented to the Town Council a report by Mr. Manville in relation to the most economical method of supplying the tramway system with electricity. He proposed to utilise the existing machinery for the supply of current to the tramway system by using a battery of accumulators for the heavy load times. This scheme would be much cheaper than installing fresh machinery, and the cost would be no greater than if separate plant were installed and worked. As to the question of accumulators, so long as the spare lighting plant was in working order they would only do half of the work of the trams during heavy load times, and whilst on this half a loss of 25 per cent. in the energy generated would be made, this represented a loss of only 12½ per cent. on the total tramway load during the four heavy hours of lighting, or a loss of about 3½ per cent. on the whole tramway supply. This loss of energy would only be incurred during the dark months of winter. During the rest of the year the maximum lighting load supply would be reduced so as to enable the lighting engines to supply the tramway load during the heaviest hours of the day without any help from the accumulators. In the future, when the tramway load was much increased, he agreed it would be desirable to further consider the desirability of putting in a separate generating plant. In that event the accumulators now installed for the tramway load could be applied to meet the increased demand for lighting, in place of installing further boilers and engines that would otherwise be necessary for that purpose. As to the successful use of the combined system of steam generation and accumulators for electric supply, that was exemplified by the successful installations of the type in some of their principal cities such as Manchester, Birmingham, Edinburgh, and elsewhere. The Joint Committee recommended the Council to adopt the report and estimate of the Electric Lighting Committee, and to apply to the Local Government Board for sanction to borrow the sum of £17,159. The report was adopted.

Newington.—The Electric Lighting Committee of the Vestry have presented an exhaustive report upon the arrangements and rates of remuneration for the working staff to be appointed at the electric lighting works. The wages sheet showed an annual charge upon the revenue of £943. 16s. per annum, being an estimated output of 370,000 units. equal to 0·61. per unit. The following is the scale of wages laid down by the committee: two assistant engineers, at 45s. each per week; one engine driver, 40s.; two engine-drivers, 36s.; two stokers, 28s.; one carbon trimmer, 28s.; one mate to ditto, 25s.; one engineer's labourer, 28s.; two boys, 12s.; one jointer, 40s.; one mate to ditto, 28s. According to the published returns of 60 municipal electric lighting undertakings in the provinces and London, the wages were in 39 stations less than this estimate, while those at the other 21 stations stood above 0·6d. per unit. This, the committee remarked, tended to prove that 0·6d. per unit for labour on the production of the current was a reasonable allowance from a labour point of view. The staff, as enumerated by the committee, would work from 54 to 56 hours per week, and could, by an arrangement amongst themselves, and by working extra hours on Sundays, secure a day off once a fortnight without increasing their respective weekly average of hours of labour. The committee proceeded: "It has been suggested that each man should only work six days a week, but this could not be arranged with the working staff proposed, unless in turn they worked in shifts of 16 hours, which is objectionable. If the Vestry insist, therefore, upon each assistant and workman only working six days a week, it will be necessary to appoint a third assistant at 45s. a week, or an extra charge upon the station of £117 per annum, and in addition to allow the engineer's labourer to perform on Monday mornings stoker's duty. Your committee hold that, whilst keeping in view the principle of trade union rate in wages and hours of labour so far as possible and reasonable, it should be borne in mind that the undertaking is not of a philanthropic nature, but purely a commercial undertaking, established for the object of supplying electric light for the benefit of the consumers, both public and private." After considerable discussion, the report has been agreed to.

Edison and Swan Company.—The accompanying illustration shows what is to be called the "Rex" outside shop window lantern, which is manufactured by the Edison and Swan United Electric Lighting Company, Limited. The fitting is specially designed for lighting shop windows from the outside, and as such should find favour with wiring contractors and their customers. As can be seen from the illustration, the great feature in the fitting is the globe, which is made of half opal glass and half clear. The opal half is placed furthest from the window, so that it reflects light on

to the goods being displayed in the window. At the same time, by placing black letters on the opal, a good advertisement can be obtained. The globe carrier is the essential point of a fitting of this kind, and we trust that the arrangement designed by the company in this case will withstand the vibration caused by high wind. The general finish of the upper part of the fitting leaves nothing to be desired, and at the same time it is comparatively cheap to make The fitting is arranged to take three lamps of from 8 c.p. to 32 c.p.

Greenock.—The *Glasgow Herald* gives the following *résumé* of the report just issued by Mr. John Young, manager of the Glasgow Corporation tramways, on the tramways of Greenock, and on the question whether the Corporation should re-lease or municipalise. Mr. Young says he has no doubt the Greenock Police Board could successfully work the tramways within its own boundary independently of the sections within Port Glasgow and Gourock, but he is pleased to know it is not contemplated to work it apart, as it is a case in which all mutually interested should stand together. Exclusive of rolling-stock, he estimates that to renew the tramways throughout, double the lines where they are at present single, and electrically equip them, would cost about £96,400. If it is decided to lay a single line for a little over two miles at the Gourock end the cost would be about £87 680. With the prospect of serving three burghs, representing a resident population of about 85 000, in addition to the large influx of summer visitors, Mr. Young would recommend a no less frequent service than 7½ minutes in the thickly-populated part of the route in Port Glasgow and Greenock, and 15 minutes on the Gourock end, with augmentations at busy times, and he estimates that such a service would give a total of 547,560 car miles per annum. The estimate of total capital expenditure is put at £159,680; the average revenue first three years at 11d. per mile at £25,086. 10s.; working expenses, £13,689, and after deducting interest, sinking fund, and depreciation, a credit balance of £229. 18s. is shown. For the following three years the credit balance is made £2,238. 8s., and afterwards it is placed at £4,633. 8s. on a regularly increasing traffic. Mr. Young states that if the Board were to grant a lease on the lines of the present offers, and afterwards to exercise the option of breaking the lease at 14 or 21 years as proposed, this would be very much more costly, seeing the valuation would be based on the profit-earning capacity of the undertaking. The lessees would require to be recouped not only for their greatly-increased capital outlay, but also for their prospective profits during the remaining years of the lease. Looking at the whole question, he has no hesitation in advising the Board to make arrangements to acquire, connect, and municipalise the whole system within and without the burgh in preference to granting a lease on the terms indicated. He has no doubt the Commissioners of Port Glasgow and Gourock would naturally prefer that Greenock should finance as well as operate the whole system, and with the prospects which the undertaking now presents he sees no reason why the Greenock Board of

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Police should shrink from the responsibility. In addition to this report by Mr. Young, the special committee has under consideration improved offers from the Port Glasgow Tramways Company, and also from Mr. W. M. Murphy, of Dublin and London.

Burton.—It is intended to introduce free wiring when the new plant at the electricity works is in order. In reply to the letters which appeared in the *Burton Chronicle* under the signature of Mr. A. B. Wardle, of Shobnall, condemning the present system of electric lighting of the borough and its working, Mr. F. L Ramsden, the manager and engineer, has prepared a report. He says that he had been closely connected with the enterprise since its initiation, and the occasional failures of the light, and the unsatisfactory financial results, were a source of great anxiety to him. He hoped, however, to be able to overcome the difficulties, and in time to bring the undertaking to a satisfactory condition. Public lighting could not be undertaken until the new machinery was ready for use. The reason of the unsatisfactory financial results was neither the fault of the system nor of the site of the works; the works were too small to be profitable with the existing class of customers, these being chiefly shops and offices. The former during the summer months only lighted up one, two, or at the most three night in the week, whilst the latter, in a general way during the same period, did not light up at all. The class of their customers was shown by the fact that the revenue represented less than one hour's average daily use throughout the year of each 16 c.p. lamp connected. The expenditure during 1898 was £3,551. 13s., which was made up as follows: fuel, £184. 3s. 2d.; oil and stores, £74. 18s. 8d.; wages, £918. 17s. 2d.; repairs and maintenance, £217. 0s. 1d.; rents and taxes, £77. 3s. 8d.; salaries, £130; establishment charges, £54. 12s. 6d.; insurances, £12. 4s. 6d.; interest, £15. 0s. 2d.; dividends, £875. 8s. 8d.; redemption fund, £992. 4s. 5d.—a total of £3,551. 13s. Deducting from these items proportion of wages, £800; rents and taxes, £77. 3s. 8d.; salaries, £130; establishment charges, £54. 12s. 6d.; insurances, £12. 4s. 6d.; dividends, £875. 8s. 8d.; redemption fund, £992. 4s. 5d., or a total of £2,941. 13s. 9d., as being standing charges which must be met so that the works may be ready at all hours of the day or night to supply any one customer who requires the current, only about £600 was left as bearing any relation to the quantity of current generated. It was very easy to criticise and to condemn what was being done there by comparing it with what was done in other towns, but without being in possession of all the facts it was impossible to make a fair comparison. Mr. Wardle appeared to be an ardent advocate of the high-tension continuous-current system. They had that system at the neighbouring town of Walsall, but so far, although they had a larger output than Burton, they had not made it pay. He explained how it was that, notwithstanding the fact that they could not make the undertaking pay under present circumstances, they hope to do so by increasing the plant and thus adding to their capital expenditure. This might be done (1) by putting down one large machine with the other necessary extensions—the plant capacity will be doubled for little more than half the cost of the three existing sets of machinery; (2) a plant of twice the capacity of the present one can be worked at very little extra expense so far as the staff and labour are concerned. The customers to justify such an increase would be found in the present and new districts in the borough, and in the public lighting if it was decided to adopt it.

PROVISIONAL PATENTS, 1899.

April 10.

7466. An improved electrical switch. Thomas Duncan Dundas, 8, Rastell-avenue, Streatham Hill, London.

7471. An electrical apparatus or machine for the display of cartoons, autographs, diagrams, numerical results, advertisements, etc. Alexander Jack, 164, Windmillhill-street, Motherwell.

7479. Improvements in secondary batteries. Philip Middleton Justice, 55, Chancery-lane, London. (Preiss Electric Storage Syndicate, Limited, South Australia. (Complete specification.)

7494. Improvements in or relating to electrically-controlled valve gear for gas and other motors. Alfred Julius Boult, 111, Hatton-garden, London. (David W. Payne, United States.) (Complete specification.)

7523. An improved clip for shades for electric lamps, candles, or other illuminating devices. Ernest Dunand, 13, Linacre-road, Willesden Green, London.

7525. Improvements in telegraphic transmitting, receiving, and translating arrangements. Alexander Muirhead, 323, High Holborn, London.

7527. Improvements in thermo-electric batteries or piles. Joseph Matthias, 115, Cannon-street, London. (Complete specification.)

April 11.

7577. A new or improved method and apparatus for operating contacts for electric traction. Arthur Ballance and Samuel Ambrose Jefferson, 14, Ferris-street, Hedon-road, Hull.

7579. Switching apparatus for controlling the distribution of electricity. John Liddle, 154, St. Vincent-street, Glasgow. (Jacob Cloos, United States.) (Complete specification.)

7580. Switching apparatus for controlling circuits. John Liddle, 154, St. Vincent-street, Glasgow. (Jacob Cloos, United States.) (Complete specification.)

7584. Improvements in electric switches. Crompton and Co., Limited, and Henry William Wartnaby Dix, 55, Chancery-lane, London.

7589. Improvements in the construction of electric arc lamps. John Ambrose Fleming, The Electrical Laboratories, University College, Gower-street, London.

7618. Electrical apparatus for diminishing the apparent self-induction of alternating-current circuits and capable of being used in lieu of condensers. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (La Société Anonyme pour la Transmission de la Force par L'electricité, France.)

7641. Improvements in Hertzian wave telegraphy to enable signals to be transmitted to any distance by means of intermediate relay stations. Philip Henry Cole and Bertram Cohen, 20, Lessing-street, Honor Oak Park, London.

7650. Improvements in or relating to sockets or connections for electric light fittings. Henry Albert Knight, 99, Cannon-street, London.

7654. A method of and apparatus for starting alternating-current electromotors or bringing them up to synchronism. William Du Bois Duddell, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

7656. Improvements in current collectors for electrically-driven vehicles. Robert Edward Carroll, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

April 12.

7680. Improvements relating to galvanometers, voltmeters, and the like electrical instruments. Charles Herbert Offord and Archibald Carlyle Barfield, 18, Southampton-buildings, Chancery-lane, London.

7713. Improvements in or relating to wireless telegraphy. William Henry England, 111, Hatton-garden, London.

April 13.

7756. Improvements in magneto-electric generators or dynamos. Sir William Arrol and Thomas Blackwood Murray, 121, West George street, Glasgow. (Complete specification.)

7761. Improvements in or relating to telegraphic transmitting instruments. John Gardner, 70, Market-street, Manchester.

7776. An improved method of adapting existing fittings for the electric light. Bernard Mervyn Drake and John Marshall Gorham, 60, Victoria-street, Westminster, London.

7785. Automatic electric time switch. Arthur Booth Webber, 837, High-road, Leytonstone.

7800. Improvements relating to fusible electric cut-outs. Horace George Calthrop, 70, Chancery-lane, London. (Charles E. Peebles, Orange Free State.)

April 14.

7814. Quick-action reciprocating motion chiefly for making and breaking electrical circuits. John Sibley Richardson, 41, Waverley-road, Small Heath, Birmingham.

7863. Improvements in electric incandescent lamps and in their manufacture. Francis Michael Frederic Cazin, 37, Cursitor-street, Chancery-lane, London.

7883. Improvements in vehicles electrically propelled from a line conductor. William Humphrey Wheatley, 40, Chancery-lane, London. (Dwight G. Stoughton, United States.) (Complete specification.)

7886. Improvements in apparatus for producing electric sparks. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Albert Richardson Shattuck, United States.) (Complete specification.)

7887. An improved electrical percussive apparatus. Samuel Robert Skellorn, 45, Southampton-buildings, Chancery-lane, London.

7892. Improvements in electrical batteries. Ernest Waldemar Jungner, 18, Buckingham-street, Strand, London.

7895. Improvements in or relating to wireless telegraphic apparatus. William Henry England, 111, Hatton-garden, London.

April 15.

7918. Improvements in the manufacture or production of bands and strips of copper and other metals by electrolysis on rotary mandrels. William Edwin Heys, 70, Market-street, Manchester. (Emilien Dumoulin, France.) (Complete specification.)

7924. Improvements in continuous-current electric dynamos and motors. James Atkinson, The Woodlands, Marple, near Stockport.

7925. Improvements in and connected with globes for electric arc lamps. Henry Stenz and Joseph J. Weyer, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

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7927. Improvements in or relating to electric contact makers and breakers. Edwin Perks, 18, Hertford-street, Coventry.

7942. Method or methods for finding the direction and position of a transmitter of Hertzian waves. Charles John Evans, Ernest Wilson, and Herbert Godsal, 108, Castelnau, Barnes, London.

7943. Improvements in apparatus for use in wireless telegraphy. Sidney George Brown, Van Buren, Poole-road, Bournemouth.

7948. Improved device for the transmission of a rotary motion in eccentrically shaking and oscillating machines. Andreas Hugo Christian Laute, 31, Southampton-buildings, Chancery-lane, London. (Complete specification.)

7953. Improvements in and relating to mechanism for automatic or coin-freed machines for the sale of electricity, gases, or liquids. Alfred George Brookes, 55, Chancery-lane, London. (L. Sell, Germany.) (Complete specification.)

7978. Improvements in and relating to electric motors or dynamo-electric machines. Robert Lundell, 45, Southampton-buildings, Chancery-lane London. (Date applied for under Patents, etc., Act, 1883, Sec. 103 Jan. 18, 1899, being date of application in United States.) (Complete specification.)

7979. Improvements relating to methods of and means for regulating electric motors. Robert Lundell, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, March 3 1899, being date of application in United States.) (Complete specification.)

SPECIFICATIONS PUBLISHED

1897.

29306. Wireless telegraphy. Marconi. (Amended.)

1898.

6695. Electrical measuring apparatus for use in regulating electric currents. Crompton and Ashley.

6720. Depressible rail systems for electrical railways. Grunow and Goodsell.

6865. Electric conductors and appliances for making connection with same. Andrews.

6903. Electric plug connectors. Tanner and Lowcock.

7164. Apparatus for electric signalling and adjuncts thereto. Herzog.

7367. Electric indicators or annunciators. Boult. (Antwerp Telephone and Electrical Works.)

7798. Electrical switch. Nunns.

8043. Sockets or holders for incandescent electric lamps. Mackenzie. (Allgemeine Elektricitäts Gesellschaft.)

9330. Controllers for electric motors. Belfield. (Westinghouse Electric and Manufacturing Company.)

9983. Telephonic apparatus. Von Kronmyrth.

10617. Controlling switch for large numbers of electric circuits. Smith and Eck.

11175. Switches for electric circuits Callow and Eck.

11290. Electric arc lamps. P. R. Jackson and Co., Limited, and Mensing.

11326 Adjustable cord reels for electric leads and other similar purposes. Sturge.

11426. Electrically-propelled vehicles. Brougham and Bersey.

11519. Electric brakes. Davis. (Date applied for under International Convention, Oct, 22, 1897.)

12201. Apparatus for obtaining synchronous movement at the ends of submarine cable or other telegraph lines. Brown.

12860. Telegraphy by means of electric light. Zickler.

16552. Electrodes for arc lamps. Bremer.

16553. Electric arc lamps. Bremer.

19972. Electric switch worked by clockwork or electricity, or both, or by hand independently of either. Hooper.

21044. Prepayment electric motors and meters. The British Thomson-Houston Company, Limited. (Cox.)

27370. Automatic regulation of monophase or polyphase alternators. Ransford. (Société Sautter, Harlé, et Cie.)

27599. Electrohydraulic brakes for railway vehicles and other purposes. Durey.

1899.

626. Telephonic instruments. Baird. (Barnet.)

1683. Arc lamps. Melzer, Haffner, and Koch.

2325. Electric switches. Fürer.

2396. Fixing of insulators for carrying electric line wires. Fleischhacker.

2971. Arc lamps. Bagley.

3189. Electric insulators. Withycombe.

3735. Method of and apparatus for utilising the waste gases and heat from electric furnaces. Borchers.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1899.	Corresponding week 1898.	Increase or decrease.	Total receipts for half-year. 1899.	1898.
		£	£	£	£	£
Birmingham Tramway	April 15	3 864	4,139	– 275	57,173	53 888
Blackpool and Fleetwood Tramroad	,, 15	222	—	—	3,346	—
Bradford City Trams	Feb. 5	145	—	—	6,733‡	—
Bristol Tramways and Carriage Co.	April 14	2,543	3,273	– 730	—	—
City and South London Railway	,, 16	1,050	945	+ 105	17 301	16,771
Dover Tramways	,, 15	151	180	– 29	2,261	1,695
Dublin U.T., elec. cars	,, 14	656	700†	– 44	9,723	6,253†
Dublin S.D. Electric Tramways	,, 14	947	989	– 42	13,506	10,877
Halifax Corporation Tramways	Mar. 29	312	—	—	10,712*	—
Liverpool Overhead Railway	April 16	1,404	1,736	– 332	21,394	22,031
South Staffordshire Tramways	,, 14	614	856	– 242	9,203	8,938

* Since June 30, 1898. † Including horse cars. ‡ Since July, 1898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	24½-25½
Bournemouth and Poole Electric Supply, Limited, Ord.	10	13½-13¾
—— 4½ per cent. Cum. Pref	10	10½-11
British Electric Traction, Limited, Ordinary, Nos. 1-80,000	10	18½-19
—— 6 p. c. Cm. Pf., 80,001-40,000 (all paid)	10	13½-14½
—— 5 per cent. Perpetual Debenture Stock	100	126-129
Brush Electrical Engineering Limited, Ordinary	2	1¾-2¼
—— Non. Cum., 6 per cent. Pref.	2	2¼ 2⅜
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	101-103
Callender's Cable Company, Debentures	100	114-117
—— Ordinary	5	12-13
Central London Railway, Ordinary	10	9¾-10¼
——	8	7¾ 8¼
—— Pref. Half-Shares	3	3¾-4
—— ,, ,,	5	4¼-4¾
Charing Cross and Strand	5	11-12
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	7½-8¼
—— 4½ per cent. Debentures	100	114-116
City of London, Ordinary	10	17½-18½
—— ,, 90,001-100,000	10	17½-18½
—— 6 per cent. Cumulative Pref.	10	15-16
—— 5 per cent. Debenture Stock	100	124-129
City and South London Railway, Consolidated Ordinary	100	68-70
—— Ordinary	3	4¾-5¼
—— 4 per cent. Debenture Stock	100	133-135
—— 5 per cent. Pref. Shares	10	14¾-15¼
—— ,, ,, '96	10	14-15
County of London and Brush Prov. Elec. Light Co., Ord.	10	11-12
—— ,, ,, No. 80,001-40,000	10	11-12
—— 6 per cent. Cum. Pref.	10	14-15
Crompton and Co.	3	3¼ 3⅜
—— 5 per cent. Debentures	—	98-101
Crystal Palace District, Ordinary 5 per cent. Stock	100	130 135
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2-2¼
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	96-98
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5¼-5¾
Electric Construction, Limited	2	2-2¼
—— 7 per cent. Cumulative Pref.	2	3-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	103-106
W. T. Henley's Telegraph Works, Ordinary	10	24-26
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	113-115
House-to-House Company, Ordinary	5	8¼-9¼
—— 7 per cent. Preference	5	9-10
Imperial Tramways, Limited	6	24½-25½
India Rubber, Gutta Percha, and Telegraph Works	10	21½-22½
—— 4 per cent. Debentures	100	101-105
Kensington and Knightsbridge Ordinary	5	12½-13½
London Electric Supply, Ordinary	3	3¼-4
—— 6 per cent. Pref.	5	6¼-7
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	106-108
Metropolitan Electric Supply, Limited, Ord., No. 1-62,500	10	17-18
—— ,, ,, No. 62,501-85,000	4	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100	117-120
National Telephone, Ordinary	5	4½-5
—— 6 per cent. Cum. First Pref.	10	11-13
—— 6 per cent. Cum. Second Pref.	10	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	4¾-5¼
—— 3½ per cent. Deb. Stock, Red.	100	99-102
Notting Hill Electric Lighting Company, Limited	10	16½-17½
Oriental, Limited, 1879	1	1¼-1¾
—— £5 Shares	5	7¼-7¾
—— £4½ Shares, New	4½	6¼-6¾
Oriental Telephone and Electric Company	1	¾-1
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6¾-7
Royal Electrical Company of Montreal	1½	165-185
—— 4½ per cent. First Shares Mortgage Debentures	100	105-107
South London Electric Supply, Ordinary	3	3¼-3½
St. James's and Pall Mall, Limited, Ordinary	5	17½-18½
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	34-38
—— 5 per cent. Bonds	100	105-108
Waterloo and City Railway, Ordinary	100	109-112
Westminster Electric Supply, Ordinary	5	15-16

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NOTES.

Heavy Vehicle Trials.—The Liverpool Self-Propelled Traffic Association (the local centre of the Automobile Club) will on May 1 issue forms of entry for the heavy vehicle trials which are to take place at the end of July. These may be obtained from the hon. secretary, Mr. E. Shrapnell Smith.

Ozone.—Mr. J. H. Lamprey writes in reference to a remark of Mr. Andreoli, suggesting that water is not a good vehicle for carrying ozone. He adds that ozone has been successfully applied as an insecticide in greenhouses, when the plants have been in the first place sprayed with water and then the ozone sprayed by the aid of a fan.

King's College Dinner.—Mr. William Vincent, the hon. secretary of the committee of the Old Students' Association, King's College, informs us that the annual dinner will be held at the Holborn Restaurant on Monday, June 26. Prof. William S. Playfair, M.D., LL.D., F.R.C.P., will preside, and a representative gathering of old students is expected.

Books in the Press.—We understand that Mr. J. J. Fahie has in the press a "History of Wireless Telegraphy," on which he has been engaged for a long time. It treats the subject very exhaustively, from its first inception in 1838 up to the present day. It should be interesting reading in view of the recent cross-Channel experiments with Mr. Marconi's system.

Institution of Electrical Engineers.—Members should specially note that next Thursday's meeting of this Institution will be held in the rooms of the Society of Arts, John-street, Adelphi, instead of at the Institution of Civil Engineers, as is usual. The paper to be read for discussion is entitled "Electric Locomotives in Practice and Tractive Resistance in Tunnels, with Notes on Electric Locomotive Design," by Mr. P. V. McMahon.

Colonial Telegrams.—The outcome of the meeting of M.P.'s and others interested in Colonial telegraph rates, to which we referred in our previous issue as being about to take place, was held on Tuesday last, when a resolution was passed on the motion of Mr. R. Ascroft, M.P., seconded by Mr. W. Johnston, M.P., "That the Members of Parliament form themselves into a committee with a view to steps being taken to facilitate the formation of a cheap Imperial telegraph system."

Waterloo and Baker-street Railway.—The Select Committee decided on Tuesday last not to grant the extensions that this railway require at the Baker-street end of the line. The committee agreed, however, to extend the period for the construction of the works at present authorised on condition that the company constructed a subway from the Charing Cross Post Office to their station, and another subway to Spring-gardens, as arranged with the London County Council.

Books Received.—We have received from Mr. A. H. Gibbings, M.I.E.E., past-president of the Municipal Electrical Association, a copy of a new book published by himself on the commercial and business aspects of municipal and electrical supply. This is intended to be a handbook for the use of electrical engineers to municipal corporations and members of municipal electricity committees. The published price is 15s. We hope to give a review of this work very shortly.

Proposed Memorial.—A subscription has lately been set on foot for the purpose of providing a memorial window to commemorate the work of Clerk Maxwell in the parish church of Corsock, of which he was for many years an elder. In order that all who appreciate Clerk Maxwell's work may have an opportunity of contributing, it has been decided to limit the subscriptions to sums not exceeding half a guinea, which will be gladly received and acknowledged by Rev. George Sturrock, The Manse, Corsock, near Dalbeattie, N.B.

Advertisers' Exhibition.—This exhibition, which was opened on last Saturday at the Niagara Hall, is certainly a novel departure. Its organisers have secured a large number of interesting and historical exhibits, including an electric car, which is shown by the Leeds Corporation. The object of this particular exhibit is to indicate what parts of a car are used for advertising purposes in various towns in England. We suppose that in this case the opinion of the late Rev. J. Jenkins would be valuable if it could be obtained.

An Old Servant.—The electric lighting plant of the Society of Arts is to be disposed of, as the society has arranged to have in future its electric light from the street mains. It is of great interest to know that the engine and dynamo installed for the society in 1883 have been in regular work ever since then, and it is a compliment to both Messrs. Crossley Bros., the makers of the gas-engine, and Messrs. Siemens Bros., the makers of the dynamo, that the change over to the supply mains sets free a plant, which is quite capable of doing good service for many years to come, for a new owner.

Society of Engineers.—The next ordinary meeting of this society will be held on Monday at the Royal United Service Institution, Whitehall, when a paper will be read by Mr. James D. Roots on "Petroleum Motor Vehicles." The author will treat, among other things, of the earliest petroleum motor vehicles, as well as those of the Daimler, Hardaker, Benz, and Butler types. The Roots earliest motor tricycle will be referred to, and so will the later Daimler vehicle and those of the Bollee, De Dion, and Petter types; and there will be described also the more recent Daimler, Benz, and the latest Roots vehicles.

Bumbledom.—The Electric Lighting Committee of the parish of St. Marylebone is very much incensed with the member of Parliament for that district. This gentleman (Mr. E. Boulnois) has dared to take an independent view of the advantages of the Central Electricity Supply Company's Bill, and unfortunately this is diametrically opposed to that of the Lighting Committee. In consequence the committee has decided to express to him their surprise and regret at his action in giving evidence before the committee of the House of Commons in favour of the Bill, in spite of the fact that the Vestry were opposing it. We trust that the health of Mr. Boulnois will not be impaired by the resolution in question.

Train-Lighting.—We understand that the London, Brighton, and South Coast Railway Company have just built a new Royal train at a cost of about £8,000. It consists of five steel-framed bogie carriages 52ft. long. The equipment and furnishing of these leaves nothing to be desired, while their convenience is greatly enhanced by the fact that they are electrically lighted. In this case one dynamo, driven from one of the bogie axles, is used for the whole train. Accumulators in one of the brakes will provide the necessary energy when the train is standing. Any regular traveller on the above line or on the South-Eastern Railway will have recognised the great advantage of having electric light on the main-line service.

Institution of Civil Engineers.—The council of the Institution of Civil Engineers have made the following awards for papers read and discussed before the institution during the past session: a George Stephenson medal and

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premium to Mr. R. A. Hadfield, a Telford medal and premium to Mr. J. T. Milton, Watt medals and premiums to Sir Albert J. Durston and Mr. H. J. Oram, a Crampton prize to Mr. Francis Fox, a Manby premium to Sir William Roberts-Austen, and Telford premiums to Mr. J. M. Dobson, Mr. W. G. Kirkaldy, and Mr. A. P. Head. The presentation of these awards, together with those for papers which have not been subject to discussion and will be announced later, will take place at the inaugural meeting of next session.

Steam-Engine Trials.—A special class in this subject, intended for draughtsmen and advanced engineering students, is to be held at the South-Western Polytechnic, Manresa-road, Chelsea, S.W., on every Tuesday evening from May 9 to June 13 inclusive. This will be conducted by Prof. Pullen, Wh.Sc., A.M.I.C.E., and Mr. H. A. Clark, Wh.Sc., A.R.C.S., A.I.E.E., and the hours are to be from 7.30 to 10 p.m. The main object of the trials will be the determination of the indicated horse-power, brake horse-power, mechanical efficiency, steam consumption, and heat used per indicated horse-power and brake horse-power hour, with varying loads and constant speed and constant load with varying speed. The fee for the course is 10s.

Physical Society.—We regret to note that, owing to pressure of general work, Mr. Rollo Appleyard has been obliged to resign the official reportership of the Physical Society. Our regrets are deepened by the fact that for some years we have enjoyed the receipt of the reports from Mr. Appleyard, who possesses the happy knack of presenting even the most abstruse papers and discussions in that concise way which appeals to the general reader. In reporting the discussions of the society, he also hit the happy mean of giving the points made by each speaker without undue verbosity. While wishing him every success in his future career, we also hope that the Physical Society will be able to secure the services of a capable successor.

Bohemian Concert.—A Bohemian concert is to take place this evening in the grand hall of the Freemasons' Tavern, Holborn, and will be under the auspices of the staffs of the City of London, the Metropolitan, and the London Electric Lighting Companies. The following are announced to take part: Madame Kate Cove, Miss Jessie Hotine, Miss Emily Foxcroft, Mr. Dalgety Henderson, Mr. Charles Tree, and the Field-Fisher Quartette. Humorous sketches will find exponents in Mr. Mel B. Spurr, Mr. Charles Conyers, and Mr. Walter G. Churcher, and Mr. John Warren will also contribute to the programme. Mr. J. Cecil Bull is to preside, and the accompanist during the evening will be Mr. Sidney Hill. The concert commences at 7.30.

Speech Magnifier.—Dr. Oliver Lodge in his recent paper before the Institution of Electrical Engineers commented on the fact that up to the present it had not been possible to magnify speech with the telephonic apparatus at our command. Any attempt tends to unduly magnify certain sounds in preference to others. In this way the distinctness of utterance is lost. We are now informed that Mr. E. Berliner, of America, is trying to effect this by means of synchronising a number of phonographs, all of which are equipped with identical records of the same speech. Employing six such phonographs, all alike and speaking simultaneously, he claims that the effect produced is the same as a much stronger voice when so given to a single apparatus. It would seem to us that the trouble with such apparatus would be to get driving gear so perfect that absolute synchronism could be obtained. Otherwise the plan is exceedingly simple.

Electricity on the Metropolitan Railway.—The advantage of the introduction of electric traction on the Metropolitan and District Railways is exemplified by the evidence of Mr. Preece before the Select Committee of the House of Commons in connection with the Baker-street and Waterloo Railway Bill. Mr. Preece pointed out that by the use of electric traction the present mean rate of travelling would be increased from 11·2 miles per hour to at least 14 miles; and the present time occupied by the journey round the whole inner circle would be reduced from 70 to less than 50 minutes. This would make it possible to add eight new trains to the service, and increase the traffic capacity of the line by 35 per cent. It was also contemplated to run a 1½-minute service, which would double the carrying capacity of the Metropolitan. He considered that the contemplated changes were within a very reasonable distance of accomplishment.

Paris Metropolitan Railway.—We have received a report of an extraordinary general meeting of the Compagnie du Chemin de Fer Metropolitain de Paris, which was held last week to make certain alterations in the articles of association in order that the company may conform to the regulations of the French Government. We understand from the report of the meeting that the work is being pushed forward very rapidly, and that the first section is likely to be completed by the end of this year. The company has already ordered 40 carriages equipped with motors, and 115 ordinary carriages. The electrical equipments for these motor vehicles will be supplied by the Compagnie Générale de Traction, and will be of the Westinghouse type. Two motors, each of 100 h.p., will be placed on each vehicle. The cables and other requirements of the line are also ordered. The electric power station will be equipped by Messrs. Schneider and Co., of Creusot. It is hoped that one track will be ready by the time the exhibition opens next year.

Electrocution.—Messrs. J. L. Prevost and F. Battelli presented a communication to the Academie des Sciences at Paris on March 13 on the action of continuous currents on animals, such as the dog, the fowl, the rabbit, and the rat. These gentlemen had previously presented a note to the institution on the effects of alternating currents, and their results with continuous currents are compared with these. A more cold-blooded series of experiments we should think it would be difficult to find, and it is a matter of opinion whether the results obtained are worth what has been gone through to obtain them. The authors found that dogs died from paralysis of the heart when subjected to the comparatively low tension of 50 or 70 volts, but that respiration continued for several minutes. After being subjected to the current for a short time the dogs could not be restored to life by artificial respiration. With a common fowl higher voltages up to 100 were required to produce similar effects, and from 2,000 to 3,000 seemed to be the most favourable voltage to stop the action of the heart. With a rabbit the cause of death was due to interruption to respiration rather than to interruption of the heart's action. The same results were found in the case of a rat.

Electrical Developments in Italy.—According to a writer in the *Financial News*, electricity is playing a prominent part in the development of Italian industrial life. Every day witnesses the application of it in one form or another. Electric lighting is the order of the day throughout the country. Small rural places which never found the means of defraying the cost of a public gas illumination, and were satisfied with oil lamps, have suddenly awakened to the advantages of electric lighting, and have adopted it. Horses and steam power, which used to propel

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numerous omnibus and tramways, have been replaced by electric traction, and municipalities are daily petitioned for the granting of similar concessions. A patent has just been taken out in Italy by a Captain Stassano for a process to produce iron and its derivatives by means of special electric furnaces. A group of capitalists and manufacturers of Brescia, Turin, and Rome, confident in the future of the patent, have formed a company for its exploitation, called the Società Elettrosiderurgica Camuna. The capital is £36,000, of which about £24,000 has been issued in shares of £40 each. Technical details of the process are not to hand, but the capital available should enable some commercial experiments to be made.

Electric Traction in Switzerland.—We gather from statistics furnished by Mr. Charles Rochat to the *Street Railway Journal* of New York that in Switzerland last year 13 new lines or portions of lines for electric traction, representing a total length of over 47 miles, were put in operation. This is an increase of 65·5 per cent. over the entire length of line as existing at the end of 1897, and it brings up the total length of electric railways and tramways now in operation in Switzerland to a trifle over 105 miles. The author proceeds to give some useful details of the electric tramways and railways which are working, and also of those which are in course of erection. It is interesting to note that in the case of nearly one half of the lines power is obtained from water. In this way the tramways of Switzerland will cost comparatively little to work as compared with some lines in which coal has to be used. In a number of other instances we notice that the necessary power has been taken from the electricity supply stations of the towns through which the tramways pass. Here, again, the combination of lighting and power is good, and we are glad to notice that the tramway companies in Switzerland are not so keen on owning their own power works as are companies in England.

All-British Cable.—By a Reuter's telegram from Ottawa we learn that Mr. William Mulock, the Dominion Postmaster-General, has given notice of a resolution authorising the Government to enter into an agreement with the United Kingdom and the Australasian possessions to construct, lay, and operate a cable between Canada and Australasia on the following conditions: A Board of Commissioners to be created under the legislative authority of the British Parliament, and the cable property to be vested in such Board in trust for the benefit of the respective Governments sharing in the undertaking, and in proportion to their respective interests therein; the Board to issue debentures for the necessary payment of capital, and the said capital, principal, and interest to form a first mortgage on the property and earnings; all the landing points to be in British territory; the number of the Commissioners and their tenure of office to be determined from time to time by the interested Governments, each having appointments of a number proportionate to their contribution; the respective Governments to be interested in the profits and losses in the same proportion. Finally, the Governor in Council is to be authorised on behalf of Canada to guarantee the payment of five-eighteenths of the principal and interest.

Electrolysis of Alkali Chlorides.—A valuable communication on this subject by Mr. F. Winteler, which appeared in the *Zeitung fuer Elektrochemie*, 1898, v., 10-15 and 49-51, is condensed in the *Journal* of the Chemical Society, which begins by a reference to the behaviour of different kinds of carbon when employed as anodes in the electrolysis of solutions of alkali chlorides. The formation of oxygen at the carbon anode, and consequent production of carbonic anhydride, is regarded as due to the decomposition of water by the chlorine condensed in the pores of the carbon. The greater the amount of hydrochloric acid present in the electrolyte, the less oxygen is evolved. Numerous experiments are described in which a solution of potassium chloride is electrolysed with a carbon anode, an iron cathode, and a porous porcelain diaphragm. The anodic liquid is always found to contain free hydrochloric acid, but neither hypochlorous nor chloric acid. The chlorine evolved contains about 5 per cent. of impurity, mainly oxygen and carbonic anhydride, with a trace of carbonic oxide. If it is attempted to increase the concentration of the caustic potash formed in the cathode compartment beyond about 8 per cent., the current efficiency falls below 70 per cent. By using a double diaphragm, a higher concentration of the caustic alkali may be attained, together with good current efficiency, but at the cost of a higher E.M.F. A number of samples of commercial electrolytic potassium chlorate were examined for perchlorate with negative results.

Sydney and Electric Lighting.—Sydney has at length arisen to its responsibilities in the matter of public lighting, and the streets may be lighted with electricity in the near future. According to the *New South Wales Railway Budget*, the City Council seems to have taken the matter up in earnest. A sub-committee has been appointed to take evidence from experts, and a number of gentlemen have come forward to give their testimony, all being in favour of the adoption of an improved system of lighting. If economically managed, our contemporary says that the lighting should be a source of profit to the municipality instead of a burden on the rates, and the evidence of Mr. P. B. Elwell, the electrical engineer of the Railway Department, it says, clearly shows that the City Council has an opportunity of supplying the light without being saddled with the expense of erecting and maintaining the machinery necessary to produce it. The Railway Commissioners are laying down a plant at Ultimo for supplying sufficient power to work the whole system of tramways in Sydney, and at the same time this plant can economically provide for the lighting of the city. An offer has accordingly been made to the Council to allot sufficient power at a cost far lower than would be the case if the municipality were to lay down and maintain the machinery necessary for the purpose. If the Council is wise, our contemporary adds, it will take this matter into serious consideration, more particularly as it would give an opportunity of testing the financial effect of the lighting without incurring a heavy initial outlay.

Tramway Speed Curves.—Our readers will remember that in Mr. Dawson's excellent paper on electric traction read before the Society of Arts recently, he discussed the best way in which a quick schedule could be maintained on electric tramways and railways where the stopping intervals were frequent. Mr. Dawson's conclusions were that it paid to have a very rapid acceleration, thus bringing the car quickly up to a predetermined maximum speed. When this speed had been reached, the current could be turned off, and the car or train allowed to drift until the next station was approached. In this way the energy lost through braking is reduced to a minimum, and the energy required for the journey is also smaller than with a slower acceleration and a longer period of braking. In the current number of the *Electrical World* of New York the same subject is discussed by Mr. J. R. Cravath. This gentleman arrives at practically the same results as Mr. Dawson, and he also investigates the inter-connection of the power required and the time schedule. Curves connecting the number of watt-hours for a given train for a run of 2,000ft. when the schedule miles per hour varied from 14 up to 24 are given, and from the results (also shown by the same

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diagram) it is seen that it is most economical to use the whole of this energy in accelerating the car. The curve connecting the speed and energy, with the most economical arrangement, turns distinctly upward after 20 miles per hour with this length of run. For instance, the Board of Trade units required in a run of 2,000ft. are as follows: 16 miles per hour, 1·4 units; 18 miles per hour, 2 units; 20 miles per hour, 3 units; 22 miles per hour, 5 units; and 24 miles per hour, 7·5 units. It is not quite clear from the article what the weight of train is that the author refers to, but, of course, the figures will hold relatively in any case.

Electric Eddy Currents. — Prof. Silvanus P. Thompson, D.Sc., F.R.S., M.R.I., is to deliver early next month a course of two lectures on "Electric Eddy Currents." They are Tyndall lectures, and will be delivered on Tuesday, May 2, and Tuesday, May 9, at the Royal Institution at 3 p.m. In the first lecture Prof. Thompson will deal with the law of induction and its consequences, and will define the various quantities and units used in his lecture. He will also describe the discovery by Arago in 1824 of magnetic retardations, and will then refer to the researches of Barlow, Babbage and Herschel, Christie and Sturgeon. He will next proceed to deal with the "alleged magnetism of rotation." Prof. Thompson will give in detail the researches of Faraday in 1831, explaining these phenomena. After referring to the researches of Le Roux and of Foucault, he will proceed to describe the heating phenomena due to eddy currents, which lead up to the necessity of laminating cores and coils. The syllabus of the second lecture is somewhat as follows. At the outset Prof. Thompson will consider eddy currents as retarding motion, and will refer to the Faraday pendulum, Foucault's gyroscope, the Arago disc as a brake, and to applications of the magnetic brake in instruments for measuring velocity in arc lamps and in electric supply meters. Eddy currents as retarding changes of magnetism are to be next dealt with, and reference will be made to copper damping circuits, and to the "amortisseur." Lastly, eddy currents as generating motion will be considered, and Prof. Thompson will refer to Elihu Thomson's researches, to Baily's motor, the researches of Ferraris on the rotary magnetic field, Tesla's motors, to Shallenberger's motor, and to modern induction motors. The fee for this course of lectures will be half a guinea.

Calcium and Calcium Hydride.—A communication on this subject by Béla von Lengyel, which was reproduced in the *Chemischer Centralblatt*, 1898, ii., 262, is thus given in an abstract form in the *Journal* of the Chemical Society: The author has obtained calcium by electrolysing anhydrous calcium chloride in a graphite crucible containing a porous earthenware cell, the former being connected to the positive and the latter to the negative pole by means of iron wire; a current of 10 to 18 amperes at 70 to 110 volts is employed. After removing the excess of calcium chloride by allowing the regulus to remain in anhydrous ether, a material containing 99·2 per cent. of calcium may be obtained. The metal has a specific gravity =1·5540 at 18deg, and its properties correspond with those of Mathiessen's preparation; it has the colour of a gold alloy rich in silver, and is not affected by cold dry air, but burns with a dazzling light when heated to bright redness; it also burns in chlorine and in sulphur vapour, but combines with iodine without emitting light. From concentrated or dilute hydrochloric acid and from water, calcium liberates hydrogen, but it is not attacked by concentrated sulphuric or concentrated nitric acid unless boiled with it. Calcium unites with hydrogen at the ordinary temperature to form the hydride, CaH_2, and at a red heat the action is very energetic; the hydride is a greyish earthy substance, and decomposes water more readily even than the metal, the hydrogen often inflaming. It burns in oxygen at a red heat, emitting a brilliant light, combines energetically with chlorine at a red heat, glows when heated in iodine vapour, and falls to a grey dust when heated in sulphur vapour. Towards acids, calcium hydride behaves like calcium itself, but it attacks ether with violence. The author has not succeeded in preparing metallic barium, and finds that strontium is more difficult to obtain than calcium.

Smart Tramway Work. — The London United Tramway Company have in the past found great difficulty in persuading various local authorities to allow them to run electric tramways through their districts. Having acquired permission in a large number of cases, the managing director of the company, Mr. Clifton Robinson, is pushing the work on at great speed, and he has succeeded in disposing of some opposition in a way which commends itself to the approval of engineers in general. It seems that on a certain part of the Chiswick High-road a few old houses projected a long way in front of the frontages of other houses, leaving only a comparatively narrow footway. These houses are to be removed shortly, and the tenants will have to suffer some inconvenience in consequence. The tramway company's mains are being laid along that side of the road, underneath the footway, at a considerable depth—8ft. or 10ft. When the trenches for the ducts were being laid in front of these houses, one of the owners decided to apply for an injunction to restrain the company from carrying out the work on the ground that damage would result to the property. A writ was served on the tramway company after six o'clock in the evening, and when all the workmen had left for the day. This fact, however, did not paralyse the managing director of the company, who promptly hunted up all the men he could find, of whatever sort. With the aid of these, the work in front of the house in question, and of the neighbouring four houses, was completed and the trench filled in by six o'clock next morning. As a consequence, when the application for an injunction came on for hearing the next day the plaintiff thought it wise to pay the costs of both sides, as it was obvious that an injunction could not be granted when the work was completed. Our readers will thus discern that the London United Tramways' work is in able hands.

Lightning Discharges.—Mr. W. J. Morton, M.D., communicates to the *Electrical World* a short article on "Spiraling and Vibratory Nature of Lightning and other Electric Discharges." He refers particularly to a photograph of a lightning discharge which appears to consist of a number of spirals. Dr. Morton considers that this spiraling effect is not caused by anything in the camera, but that it actually occurs in oscillatory discharges. He considers that the electric disruptive discharge or spark consists of two parts travelling in opposite directions, together constituting a current; that these two parts move in opposite spirals around each other; that, in the spark form, the direction of the spirals is frequently and mutually alternated; and that the angular, broken, or zigzag appearance of lightning and of large and long sparks represents the point at which the alternations in direction of the double spirals occur. He also says that if in the air-gap part of an electric circuit a current consists of two parts spiraling around each other, the same may be true of the current in the metallic or conducting part of the circuit. Finally, he considers that two spirals moving in opposite directions and upon each other must be subject to friction, and thus occupy time in

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their progress, as well as present other phenomena of friction.' The author concludes by stating that yet another hypothesis may be added to the thesis thus far adduced that the nature of the disruptive discharge is spiraling, and this is, that not alone is the discharge spiraling, but also that an entire discharge or any single oscillation constitutes a rate of vibration where each wave is of a spiraling type (probably like reversed corkscrews worked one within the other), and where an electrical node exists indicated by the point where the double spirals take a new or a renewed direction of rotation. From this point of view it is not unlikely that the "zigzag" appearance of lightning and ordinary spark discharges indicates a number of spiraling wave lengths whose nodes are visible as sharp and abrupt changes of direction.

Glasgow Telephones.—An enquiry has recently been held in Glasgow, at the instance of the Lord Advocate, on behalf of the Postmaster-General, in which his lordship was asked to intervene between the Post Office authorities and the Glasgow Corporation as to the laying of telephone lines under the city streets. The Telephone Company were refused permission to put down underground wires, and the Postmaster-General now applies to do this on his own account. The Corporation again object, on the ground that the same veto exists against operations by the Postmaster-General as was provided by the Act of 1892 against private companies. The Corporation's position with respect to the Telephone Company, whose application had previously been rejected, was that it was injudicious to give a company a right to use their streets, as by so doing the municipality would be deprived of their control. In support of the application it was, however, urged that the telephone was part of the telegraph system, and that the Postmaster-General had power to grant licenses and apply for wayleaves from municipalities. Whatever the result of the enquiry one thing is clear, and that is, that it is no business of a municipality to oppose what is intended for the public good. Glasgow is the home of municipalisation, but that is no reason why there should not be allowed occasionally a little healthy competition. Again, there seems to be a tendency in some quarters to impose all kinds of royalties before allowing mains to be laid down, but, as we recently pointed out in dealing with a case in point, the terms imposed did not seem to us to be reasonable, as if a telephone company made good the streets after opening them up this was all that should be expected of them, for any other charge would have to be borne by the subscribers themselves. Since the above was written, Sheriff-Principal Berry has issued his award. The Sheriff, having considered the case and the various documents, awards and orders that the said condition ought not to be attached to the consent of the Corporation of Glasgow.

Alternate-Current Curves.—The article in the March number of the *Physical Review* by Mr. H. J. Hotchkiss on a portable apparatus for photographing the curves of two variable currents simultaneously is of great interest, especially at the present time. It should be read and compared with the excellent paper by Messrs. W. Duddell and E. W. Marchant under discussion yesterday at the Institution of Electrical Engineers. There are, in fact, several points of similarity between the apparatus designed in America and in England; and, again, there are several distinctive variations. Mr. Hotchkiss uses a needle of soft iron, mounted on one side of a quartz fibre with a mirror about one-third as large as the iron on the other side. The fibre is supported vertically in a comparatively weak field with an iron needle 1mm. wide, 1·9mm. long, and ·06mm. thick. A period of vibration corresponding to 8,500 double vibrations per second is obtained with a strong field, and with a stiff fibre the author has obtained 10,000 double vibrations per second. Two such galvanometers are used side by side in a box about 18in. long and 6½in. wide. The galvanometers are placed at one end of this box and the photographic plates for recording at the other. The arrangements for moving the photographic plate are very ingenious, and take up much less space than in Messrs. Duddell and Marchant's apparatus. Photographs of the full details of this apparatus are shown in our contemporary, and also some most interesting curves obtained by it. By using two galvanometers in the same box, simultaneous readings of electrical quantities can be obtained on the same photographic plate. In this way the action of an electrolytic cell with carbon-aluminium electrodes is clearly shown. The complete cutting off of current in one direction is most marked, except when higher voltages are used, in which case a small amount of current is got through a cell in one direction. The author has used his apparatus to experiment on a large number of alternators, and it seems that the true form of these E.M.F. curves are given by it.

New Theories. — Almost everyone interested in scientific work, particularly, perhaps, in electrical science, has met at one time or another a man who has gone more or less mad on a theory of his own. Probably electrical editors have special facilities for observation in this line, and have to endure at times larger wastes of mental energy than others in trying to convince such enthusiasts of the errors of their ways. We notice that the *Electrical World* of New York has recently had some such theorist to deal with. On the general hypothesis of the composition of the sun this gentleman writes as follows: "An ice lens will converge the rays of the sun to a focus and set fire to combustibles, and no person possessed of a competent faculty of thinking and reasoning will, he believes, venture to assert that actual heat can come from the sun to the earth through 93,000,000 miles of cold and darkness of space and pass through a lens of ice and ignite combustibles. It follows that something which is neither hot nor bright comes instantaneously and incessantly from the sun to the earth and awakens our atmosphere to heat, light, and power. The sun, consequently, may be dark, cool, and habitable, and filled with light, intelligence, and beauty, like unto the earth, and still heat and light the satellites the same as now. These facts the enthusiast asserts are conclusive, and clearly show that the present theory of an incandescent ever-consuming sun is an absurdity and a stigma upon science. The assertion is made that 'the sun does not consume; that for millions of years it has not been known to lessen a single foot in its dimensions or a single foot-pound in its energy.' The 'fireball' sun of science must therefore be relegated to the shades of a misty past, and motion as a cosmical principle take its true and just position in the great cosmical field. But how do the motions of the heavenly bodies become transmuted into every form and manifestation of force? The enthusiast's reply is that this is no longer a mystery. The explanation, he says, is 'simple, very simple.' The earth is a magnet with a magnetic axis and poles. The sun and all stars are magnets polarised in immensity. The sun in motion, acting and retroacting in concert with its celestial neighbours, becomes a stupendous dynamo magnet, with all the powers which its vast mass and its inconceivable velocities imply. Following the statement that it is a principle of electrical science that two bodies rotating near each other disturb and set in motion electrical currents in both bodies, the final conclusion is given in display type, 'Electricity is the universal force.'"

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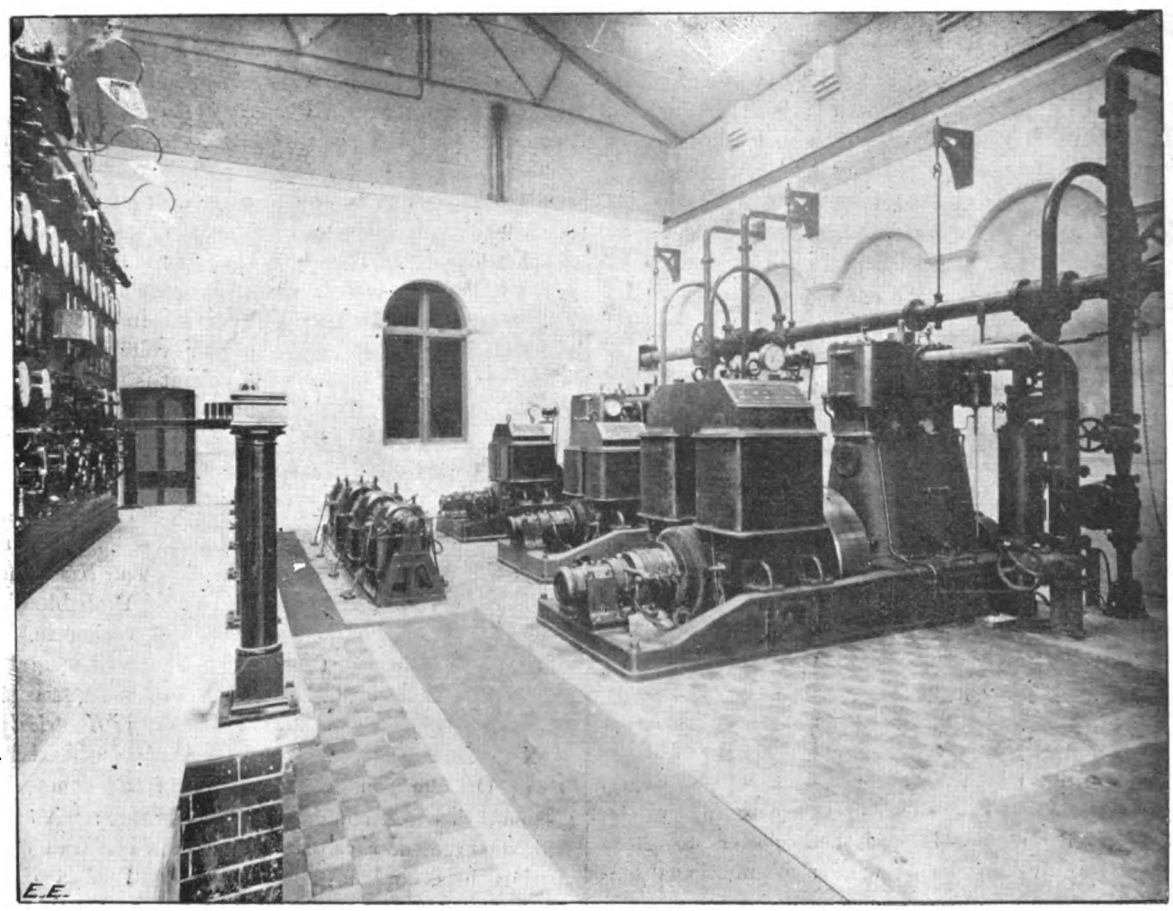
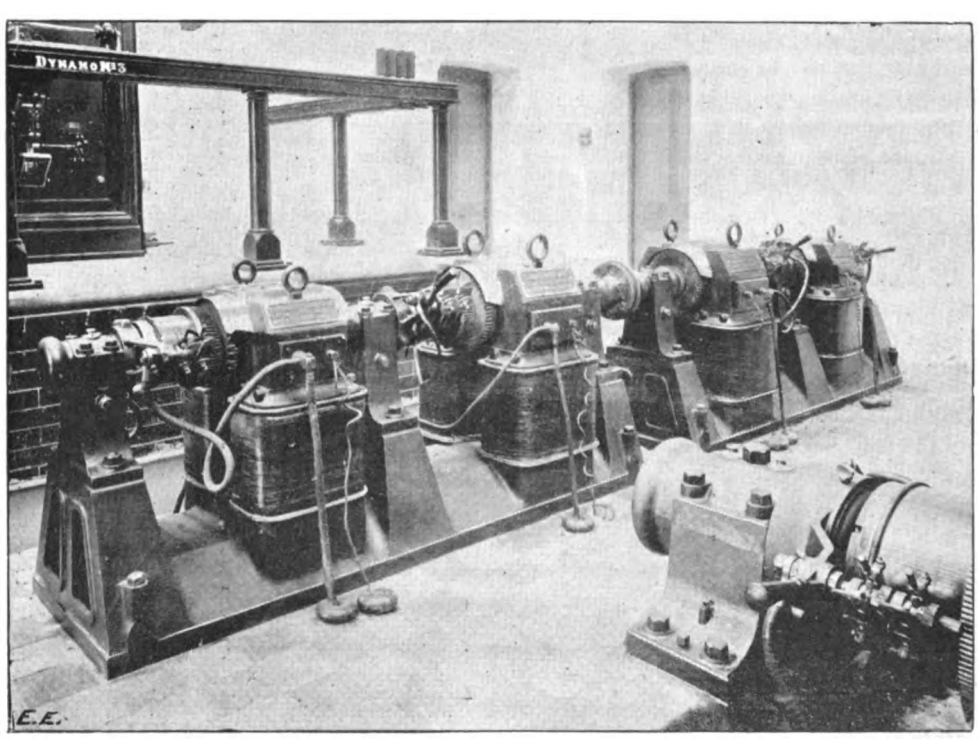
BOOTLE ELECTRICITY WORKS.

(Continued from page 501.)

Switchboard.—This is arranged for the connection of four dynamos, four feeders, two batteries, one balancing transformer, two boosters, and also for the middle-wire connections from feeder points Nos. 2 and 4, the middle wire being permanently earthed at the station through a recording ammeter. The switchboard is arranged on three slate panels carried in steel frames, and cased in on the outside with varnished teak. The instruments and apparatus in connection with the battery and the balancing transformer and the boosters are arranged on the centre panel, together with the voltmeters and their switches. The instruments and apparatus on the negative side of the dynamos and feeders are arranged on the panel to the right of the centre one, and those on the positive side on the left panel. In the circuit of each dynamo there is one automatic switch, fitted with fuse, and arranged to drop when the current falls below 10 amperes; and interlocked with this is a shunt



View of the Engine-Room at Bootle.—Photo by W. H. Dowden.



The Balancing and Boosting Set at the Bootle Electricity Works.—Photo by W. H. Dowden.

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switch, by which the field is closed through a non-inductive resistance when the circuit is opened. One ammeter and one 25-way multiple-contact switch with suitable resistance coils is provided for regulating the shunt circuits of each dynamo. In the circuit of each feeder are placed two duplex fuses, each provided with a switch by which the fuses can be used singly, and the corresponding fuse disconnected, and two ammeters. At the back of each outer or feeder panel three horizontal omnibus bars of wrought copper are fixed, the two upper ones being provided with screwed holes placed opposite the plugholes in the vertical feeder and dynamo bars; and the lower one being provided with screwed holes placed opposite the plugholes in the vertical dynamo bars only, so that any dynamo may be connected to the traction board. On the centre, or battery and balancing panel, is placed one double-pole starting switch and fuse in the circuit of the balancing transformer, interlocked with the multiple-pole starting switch; two multiple-way switches for regulating the fields of the transformers; one ammeter in the circuit of each balancing armature; one middle-wire ammeter; and one recording ammeter connected up in the earth circuit. In the circuit of each battery is one single 14-way charge and discharge switch, one battery ammeter, one registering meter reading direct in ampere-hours; one battery emergency switch, and one single-pole throw-over switch for connecting the battery either on to the booster for charging or to the mains. In the booster circuit one multiple-way switch for regulating fields of booster is placed. The ollowing voltmeters are also arranged on the centre panel: two dynamo and 'bus bar voltmeters, two feeder voltmeters two battery voltmeters, and two booster voltmeters. A meter registering in ampere-hours is also fixed in the circuit of each dynamo, and two recording voltmeters for registering the E.M.F. at various feeding points. All the ammeters are Kelvin ampere-gauges, while the feeder voltmeters are of the Weston type. The dynamo 'bus bar and battery instruments are of the Kelvin electrostatic type.

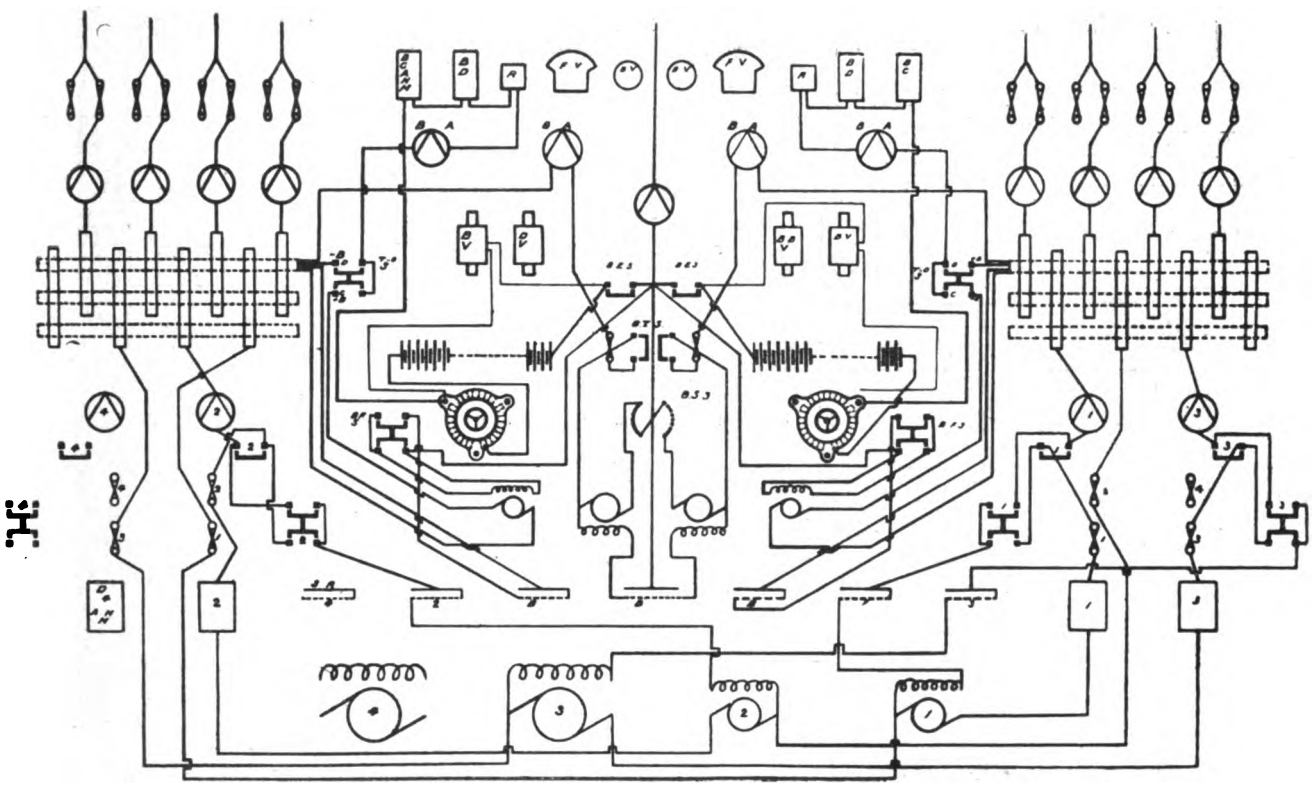
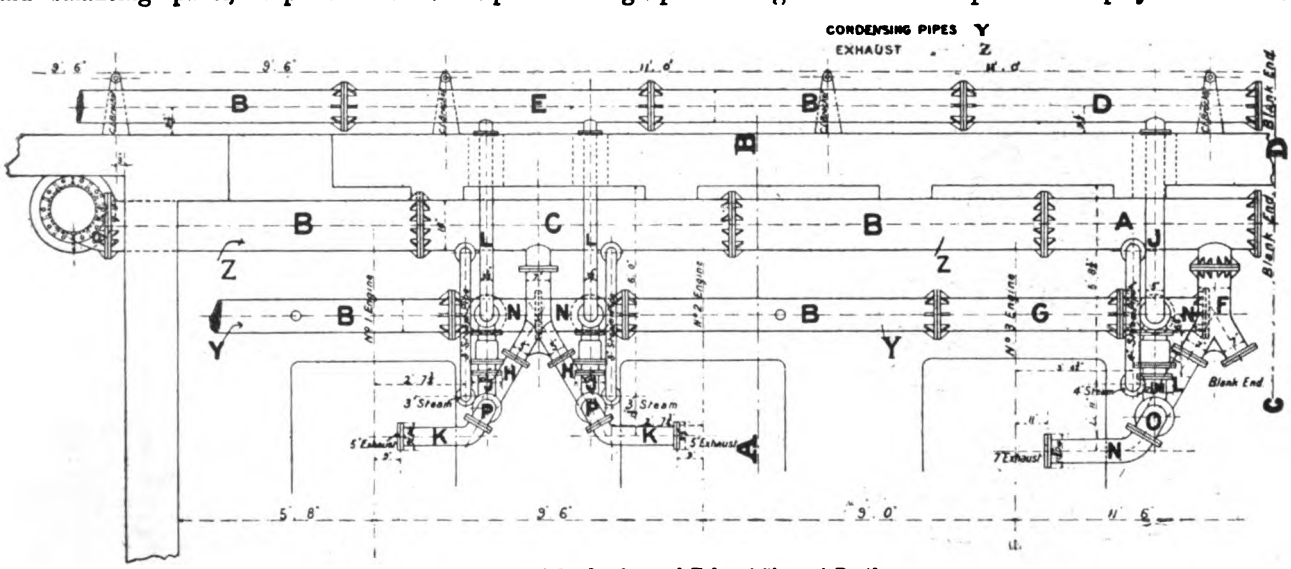


Diagram of Switchboard Connections at Bootle.

Pumps and Pipes.—The two feed pumps are of the Worthington type, each having a capacity of 1,500 gallons per hour against the boiler pressure employed. The feed pipes are arranged to draw from the feed tank, delivering through the small heater and thence through the meter to the economiser, or else past both heater and economiser to the boilers. They are of cast iron, with copper connections to boilers. The steam-pipes are of steel, with branches riveted on. The ring main is 8in. diameter by ¼in. thick, and the branch pipes from the boilers are 6in. diameter. The bends are of copper. The main exhaust pipe is 16in. diameter, and of cast iron. The condensing water pumps



Arrangement of Condensing and Exhaust Pipes at Bootle

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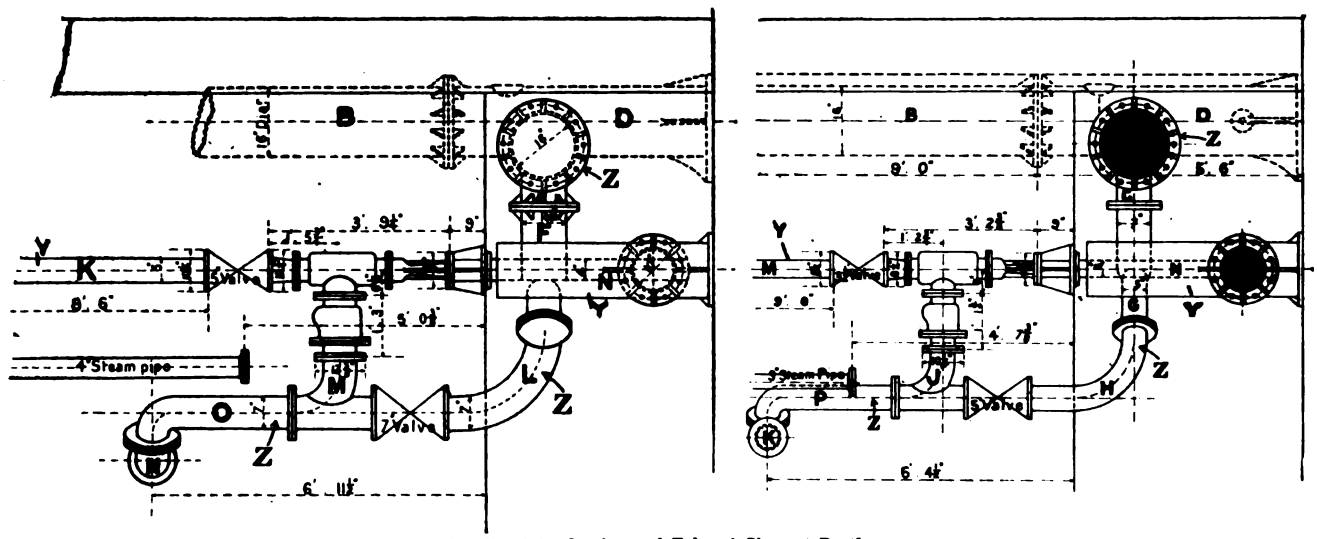
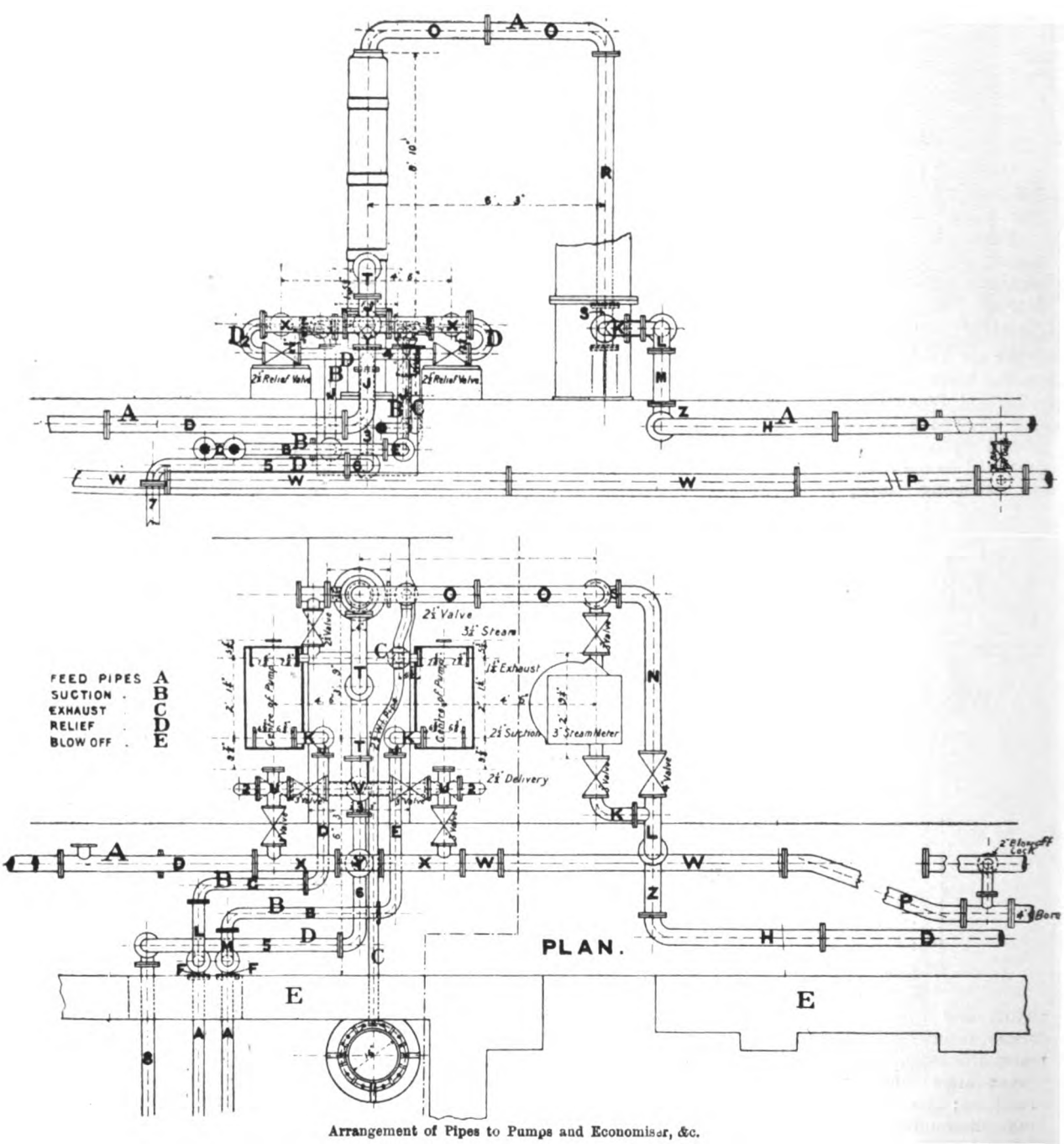
draw from the brick feed tank, which is of 22,500 gallons capacity, and is placed under the pump-room and connected



Details of Condensing and Exhaust Pipes at Bootle.



Arrangement of Pipes to Pumps and Economiser, &c.

with the canal by two inlets, each being provided with a coke filter, and deliver into a cast-iron tank of 7,500 gallons capacity placed on the roof of the pump-house to give the necessary head for the condensers. From this tank a 10in. diameter cast-iron supply pipe is taken, from which the branches to the condenser on each engine are

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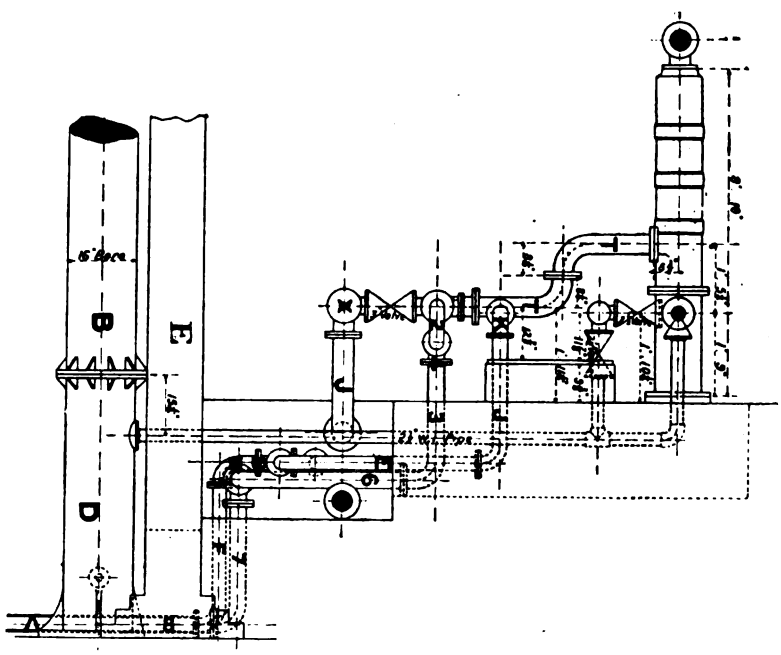
led. Carrick and Ritchie have supplied a travelling crane, capable of lifting eight tons, which traverses the full length of the engine-house.

Battery.—There are two Chloride batteries of the R type, each containing 125 cells, and having a normal capacity of 500 ampere-hours—*i.e.*, 100 amperes for five hours, or 300 amperes for one hour, without the E.M.F. falling below 1·86 volts. Each cell contains 25 plates in a glass box.

Mains.—The feeder points are shown on the map. The mains are paper-insulated, lead-covered, and are laid in earthenware troughs, and run in solid with bitumen. The feeders laid are as follows: No. 1, ·6 square inch; No. 2, ·6 square inch; No. 3, ·4 square inch; No. 4, ·6 square inch. Neutral wires are run from the station to Nos. 2 and 3. The distributing mains are of the following sizes—viz.: large size, ·25, ·125, and ·25 square inch; medium size, ·15, ·10, and ·15 square inch; ordinary size, ·10 ·06, and ·10 square inch; small size, ·06, ·06, and ·06 square inch.



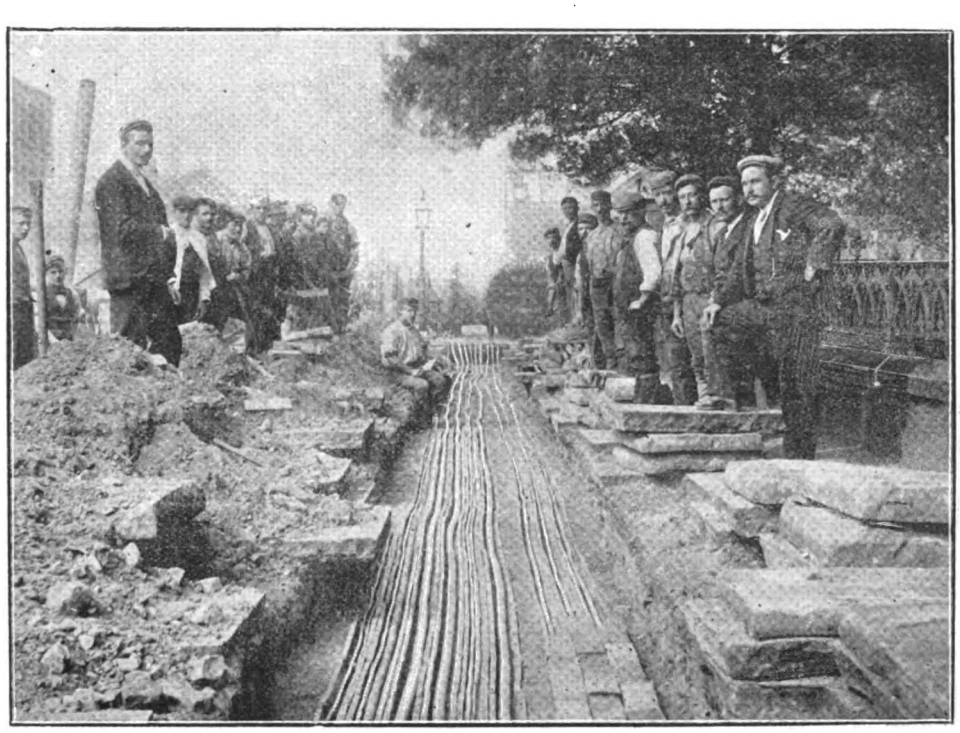
Arrangement of Pipes to Pumps and Economiser, &c., at Bootle.

Public Lighting.

A total of 72 10-ampere lamps have been sanctioned, the lamps being of Johnson and Phillips's make, fixed on poles by Lucy and Co., each pole being arranged with brackets for two 16-c.p. incandescent lamps, with "Friedreau" lens reflectors, which will be switched in at midnight when the arcs are turned off. In the extended scheme for which application is being made by the Council for borrowing powers, the public lighting will consist of 232 10-ampere arc lamps, each fitted with two 16-c.p. incandescent lamps, and 223 converted gas lamps, in which 16-c.p. incandescent lamps in "Friedreau" lens reflectors will be placed.

System of Charges.

The Brighton system has been adopted, the charge being 7d. for the first hour and 3d. per unit after. The load on the station at the present time is that obtained from the equivalent of about 7,000 35-watt lamps connected. It is intended to increase the public lighting to 232 arc lamps and 687 incandescents.



Laying Mains at Bootle.

Staff.

The station has been placed in the charge of Mr. F.

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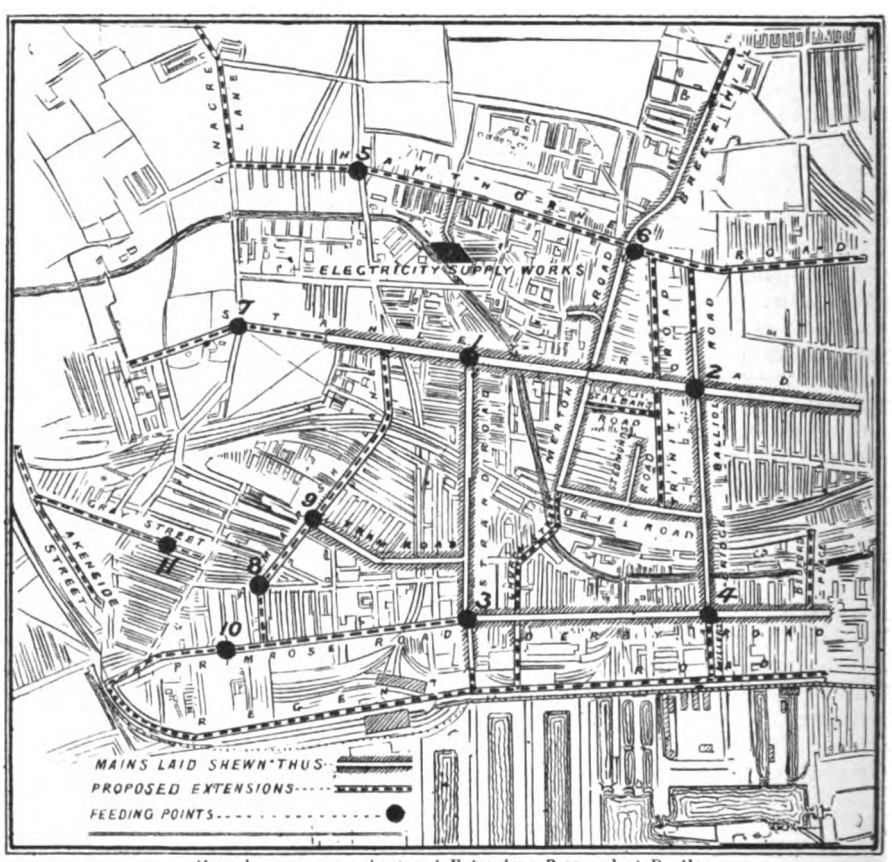
Robins, who will be assisted by Messrs. Hall and Francis; these gentlemen, acting for the contractors—Messrs. T. Parker and Co.—who are answerable for the efficient working of the station over a given period.

The Opening Ceremony.

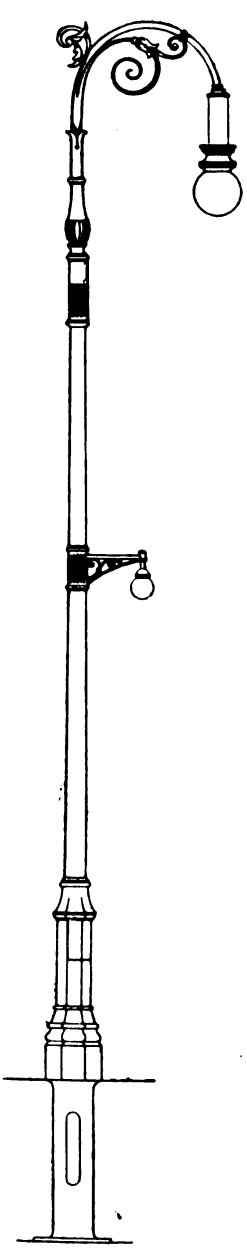
On Thursday, April 20, 1899, the Bootle central station was formally opened. A large number of guests assembled at the town hall, from whence a few minutes' drive took them to the station. The formal proceedings were exceedingly business-like and practical. The chairman of the Watch Committee, Mr. I. A. Mack, welcomed the visitors, and briefly referred to the work, the successful completion so far being seen that day, and called upon the engineer, Mr. T. L. Miller, to technically describe the works. This Mr. Miller proceeded to do without waste of words, clearly describing the details of the apparatus. Then Mr. T. Parker, the contractor, took up the parable, referring more especially to the ruling conditions under which ratepayers became owners of such electrical works. The Mayor was then asked to switch on the light, the operation being quite successful. On this occasion the proverbial hitch was absent. Steam was then turned on to another engine and the street lights switched on, the guests driving back through the wide and well-paved streets to see the effect of the arc lamp lighting. On returning to the town hall the guests were

COUNCILLOR I. A. MACK, CHAIRMAN OF COMMITTEE, BOOTLE.

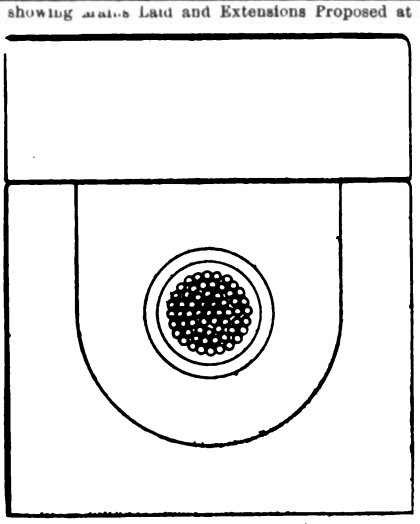
invited to dine with the Mayor, and spent a most enjoyable evening discussing a good dinner, with the after accompaniments of speeches and music. The speeches were excellent of their kind, but mostly for local consumption, hence with



Map showing Mains Laid and Extensions Proposed at Bootle.



Lamp-Pillar. Total length—30ft. from base, 26ft. from ground line.



Earthenware Trough, with ·5 Low-Pressure Single Cable—B. I. W. Co.—Bootle.

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best wishes for the success of the undertaking we close our description of this neat little station.

Mr. Isaac Alexander Mack is the chairman of the Watch Committee of the Corporation of Bootle. He has been a member of the Town Council since 1887, and for the past 10 years has been chairman of the Watch Committee. That committee has been entrusted by the Council with the execution of its powers in regard to electric lighting. Mr. Mack is a member of the firm of Messrs. J. J. Mack and Sons, shipowners and stevedores, Liverpool, and is connected with several commercial undertakings. He has for many years taken an active interest in public affairs in Bootle, and was appointed a magistrate of the borough in January, 1893. He occupied the position of mayor of the borough for the two years 1896 and 1897. In the latter year he represented the borough at the Jubilee of her Majesty. Mr. Mack takes keen interest in philanthropic and social work, and has been ably assisted in this respect by his wife.

NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

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CLXIII.

The Crowdus accumulator hails from America, and was originally supposed to embody several points of originality, including an aluminium support for the spongy-lead active material, and the indirect reduction of this material by the deposition of zinc from an electrolyte of sulphate of zinc in lieu of the usual dilute sulphuric acid. These two novelties have probably been dropped altogether, but some others, such as the mode of connecting the plates of similar polarity at two or more points beneath the surface of the electrolyte, may very possibly have been adhered to. The battery is of the pasted type, and the peroxide support, at least, is of thin rolled lead, with elongated rectangular apertures produced without any removal of material by bending portions of the plate alternately in opposite directions, so as to form ribs which constitute longitudinal recesses extending practically from top to bottom of the plate. Within these recesses is contained the active material, "which consists preferably of a specially prepared hard, but porous, paste of red lead." The support may be said therefore to be *embedded* in the active material, and thus to a great extent protected from local action—a point which constitutes the main advantage of the battery in combining lightness with durability.

It must be conceded that a plate so constructed has but little tendency to warp or buckle, and such action is further counteracted by the means adopted to obviate internal short-circuiting—viz, by the insertion between the plates of a corrugated and perforated separator, usually of ebonite.

In March, 1898, when this accumulator was in process of development, Mr. A. M. Keays, A.I.E.E, carefully tested four of the cells under my supervision. The results obtained were encouraging, though they were not regarded as entirely satisfactory, the rates of discharge per pound of cell complete being respectively ·637, ·637, ·673, and ·664 ampere. The capacities per pound of cell were 5·13, 4·99, 4·87, and 5·72. I have not had an opportunity of testing the cell as at present manufactured, but taking the case of the 225 ampere-hour accumulator, the specific capacities at three different rates of discharge which are now claimed for it are as follows:

(*a*)	$\frac{\text{Ampere}}{\text{lb.}}$	= ·767,	$\frac{\text{Ampere-hours}}{\text{lb.}}$	= 7·5 ;
(*b*)	,,	1·17,	,,	6·6 ;
(*c*)	,,	1·50,	,,	6·0 ;

The Crowdus accumulator is now being manufactured in this country.

CLXIV.

MM. Valls et Cie., of Paris and Lagny (Seine-et-Marne), are amongst the firms which have laid themselves out to meet the prospective demand for traction batteries. Admitting the impossibility of deciding at the present moment whether the lighter forms of accumulator will have more than a transient *vogue*, and may not ultimately have to give way to others of a more solid and durable description, they have designed three kinds of cell, respectively designated as "normal," "light," and "very light." These are all of the "pasted" type, and they bear a general resemblance to some of the forms which have been manufactured by the Electrical Power Storage Company. In the "normal" cell, the supports for the peroxide active material are constructed to withstand the effect of peroxidation of the metal, and of local action, for a very considerable period; having a substantial solid core, bearing subdivided grooves with a downward slant; the sub-divisions constituting cellules in which the active material is packed and securely retained. This support is symmetrically perforated with large apertures, for the double purpose of obviating the deformation of the plate and allowing circulation of the electrolyte. The weight of a "normal" peroxide plate 5·8in. by 5·8in. is 1·43lb., exclusive of lug and contact piece. That of the spongy-lead plate is ·88lb. (14oz). This is also given as the weight of the plates, of both kinds, in the case of the "light" and "very light" batteries, although the proportion of active and merely conductive material necessarily varies. In the case of the "normal cell" the specific rate of discharge and capacity are as follow:

$$\frac{\text{Ampere}}{\text{lb.}} = \cdot 73, \qquad \frac{\text{Ampere-hours}}{\text{lb.}} = 3 \cdot 63.$$

These are very low values for any traction cell, but it is interesting to compare them with the results obtained in the case of the somewhat similar E.P.S. "K" cell—viz.,

$$\frac{\text{Ampere}}{\text{lb.}} = \cdot 39, \qquad \frac{\text{Ampere-hours}}{\text{lb.}} = 1 \cdot 30.$$

In both cases "lb." signifies pounds of cells complete.

Passing on to the "light" form of the Valls accumulator, in which open grids are used for the supports of both kinds of active material, the specific values claimed are

$$\frac{\text{Ampere}}{\text{lb.}} = \cdot 79, \qquad \frac{\text{Ampere-hours}}{\text{lb.}} = 4 \cdot 77.$$

Lastly, in the case of the "very light" form, we have:

$$\frac{\text{Ampere}}{\text{lb.}} = \cdot 86, \qquad \frac{\text{Ampere-hours}}{\text{lb.}} = 4 \cdot 82.$$

In some experimental trials of this last form of the battery in traction work, the weight of the accumulator was 774lb., that of the vehicle when loaded was 2,860lb. (25½cwt. or 1·27 ton), and the distance traversed was 37½ miles, at the rate of about 7½ miles an hour. Thus 1cwt. of accumulator gave 6·9 ton-miles, or 16¼lb. of battery gave one ton-mile. The ton-mile is, however, a very indefinite unit, and the above data are of little value in the absence of information as to the character of the road traversed. From the point of view of practice, we shall always be on the safe side if we assume that the road is both hard and level, so that the traction pull (K) may, in the case of pneumatic-tyred vehicles, be taken as low as 28 (lb. per ton). On this assumption, 1 h.p. would run 30cwt. at the rate of 10 miles per hour. The assumption may be altogether unfair to the battery, since the coefficient of traction may often be as high as 140; but those who carry out experiments on traction with storage batteries should either give full particulars as to the road, or an experimental mean value for K, or else take the risk of its being assumed that the road is level and of the most perfect kind.

CLXV.

The "Pulvis" accumulator has attracted some attention in France. The active material, originally, is lead in the condition of powder. The lead support for the peroxide material is subjected to hydraulic pressure, which by closing the pores in the metal tends to render it less susceptible to chemical action. This support, about ⅓in. in thickness, is closely grooved on each face, the grooves being filled with active material. The spongy-lead support is of less thickness, and carries ribs of dovetail section. The corrugated and perforated ebonite separators which have been previously mentioned, are used to prevent contact between the plates. One point of novelty is that the containing vessels, and the prisms which support the plates, are made of *ambroine*, a material com-

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posed of fossilised resins, asbestos, and mica, finely ground, and moulded under pressure whilst hot.

The specific rate of discharge and capacity are :

$$\frac{\text{Ampere}}{\text{lb.}} = \cdot 85, \quad \frac{\text{Ampere-hours}}{\text{lb.}} = 4 \cdot 26.$$

CLXVI.

In the discussion (Nov. 11, 1897) on Mr. Epstein's paper, "Accumulator Traction on Rails and Ordinary Roads,"* the Marschner accumulator, used on the Dresden tramways, was referred to by Mr. E. Manby. In this battery the peroxide active material appears to bear some resemblance to lithanode. According to Mr. Manby, "the patent consists in the paste, which is composed of the ordinary salts (? oxides and sulphate) of lead incorporated with powdered amber and an essential oil. This mixture acquires a wonderful degree of hardness when formed into plates. These plates have been subjected to very severe tests at Dresden, have shown a very large electrical capacity, and have never cracked or broken up under the severest treatment. In the cells which are used on the Dresden tramways the plates are 11cm. by 27cm. There are 13 of those plates in each cell, and they weigh 13½ kilos; so that each plate, positive or negative, weighs about a kilo. With this small surface, they have given a very high efficiency, working at a normal rate of discharge of 65 amperes, and on emergency have risen to 120 amperes, without the slightest deformation of the electrodes, or without the slightest injury to the battery. They have run the Dresden tramway cars for a whole working day of 15 to 17 hours over a distance of 130 miles, without recharging. . . . The maximum discharge per kilometre of plates is nearly nine amperes. The normal discharge is one ampere for about 8½ square inches of positive plate, and the maximum discharge one ampere per 4·6 square inches of positive plate."

According to these figures, the capacity—4·1 ampere-hours per pound of plates—is nothing remarkable, but the current density, $\Delta = \frac{C}{a(n-1)}$ (LXXXVI.), is extraordinarily high. The size (not the surface) of a single plate is

$$a = (11\text{cm.} \times \cdot 4) \times (27\text{cm.} \times \cdot 4) = 47 \cdot 52 \text{ square inches};$$

the number of plates is $n = 13$;

the normal current is $C = 65$;

and the normal density is

$$\Delta = \frac{65}{47 \cdot 52 \times 12} = \cdot 114.$$

Whilst the maximum density is

$$\Delta = \frac{120}{570} = \cdot 21.$$

The number of square inches of peroxide *surface* required to give a normal current of one ampere is

$$\frac{1}{\cdot 114} = 9\text{in. (nearly)}.$$

CLXVII.

In the Headland accumulator the open-work lead supports for the active materials are of square cross-section, the peroxide and spongy-lead elements being arranged alternately in a suitable receptacle. This peculiarity of construction is advantageous in several respects; and the battery appears capable of withstanding a great amount of rough usage. So little has been published in relation to it that the following report may be of special interest:

"Report to Headland's Patent Electric Storage Battery Company, Limited, 11, Pall-mall, S.W., July 11, 1898.

	Cell No. H1.		Cell No. H2.
Mean current, amperes	25·0	...	25·0
Hours run	6·05	...	5·67
Ampere-hours	151·3	...	141·7
E.M.F. initial, volts	2·22	...	2·17
„ final, „	1·80	...	1·80
Potential difference initial, volts	2·14	...	2·14
„ final, „	1·60	...	1·58
Mean potential difference „	1·89	...	1·91
Total watt-hours	286	...	270
Weight of cells, kilos	14·9	...	14·9
„ „ pounds	32·8	...	32·8
Watt-hours per kilo of cell	19·1	...	18·1
„ „ pound „	8·7	...	8·2

The Electrical Standardising, Testing, and Training Institution; Hugh Erat Harrison, Principal."

From this report it appears that the following specific rate of discharge and corresponding specific capacity are applicable to this cell :

$$\frac{\text{Ampere}}{\text{lb. of cell}} = \cdot 75, \quad \frac{\text{Ampere-hours}}{\text{lb.}} = 4 \cdot 6.$$

CLXVIII.

In the Rosenthal accumulator (Patent No. 14,250–92), the active material is held in a perforated and corrugated piece of sheet lead forming the conductive support, so that the material on both sides is keyed together by contact through the perforations. The plate is contained within a frame of ebonite or other suitable non-conductive material; such frame being of about the height or thickness of the corrugated plate. The frame is on both sides covered with a perforated lid of ebonite; the lids and the frame being held together by through rivets, so as to form a closed box containing the plate.

The following specific values are claimed for this cell :

$$\frac{\text{Amperes}}{\text{lb.}} = \cdot 45\,;\ \cdot 91\,;\ 1 \cdot 36\,;\ 1 \cdot 82.$$

$$\frac{\text{Ampere-hours}}{\text{lb.}} = 7 \cdot 27\,;\ 6 \cdot 36\,;\ 5 \cdot 91\,;\ 5 \cdot 45.$$

The maximum specific rate of discharge is given as 2·7 amperes per pound of cell.

This battery has been adopted by the National Motor Carriage Syndicate, Limited.

ELECTRICITY ON AMERICAN VESSELS

BY J. MOGHIE.

(*Concluded from page 466.*)

The "Bremen," one of the new liners of the North German Lloyd line, can hardly be classed among the United States steamers, yet her electrical equipment closely follows, as far as generation and distribution is concerned, the systems installed on the vessels previously mentioned. The electrical installation was effected by the Union Electricitäts-Gesellschaft of Berlin. The "Bremen" is, perhaps, more fully equipped, electrically speaking, than any other vessel of the merchant marine of the world, for aside from the usual lighting plant, she has a complete and novel power plant.

The first power installations on the steamers of the North German Lloyd were made on the steamers "Darmstadt" and "Prinz Heinrich"; on these two vessels the noisy donkey engines were superseded by electrically-operated winches. It was the successful operation of these that determined the North German Lloyd to extend the use of electricity on the "Bremen." In this case, however, in lieu of winches a full equipment of electric cranes was installed. These cranes are 16 in number, eight on the starboard side of the vessel and eight on the port side. Four of these have a capacity of 3,000 kg., or 6,614lb., and 12 of 1,500 kg., or 3,307lb., with a total swing outboard of 20½ft.

The power generating plant (Fig. 13) is in the after portion of the engine-room, and consists of four dynamos, each directly connected to its own engine. Two of these are placed on the starboard side and two on the port side. The dynamos have each a capacity of 75 kw., or 100 h.p., and running at a speed of 210 revolutions per minute, delivering current at a pressure of 105 volts. The output of two of the dynamos is used for the cranes; one is used for the lighting of the ship, and the fourth dynamo is held in reserve in case of accident or other emergency. The

* *Journal* of the Institution of Electrical Engineers, No. 131, February, 1898.

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engines are of the triple-expansion type, and were built at Elbing, near Dantzig.

The most notable feature of the electrical equipment is the cranes, the lighting installation conforming to the standard practice. In designing the cranes, the principal requirements specified and obtained were as follows:

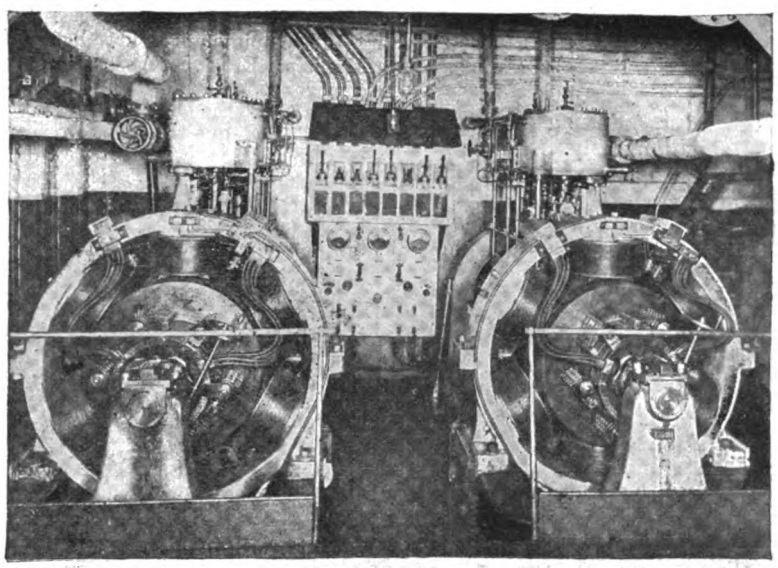

FIG. 13.—The Starboard Side of the Engine-Room, ss. "Bremen."

The load should be lifted smoothly; the resistances should be so arranged that the various speeds of the motors should be obtained without too apparent and sudden changes; the control of the different motions should be instantaneous and positive (these motions to be effected in the smallest possible space); the cranes to be compact and contain the smallest possible number of parts; the controlling mechanism to be of the simplest to suit the class of operator likely to handle them; and the electrical apparatus to be absolutely protected against changes of weather, inroads of dust and sea water, and to be of such a nature as to withstand rough handling. In addition, all conductors were to be carefully protected, and the last consideration, but by no means the least on a passenger-carrying steamer destined to be constantly loading and unloading, the operation of the cranes was to be noiseless.

In conforming to these requirements a very decided innovation in a ship's equipment has been produced.

The cranes, motor, and controlling mechanism (Figs. 14 and 15) are mounted upon a circular iron platform, which revolves upon a pivot. This platform is turned by a motor of 7 h.p. running at 700 revolutions per minute, directly coupled to a worm gear, which in turn meshes in a gearing bolted to the deck. The loads are raised by a 25-h.p. series motor, running at a speed of 900 revolutions, and driving a special worm gear meshing into the gear of the

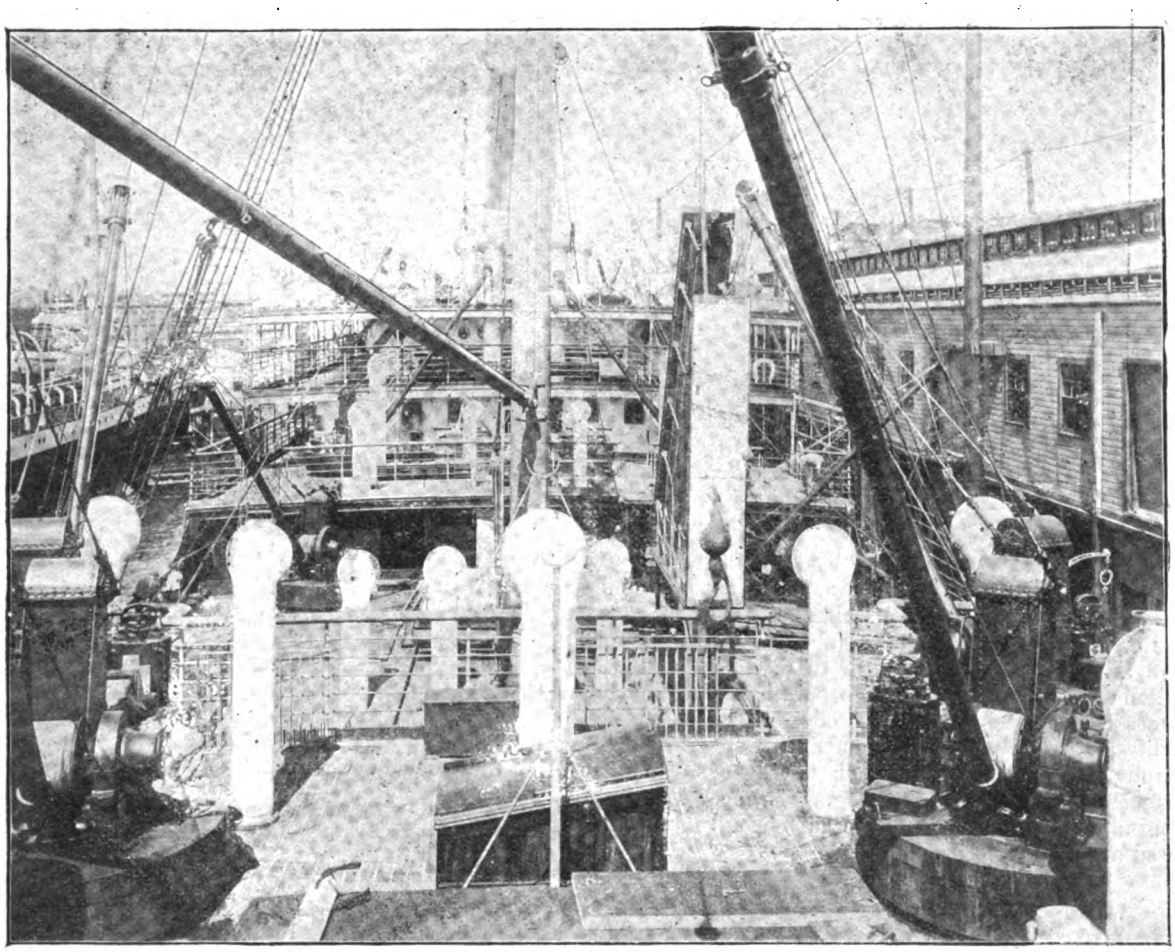

FIG. 14.—View of the Aft Deck, ss. "Bremen," showing Electric Cranes.

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drum. On the gear end of the drum shaft is fitted a winch head.

The controller (Fig. 16) is double, and is fitted with the magnetic blow-out, any spark at break of contact being immediately extinguished in a magnetic field. The contact cylinders are operated by a special mechanism moved by a simple handle or lever, the movements of which correspond to the movements of the load. Raising the handle raises the load, depressing the handle lowers the load, and movement of the crane to the right or left is obtained by corresponding movements of the lever. Raising and swinging movements can be effected simultaneously. So simple are these operations that the dullest stevedore can handle these cranes with ease. Motors and controllers are water-tight and dust-tight, but the cases of both can readily be opened when necessary. To give a more perfect control both motors are provided with foot band brakes attached to an extension of the motor shaft.

The difference between the large and small cranes lies in the hoisting speed. Practically both cranes are identical in electrical equipment, but the hoisting speed of the 3,000-kg. crane at full load 60ft. per minute is only half

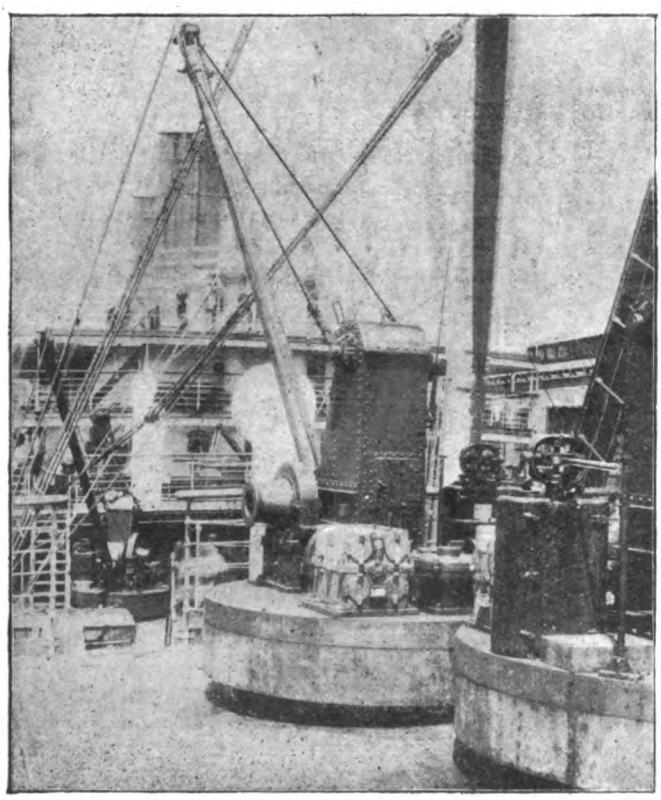

FIG. 15.—Two Electric Cranes on ss. "Bremen."

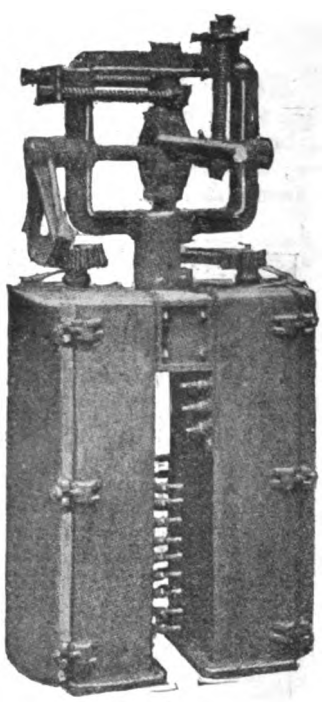

FIG. 16.—Controller for Cranes, ss. "Bremen."

that of the 1,500-kg. crane at full load 120ft. per minute. The movement of the jib of the crane is 13ft. per second.

The cranes are absolutely noiseless in their operation. With the eight starboard cranes, four on the aft and four on the forward deck, engaged in discharging cargo, the operation of hoisting and lowering would have been difficult to detect had it been necessary to depend upon the ear. It is this feature that will recommend the electrical crane to shipbuilders, especially those of passenger steamers in trades where loading and discharging is effected at every port, an innovation which might perhaps be advantageously followed on English vessels.

THE MUNICIPAL ELECTRICAL ASSOCIATION.

A special general meeting of the Municipal Electrical Association was held at the Westminster Palace Hotel, London, on Tuesday last, to consider the following: (1) the Electric Lighting Clauses Bill; (2) the sub-committee's report on stand-by supply; (3) recommendations of the Dangerous Trades' Committee affecting electrical generating works. The meeting was attended by members from Bristol, Brighton, Bradford, Bolton, Burnley, Blackpool, Coventry, Derby, Hampstead, Huddersfield, Hull, Islington, Liverpool, Newington, Paisley, Shoreditch, Southend, Sunderland, Stockport, Willesden, Worcester, and Wolverhampton, but members of the Press were not admitted.

The following is the report of the sub-committee appointed to consider and report on stand-by supply:

In the opinion of your sub-committee it is advisable that the Municipal Electrical Association should take into their serious consideration the question of stand-by supply, as in several towns where the electrical undertakings are in the hands of the councils the question has already become acute owing to the fact that large consumers have endeavoured to provide for the manufacture of electricity by machinery fixed on their own premises, using the public supply and plant as a "stand-by" in case of breakdown of their own plant, thereby imposing on the municipal councils the expenses of providing a plant in excess of their usual demand which must remain idle except when used to supply the occasional demand of those individuals who possess their own plant. Your sub-committee are therefore of opinion that the association should seek: (1) for the insertion by the Board of Trade of a relief section of their regulations; or (2) the amendment of the model order, by removing from the shoulders of the undertakers the obligation to give a supply of electrical energy to individuals who possess an independent supply of their own, or to entitle them to demand such annual revenue as would provide a reasonable return, having regard to the capital expenditure and other standing charges incurred by the undertakers in view of meeting the possible demand. Attention is drawn to the following clauses in the Electric Lighting Acts:

The Electric Lighting Orders, Confirmation No. 9 Act, 1883, *Section* 64.—The Board of Trade, at any time and from time to time upon sufficient cause shown to their satisfaction by the undertakers, and upon such conditions (if any) as the Board of Trade think just, may for any limited or unlimited period suspend or modify any obligation of the undertakers with respect to the supply of electricity under the principal Act or this order, in the whole or any part of the area of supply.

The Electric Lighting Act, 1882, *Section* 29.—Where a supply of electricity is authorised in any area by any license, order, or special Act, and a supply of gas by any gas undertakers is also authorised within such area or any part thereof by any provisional order or special Act under the provisions of which such gas undertakers are under any general or limited obligation to supply gas upon demand, the Board of Trade may, upon the application of such gas undertakers, enquire into the circumstances of the case, and if they are satisfied that any specified part of such area is sufficiently supplied with electric light, and that the supply of gas in such specified part has ceased to be remunerative to the gas undertakers, and that it is just that such gas

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undertakers should be relieved from the obligation to supply gas upon demand as aforesaid, the Board of Trade may in their discretion make an order relieving the gas undertakers from such obligation within such specified part of such area, either wholly or in part, and upon such terms and conditions as they may think proper; and from and after the date of such order such gas undertakers shall be so relieved accordingly. All expenses of the Board of Trade in connection with any such enquiry or order shall be borne and paid by the gas undertakers upon whose application the enquiry or order was made.

The first of these clauses appears to give the Board of Trade the power to act in the matter and form such regulations as we desire, upon the application of the undertakers. This, however, is a local confirmation order, applying to Bristol, Grantham, and Lowestoft only, and it is therefore possible that the same power is not given to the Board of Trade in every instance. The second clause appears to point out that the hardship of the obligations to supply light under conditions somewhat similar—that is to say, where there is an adequate and separate sources of supply—was, in connection with gas undertakings, already contemplated at the time the Act was passed, and having regard to this it seems probable that there would be little difficulty in getting the proper authorities to grant the requests put forward, your sub-committee therefore recommend the council of this association to present a report to the next general meeting of the association, and recommend the adoption of the following resolutions:

"That a circular letter be sent to all municipalities being members of this association, requesting them to empower the council of this association to take such steps in the matter as they may deem desirable, and to suggest that any expenses incurred should be shared by such municipalities in such manner as may be agreed by the council, and subject to the decisions arising from such resolution."

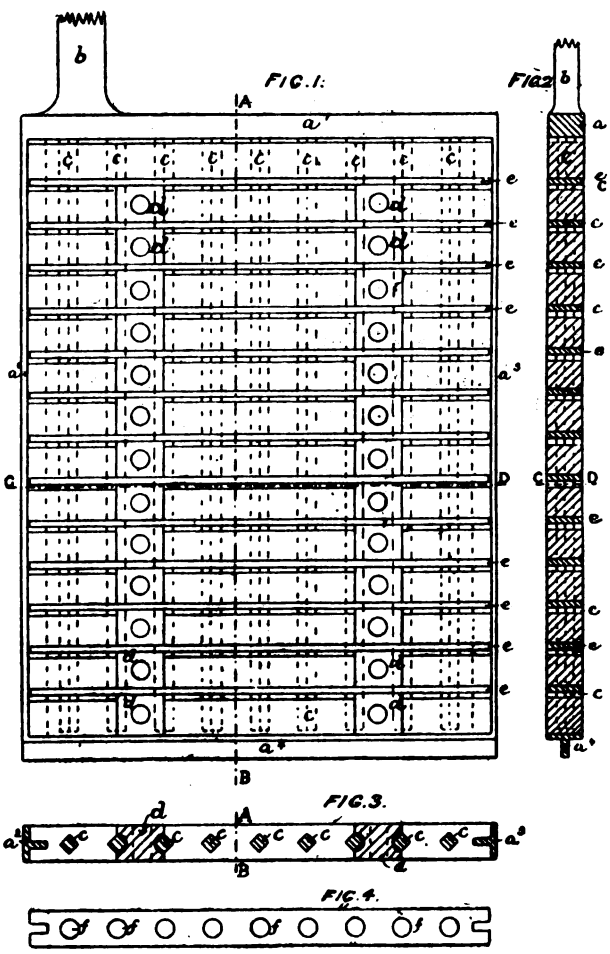
"That a petition be prepared and presented to the Board of Trade, from this association, stating that they have been empowered by certain municipalities to act for them, and requesting the Board of Trade to insert a clause in their regulations relieving undertakers of their obligations to supply under certain conditions, except on terms as before suggested."

"In the event of the Board of Trade stating that they have not power to act in the matter or declining to do so, your sub-committee fear that there is no course of action open to this association, and the matter must be left for the individual authorities to insert relief clauses in their next local Act, in which case the association, as representing many municipalities, should assist in the creation of a precedent by giving evidence on behalf of the undertakers, first applying for the limitation clauses."

(Signed) H. Faraday Proctor, John H. Rider,
Geo. Pearson, Rob. C. Quin,
Members of the Sub-Committee.

THE EVERARD ACCUMULATOR.

We have pleasure in giving below a few details of a new type of accumulator designed and patented by Mr. F. E. Everard. The construction of the plate is shown in Figs. 1, 2, 3, and 4, from which it will be seen that this consists of a number of vertical rods or bars of lead, which are attached to the upper part of the framework of the cell only. The section of these bars can be seen in Fig. 3. In order to break up into sections the active material with which the framework is pasted, Mr. Everard uses a series of insulating partitions such as are shown in Fig. 4. These dividing strips are arranged to freely slide up and down the bar vertically. The blocks or distance pieces, *d d*, serve to maintain these cross frames at equal spaces, while the fact that the lower end of the vertical bars are not connected with the framework allows of a certain amount of expansion taking place without fracturing the conducting bars, C C. The great advantage of this construction is that it enables Mr. Everard to obtain great outputs from cells which are comparatively light. As will be seen from the drawings, nearly the whole surface of the plate consists of active materials, as only the distance pieces, *d d*, project through the peroxide. The inventor does not claim a longer life for his type than is obtained from other types, but he believes that the life will be at least equally as good, and he expects to get great advantages on the score of weight. The following are particulars of a 15-plate section, consisting of seven positive and eight negative



The Everard Accumulator.

plates, which has been constructed and tried. The plates themselves weigh in all 23lb., and the complete cell with acid 34lb. Each plate is about 6in. long by 7in. high, and the width of the 15 plates as arranged for working is $6\frac{5}{16}$in. With this size the weight of a battery of 34 cells complete would be 13cwt. 40lb., and at an eight-hour discharge a current of 35 amperes could be maintained. This, with an average voltage of 1·9, would give 432 watt-hours for each cell. With the 44 cells this is equivalent to 19 kilowatt-hours, or, say, 25½ horse-power hours. This type of cell gives an output of 12·17 ampere-hours per pound of plate, or 8¼ ampere-hours per pound of cell. The curve which we give in Fig. 5 has been sent us by Mr. Everard as an example of the fall of voltage on discharge with one of his plates, but we do not understand the irregularities of this curve. We learn that the accumulators are likely to be manufactured for the market shortly, and that a special effort will be made to meet the requirements of manufacturers of motor vehicles for a high and efficient accumulator.

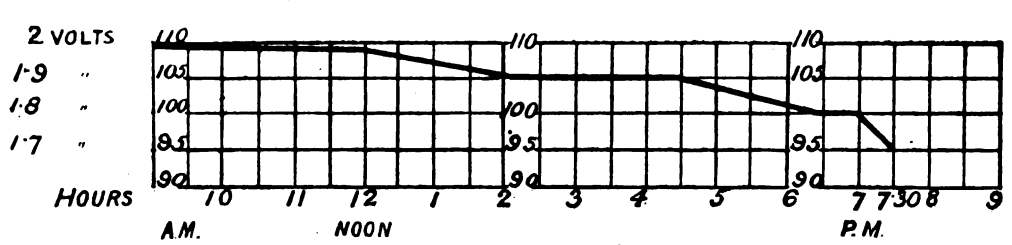


Fig. 5.—Discharge Curve of an Everard Accumulator.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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STAND-BY SUPPLY.

The members of the Municipal Electrical Association have found it desirable to enquire into the question of stand-by supply. Undoubtedly it is an important question with them, especially if they are to consider their works as commercial undertakings. However, there is another side to the question, and viewed from that side it is just possible the conclusion may be different. Briefly stated, the problem is this, the conditions being assumed and not those actually existing at any particular place. An authority or a company obtains certain parliamentary powers, enjoying certain privileges which necessarily carry certain obligations within the area of supply. One of these obligations is that the company or municipal authority shall supply electric energy to all who require it within the area over which mains are laid. In districts outside the compulsory area, and in which mains have not been provided, the undertakers have the right to demand that the persons for whom the new mains have to be laid shall guarantee a fair return on the cost of the same. With this exception the undertakers have not the right to refuse to supply anyone. That certain companies in London have refused to supply certain consumers is a matter of common knowledge, but, as far as we know, a threat of legal action is all that is required to bring the matter to a successful termination. The question is now raised as to whether consumers owning their own electric lighting plants should be allowed to use municipal electrical undertakings as a stand-by. The consumer under the present provisions of the Electric Lighting Acts is completely within his rights in so doing, and there is no doubt that such a stand-by enables the consumer in question to very much reduce his capital outlay for electrical machinery. In many other cases also it materially reduces his running expenses as well, if he is able to take the town supply during times of light load and shut down his own plant. Considering, however, the case of a total breakdown only, when the whole of the lamps would be suddenly transferred to the town mains, the question arises as to the effect of such a change-over on the undertakers. The argument that it will cause additional capital outlay is true, provided that the breakdowns occur at a time when the machinery is fully loaded. But, on the other hand, why should, say, a dozen consumers having their own plant all lay down spare power, costing, say, ten thousand pounds, when the addition of a thousand pounds' worth of more machinery at the central station would suffice. The argument that such consumers would not be profitable to the supply station, and hence should not be supplied, is open to question, but it is not more questionable than the profit-earning on which some municipalities are now so keen.

THE ALL-BRITISH PACIFIC CABLE.

It is satisfactory to record that at last the Government has come to a decision favourable to a Pacific cable, so that we may expect the work to

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be taken in hand at an early moment. The exact terms of the agreement between the mother country and her colonies are for the moment immaterial. According to the *Times* there will be a subsidy "to guarantee for the construction of an all-British cable running from Vancouver by Fanning Island and Fiji to Norfolk Island, whence it will branch to Queensland and New Zealand." We have advocated the laying of this cable from the view of Imperial interests, for strategic purposes, as much as or more so than from a purely commercial standpoint. It is probable, however, that even as a purely commercial speculation the cable line will be a success. The *Times*, in its issue of April 27, has an admirable leader on the subject, though its support in the earlier stages, if we remember rightly, was rather lukewarm. It justly points out that the commercial community will, at any rate, obtain two most valuable benefits—one, gain in cost; and the second, gain in time, as well as less probability of error in transmission. We congratulate the Government upon their action.

THE COPPER QUESTION.

Great excitement has been caused in certain circles by the news which has been cabled from the United States as to the formation of a large copper ring which hopes to control the copper market. The firms which are actually interested in the ring have secured controlling interests over some large copper mines in the States, and propose to restrict outputs in order that the present high prices shall be maintained. Claims are made that very large financial houses in England are assisting those in the ring, but from a long article in the *Financial Times* we gather that many of the claims made cannot be supported by any evidence from this side. This is not the first time that attempts have been made to control the copper market of the world, and the previous copper rings ruined most of those connected with them. Any such attempt to restrict the output of copper and to force up the price is bound to have an injurious effect on the electrical industry, and we trust soon to be able to announce that the American speculators have found that their attempt to regulate supply and demand is futile.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE TELEPHONE QUESTION.

SIR,—General Webber has done good service in drawing attention to the different factors that go to make up the telephone problem. The telephone exchange industry differs from every other in this important particular: while in nearly every other industry the larger the number of sales the less is the cost of each article, with the telephone exchange the larger the number of subscribers, provided all have equal rights, the greater is the proportionate cost of working.

A little consideration will show that the possible number of combinations increases very rapidly with the number of subscribers. The curve connecting the two quantities is a parabola, and the equation to the curve is

$$z = \frac{x(n-1)}{2},$$

where z is the number of possible combinations and x the number of stations, and the serious nature of the increase is seen when figures are taken. Thus with only 10 subscribers only 45 combinations of subscribers are possible; with 100 subscribers the number of combinations has risen to 4,950; with 1,000 subscribers it is 499,500; with 10,000 subscribers 49,995,000. Of course, as the number of subscribers increases, the probable proportion of them who wish to be connected decreases, so that the number of calls does not go up at the terrific rate indicated; but the telephone engineer has still to provide for a very rapid increase.

It would be interesting if General Webber or any of your readers who are connected with telephone exchanges would give the actual number of calls in exchanges of different sizes; and if, also, the average number for each class of subscriber was given, we should be able by the addition of constants to the equation given above to obtain a formula that would give fairly accurate results for actual practice. I think, too, that the method General Webber has suggested of classifying subscribers would materially lessen the total cost of telephone exchange working, and would also more accurately proportion the charges to the actual use made of the apparatus.

There are many cases where it is by no means necessary that a reply shall be obtained immediately. Often, if a connection and conversation were obtained in a quarter or even half an hour, it would still be much quicker than either post or telegram And so, as I understand General Webber's suggestion, Class I. might pay a lower rental, possibly a nominal rental supplemented by a small charge per message, and only have the right to connection with subscribers in the same class and *in turn*. A call might be made to the exchange and only answered in turn, or possibly a reply signal given to show the call had been received, and later the subscriber called and put through. The system would be of course somewhat similar to that now ruling with trunk-line calls, and would lead to considerable economies in first cost and in working cost. Business men, who are getting to do their business more and more by telephone, would be, as I understand General Webber, in another class, paying a higher rate and having quicker attendance; and the result of this selection should be also economies in first and working costs, even in this class, through the elimination of Class I. from the switchboard.

With regard to the control of the telephones. If one authority is to have them, this must necessarily be the Post Office; but there is much to be said for each local authority or a company working under the control of the local authority owning and working the local exchanges, while the Post Office, as at present, own and work the trunk lines. There is also much to be said in favour of the local authority establishing cheap exchanges, dealing with those specified as Class I., and so relieving the other exchanges of those subscribers who only require to use the apparatus occasionally. As General Webber has pointed out, there should be no more difficulty in making connection between subscribers on different exchanges in any town than between the exchanges in different parts of the same town, or between different towns; where, of course, provision was made that subscribers on the different exchanges could have the privilege of being connected, either by paying a higher rental or by paying for each connection.

I trust that some of your readers who have experience with telephone exchanges will give us the benefit of their experience.—Yours, etc., SYDNEY F. WALKER.

Cardiff Electrical Engineering Works,
Severn-road, Cardiff.

THE CALCULATION OF TWO-PHASE INDUCTION MOTORS.

SIR,—I beg to ask the aid of your columns regarding the following difficulty I have met with. As a draughtsman with one of the leading electrical firms, I have recently been trying to master the principles underlying the calculation of two-phase induction motors. I have got on all right, with one exception, and it is regarding this exception I ask your aid, as, though I have asked the

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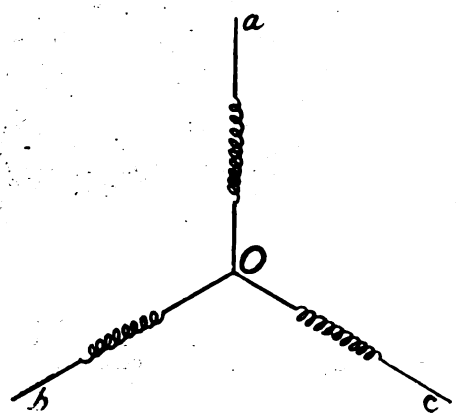
aid of several well-known engineers, none of them were able to help me.

Two-phase motors are often wound on the armature or rotor with a "star" winding, and I have been unable to do the necessary calculations for such a rotor. I got on all right with short-circuited rotors, and also those with two or more entirely separate circuits. I have hunted through all the books and papers I could find, but though I got plenty of information about short-circuited rotors, and also the formation of a "field" by a "star" winding, I found nothing about such a winding on the rotor.



I give a diagram herewith, and also enclose a print of this winding as used on a motor. *a*, *b*, and *c* are connected to the slip rings, and O is a common connection. In a two-phase motor what would be the E.M.F. produced in a rotor wound thus, what would be its equivalent resistance, and what would be the watts lost in such a winding? I really wish to know how to calculate such a winding to give a specified power. This seems to be a puzzle for most practical men, but possibly some of your readers will solve the problem for me.—Yours, etc.,

E. C. WILSON.

London, S.W., April 17, 1899.

A FAULTY DYNAMO.

SIR,—I see by Friday's issue of the *Electrical Engineer* that I did not state enough particulars in my letter to be answered fully. I will endeavour to do so now. The dynamo in question is a compound-wound, 100 volts 20 amperes, speed 1,370 revolutions a minute. The machine when started takes about three minutes to excite (open circuit); it will reach its full voltage, which it will keep for about five minutes, when it will gradually fall and lose its voltage altogether. The machine will fail to excite again until shut down for about 15 minutes. The shunt circuit was tested after running, and found to be the correct resistance; also the insulation test for earth.

April 25. A. E. B.

[Even after having received this second letter from "A. E. B.," we cannot give him a positive answer to his question. It is certain that if the armature is not at fault, as it would seem from the fact that with a new armature the same result was experienced, the fault must be in the shunt circuit of the field. We assume from our correspondent's letter that he did not take any load from the machine during the five minutes that the voltage was normal. This seems to be the next step in the investigation, to see what happens if the full load is put on immediately the machine is fully excited. As the shunt excitation is at fault it would seem that the machine got short-circuited gradually, and that the short-circuit was established between the brushes so that the series turns were not included in it. How this can happen without causing undue heat, which should be easily found, we do not see. We should advise our correspondent to see what happens when the machine is loaded up, and also to make sure that the insulation of his brush gear is in good order.—ED. *E. E.*]

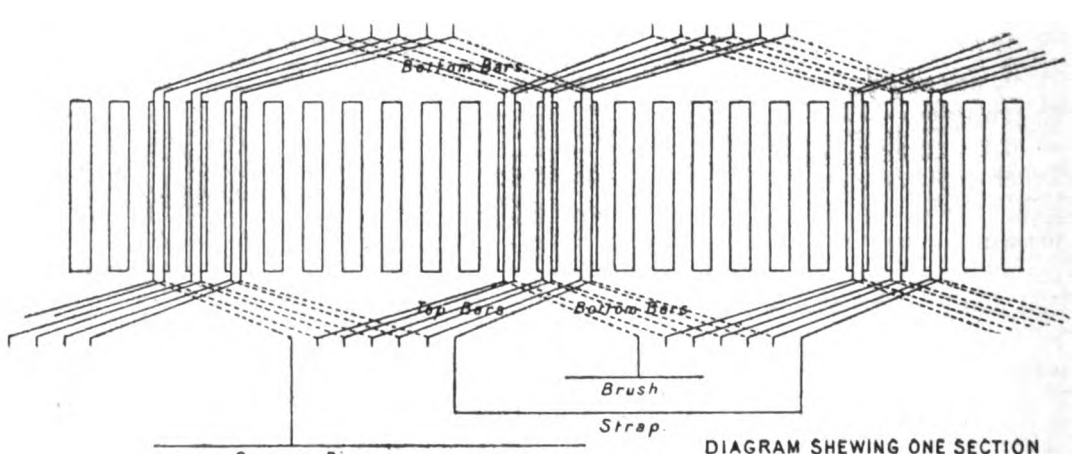
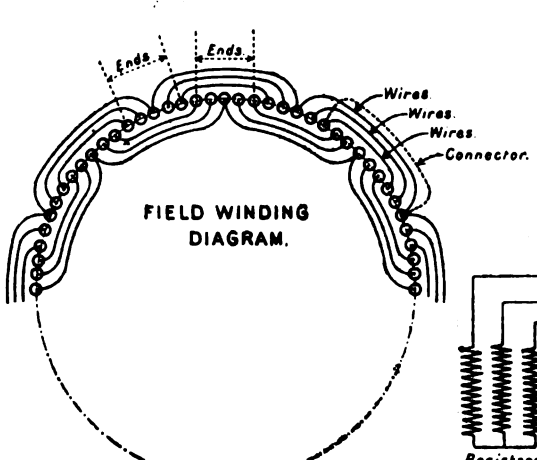


DIAGRAM SHEWING ONE SECTION OF ARMATURE WINDING.

3 Sections in all
96 Bars per Section in Series.
288 Bars in all Approx. Sec.



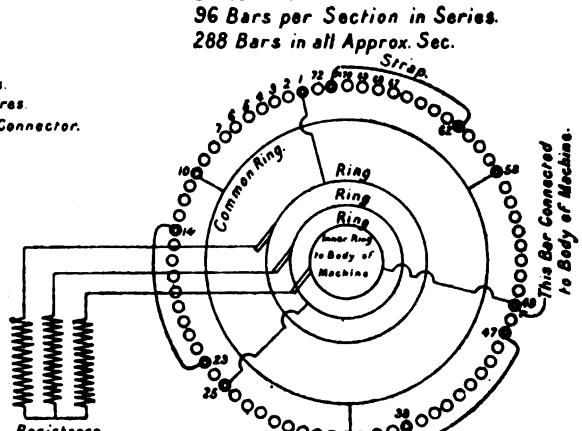


DIAGRAM SHEWING ARMATURE END CONNECTIONS.

MAGNETIC CIRCUITS.

SIR,—Will you kindly explain, through the correspondence column of your valuable paper, the method of deter-

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mining the length of the various magnetic paths of a dynamo? On p.413 of Prof. Thompson's work, "Dynamo-Electric Machinery," particulars of an Edison-Hopkinson dynamo are given as follows:

Core discs, external diameter	9⅝in.
Core discs, internal diameter	3in.
Length of magnet limbs	18in.
Thickness of magnet limbs	8 1/16in.
Length of yoke	24¼in.
Depth of yoke	9¼in.
Centres of limbs	15in.
Bore	10 13/16in.
Depth of pole-piece	9in.
Width at narrowest part	8⅝in.
Gap between pole-pieces	5in.
Depth of edges of protruding horns	5/16in.

From this data the following lengths are given:

Core	5⅛in.
Limbs	36in.
Yoke	19¼in.
Pole-pieces	4 5/16in.

The length of the path through the limbs is clear, but I am unable to see how the other lengths are arrived at.

A second core is given as under:

External diameter	10⅝in.
Internal diameter	8in.
Length of path	6½in.

I should esteem it a favour if you will give me information on these points.—Yours, etc.,

STUDENT.

FORTHCOMING EVENTS.

FRIDAY, APRIL 28.

Royal Institution.—At 9 p.m., "Some Features of the Electric Induction Motor," by Prof. C. A. Carus Wilson, M.A., M.I.C.E.

Institution of Mechanical Engineers—At 7 30 p.m., "Evaporative Condensers," by Mr. Harry G. V. Oldham, A.I.M.E

Freemasons' Tavern.—At 7.30 p.m. Bohemian Concert by City of London, Metropolitan, London Electric Lighting Companies.

MONDAY, MAY 1.

Rontgen Society.—At 8 p.m., "Fractures of the Forearm," by Dr. Lynn Thomas, F.R.C.S.

TUESDAY, MAY 2.

Royal Institution.—At 3 p.m., "Electric Eddy Currents," by Prof. Silvanus P. Thompson, D.Sc., F.R.S., M.R.I.

WEDNESDAY, MAY 3.

Institution of Electrical Engineers.—At 7.30 p.m., students' meeting, "The Enclosed Arc," by Mr. L. R. Morshead

Society of Arts.—At 8 p.m., "Etheric Telegraphy," by Mr. W. H Preece, C.B., F.R.S.

North-East Coast Institution of Engineers and Shipbuilders.—At 7.30 p.m., at Newcastle-on-Tyne, "Shop and General Establishment Charges in Engineering Works, and their Relation to Costs and Estimates," by Mr. W. E. Cowens.

THURSDAY, MAY 4.

Iron and Steel Institute.—At 10.30 a.m., annual meeting and president's address; 7 p.m., dinner at Hotel Cecil.

Institution of Electrical Engineers—At Society of Arts, John-street, Adelphi, at 8 p.m., "Electric Locomotives in Practice and Tractive Resistance in Tunnels, with Notes on Locomotive Design," by Mr. P. V. McMahon.

FRIDAY, MAY 5.

Iron and Steel Institute.—At 10.30 a.m., reading and discussion of papers; 9.30 p.m, reception at the Royal Mint.

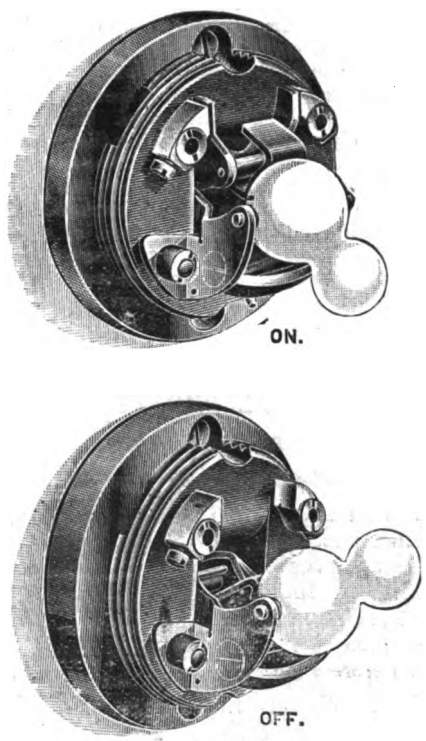
Institution of Junior Engineers.—At 8 p.m., "Gun Construction," by Mr. W. H. Owston.

SATURDAY, MAY 6.

Institution of Electrical Engineers.—Students' visit to Messrs. Siemens Bros. and Co.'s works, Woolwich. Train leaves Charing Cross for Charlton at 9 20 a.m.

DORMAN AND SMITH'S HIGH-TENSION FITTINGS.

We have received from Messrs. Dorman and Smith, of Salford, some interesting samples of the switches and fuses they are now manufacturing for circuits up to 250 volts. The switches and fuses are constructed entirely of porcelain and metal, there being absolutely no other material which could become deformed or defective through the action of moisture or heat. The construction of the



FIGS. 1 AND 2.

switch can be seen in Figs. 1 and 2, which show the gear in the "on" and "off" positions. The great feature in this switch is the good clearance between the terminals, and

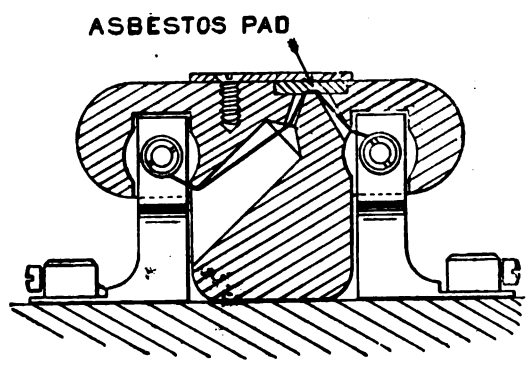


FIG 3.

also clearance between these terminals and other metal parts when the switch is in an "off" position. The firm have adopted the loose handle, which is so essential in making the quick break independent of the operating handle.

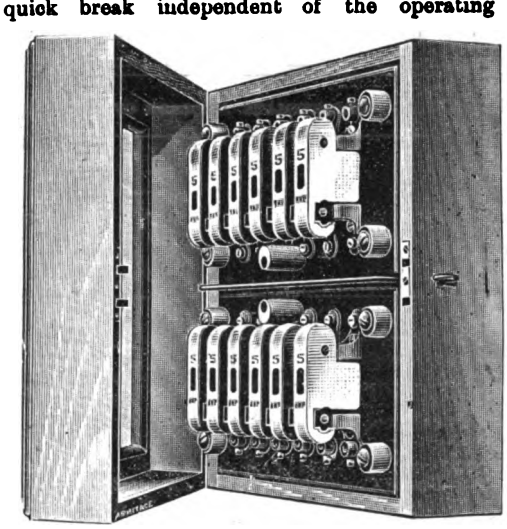


FIG. 4.

This also secures that the speed of break is quite independent of the speed at which the handle is moved. The mechanical parts seem to be amply strong, and another good point is that there are no metal parts accessible at the back of the switch.

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The fuse which the firm is adopting as their standard for high-tension circuits is shown in section in Fig. 3. The body of the fuse is of porcelain, and there is a solid wall of this between the two terminals, which are made of the clip type, and is very handy for distribution boards such as shown in Fig. 4. The fuse wire is carried through a tortuous hole in the porcelain block, and this hole is closed on the fuse at one point by an asbestos pad, which prevents the arc following the hole. The construction otherwise of the large hole seen on the left-hand side in Fig. 3 gives a quick blow-out action. With this type of fuse there is absolutely no danger of placing the distributing circuits on a switchboard close together. When a fuse has blown, the small screw seen in the section has to be removed, after which the fuse can be readily replaced. The porcelain block is exceedingly handy to take hold of when removing or replacing a fuse that has blown. These two examples of Messrs. Dorman and Smith's manufacture will do much to maintain that firm's reputation for good and substantial electric lighting accessories.

TELEPHONES.*

BY JOHN GAVEY.

(Continued from page 509.)

One great advantage of the automatic method of signalling, whether Post Office or Western Electric, is the fact that it maintains the line under a constant test; for should a fault arise on the wires at any time, the signals give warning of the fact by indicating a call to which no answer can be obtained. A lineman is at once dispatched to remedy the defect before a subscriber has learnt that anything is wrong. In the Western Electric system also the individual primary batteries at each subscriber's office are replaced by central storage batteries at the exchange, which are used both for speaking and signalling purposes. The process of replacing primary by secondary batteries at all large telegraph offices in this country has been in progress for some years, and these batteries have also been in use on the Department's trunk lines for automatic signalling purposes for a considerable period, but their use for speaking purposes also is a promising innovation. Of course, various types of modern switchboards exist, most of which have some advantage to recommend their use, but I have thought the description of the above would have particular interest as being the outcome of the general experience in the United States, which may be termed the home of telephony. If the capacity of a multiple switch were unlimited, and the telephoning of large cities could be effected by concentrating the whole of the circuits in one exchange, the problem would be easily met by the use of a switch of the above or of some similar type. Unfortunately, the number of subscribers who can with advantage be served on one switch is limited, the largest now in use providing only for 10,000 subscribers. The limit is due to various causes. The range of an operator's reach is not great, and it is obviously useless to extend the multiple jacks beyond her reach. There is also a limit to reduction which can be effected in the size of jacks, so that it is impossible to crowd more than a certain number within a given space. There are also other objections to which specific reference need not be made, but the result is that to deal with a large number of subscribers it is necessary to establish several exchanges, and these are connected together by junction circuits. These circuits are virtually the equivalent in a certain degree of the trunk circuits connecting the larger cities and towns, and they are now almost universally worked by means of automatic signals, but a detailed description of the methods in use would scarcely have sufficient interest to justify further explanation here.

It will be interesting to quote certain figures relative to the central exchange belonging to the French Government in Paris. It is at present fitted for 15,000 subscribers, and to provide for this number no less than 702,000 jacks are joined up. To connect these within the interior of the building there are 118 miles of 40-wire cable, giving an aggregate of 4,720 miles of wire in the switch-room. These cables are cut and jointed to the jacks at intervals of about 12in., and this has involved the making of 2,500,000 soldered joints. I mention these figures because it has become the fashion to under-estimate the work of constructing a modern telephone system. To take an analogy. It is a simple matter to provide the catering for a single establishment, but there are few problems of greater magnitude than the provisioning of an army of, say, 100,000 men. In the same way any plumber-electrician can run up a few score wires and connect them to a switch, but when the wires grow from scores to thousands and tens of thousands, spread over an area of some hundreds of square miles, the problem becomes as intricate as that involved in any other type of heavy electrical engineering.

The telephone trunk service of Great Britain—in other words, the system which provides intercommunication between the principal towns in the country—was fully described in a paper I had the honour of reading before the Institution of Electrical Engineers in November, 1896, and there has been no material modification in the methods then described. On March 31, 1898, the Post Office plant comprised 56,373 miles of wire at work and in course of construction, and 269 towns were connected with trunk circuits, by means of which any one of them could be placed in direct connection with any of the others. The system is being rapidly extended. The accompanying Table A, which shows the mileage of the telegraphic and telephonic systems throughout the world at the end of the year 1898 will be of interest. It is compiled from official documents supplied to the Bureau International de Berne.

Finally, I may venture to say that it is almost impossible to predict the future of the telephone. There is room for unlimited growth, and great as have been the developments of the ordinary methods of telegraphy, they are probably

* Paper read before the Society of Arts on April 12.

TABLE A.—Approximate Mileage of the Telegraphic and Telephonic Systems of the World, January, 1899.

—	Lines.				Wire.			
	Telegraph lines.		Telephone lines of States and private companies	Totals.	Telegraph lines.		Telephone lines of States and private companies	Totals.
	State administrations and private companies.	Railway companies.			State administrations and private companies.	Railway companies.		
1. Countries subject to the International Telegraphic Convention:	Miles.	Miles.	Miles	Miles	Miles.	Miles.	Miles.	Miles.
European	490,200	179,570	169,300	839,070	1,604,300	623,200	852,800	3,080,300
Extra-European	167,300	64,620	14,290	246,410	406,100	205,300	119,230	730,630
2. Countries not subject to the Convention:								
North America—								
Western Union Company	233,000	—	—	233,000	1,003,400	—	—	1,003,400
Postal Telegraph Company	18,640	—	—	18,640	108,730	—	—	108,730
Other offices	—	248,500	186,400	434 900	—	745,600	2,175,000	2,920,600
South America	15,533	9,300	3,107	27,940	29,820	27,960	31,070	88,850
Africa, Asia, and Australia	24,853	27,950	9,320	62,133	74,650	83,880	24 850	183,290
3. Submarine cable companies	167,800	—	—	167,800	169,600	—	—	169,600
	1,117,526	529,950	382,417	2,029,893	3,396,510	1,685,940	3,202,950	8,285,400

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destined to be entirely eclipsed by the telephone, which may before long be the principal channel through which both business and social intercourse of the country will be carried out.

DISCUSSION.

The **Chairman** (Mr. W. H. Preece) said this had been an absolutely practical paper; there was nothing in it controversial, and it had shown very well that the chief characteristic of the telephone was its simplicity. When he brought the first telephone to this country from America, in 1877, and described it to the British Association at Plymouth, he summed up the whole matter in two words, which had been repeated over and over again, by saying that its chief merit was its "ridiculous simplicity." Another point worthy of notice was this: that however much the use of the telephone in this country had been retarded, there had been no obstacle to the improvement in its working; nearly all the steps in its progress had emanated from this country and other countries, particularly America, had flattered them most sincerely by copying them in many particulars. Still, they could not blink the fact that for some reason the telephone in England was eminently unpopular. Why this was so he could not say; perhaps some light might be thrown on the question in the discussion, but he might suggest that one great reason was ignorance—ignorance of the construction and working of the telephone, of the appliances used to make it serviceable, and of the intricate and exacting duties which had to be discharged by the operators, who were generally, if not universally, young ladies. Mr. Gavey was a most experienced experimenter; for 21 years he had been his (the chairman's) right hand, and had experimented with telegraphs and telephones in every form and shape, and yet, when he came to read his own paper, and to show the operations of a simple instrument, he had partially failed. If this were so, surely some consideration ought to be shown to those young ladies who were doing their very best to serve the public, but who, he feared, had often to listen to very impolite remarks. Mr. Gavey had not mentioned one interesting fact—viz., that in consequence of improvements originated by the Post Office, and now adopted all over the world, the use of automatic signalling had put an end to the use of that phrase which used to be so frequent and so annoying, "Have you finished?" Those in London who used the telephone a good deal were still sometimes vexed by this question being asked, but when the automatic system would be introduced they would hear it no more. He could not help calling special attention to the immense growth of the telephone system. It was something to have lived in an age when they had seen the growth of electricity from childhood to manhood. As he had already said, he brought the first telephone across the Atlantic; he saw it before a single exchange existed in America, for there were not more than two or three circuits at work when he was sent over by the Postmaster-General of the day to enquire into the merits of this instrument. That was only in 1877, and now there were nearly 4,000,000 miles of wire employed for telephones, and the total number of miles of wire used in telegraphy was about 8,000,000. Even in one single exchange in Paris 2,500,000 joints had to be made to complete the work. This all showed that those who carried out this work for the convenience of the public should receive some consideration. An engineer had been defined to be one who applied the great forces of nature to the wants and wishes of mankind, and he ventured to think that there was no branch of engineering which had done more to make life comfortable and easy than that connected with electric telegraph and telephones.

Mr. J. E. Kingsbury said he had listened to the paper with very much pleasure, and was pleased to note the remark that the work connected with telephones was entitled to stand on a level with any other branch of electric engineering. The extent to which they were indebted to American contrivances had been referred to, but he might point out that America was also indebted to England in many points. It was within his knowledge that the cable work between London and Birmingham had attracted a good deal of attention from American engineers who had carefully investigated it, and who, he was sure, would be willing to give full credit to the originators of the system. This cable work was of quite a pioneer class, and would probably altogether change the conditions of long-line working.

Mr. Dane Sinclair said all who were familiar with telephone work must have listened to the paper with great pleasure. To him it had been quite a treat, because the exposition had been so simple, and yet so complete, and he must congratulate both the author and his audience. Mr. Gavey had led them from theory to practice, and from the earliest practice to the very latest developments. After dealing shortly with the instrument itself, he came to the part which required most attention, the switching arrangements, and on that matter he had brought them thoroughly up to date. As the chairman had said, the arrangements seemed very simple, but simple as the instrument before them appeared, when they thought of what a large exchange in Paris or London is like, they would recognise that what was in principle simple enough must become extremely intricate. Last year he was in the States and saw this new system of lamps and a common battery and was much taken with it, but was not sure that all the points had been considered which were necessary to make it suitable to a place like London. For instance, if one of the subscribers had two or three telephones in his office, how would you ensure that the right one was put in circuit when he was called up by the exchange? Apart from this difficulty, he thought the lamp was a great advance on the more mechanical systems previously in use. There was nothing to make it excessively costly, and he had no doubt that those who had charge of the telephone systems would gladly introduce anything which rendered the service more speedy and efficient.

Mr. Stanley Flint said he would endeavour to give some answer to the question of the chairman, why the telephone was unpopular. They had been shown an ideal system, but what they suffered from in London was a very inefficient system. As a subscriber for some years, he might say that he often found a difficulty in getting in connection with other subscribers, and was inconvenienced by being cut off in the middle of a conversation. If the system were more efficient, there would be more subscribers, though the charges were very high—much higher than in most Continental countries. The constant "Have you finished?" was very annoying, but it was still worse to be suddenly cut off even if you answered "No."

Mr. A. O. Granger said he was a user of the telephone on the other side of the water, and should be glad to know if any explanation could be given of the different rates which prevailed in different places. He used the telephone in Canada, and in two places in the United States. In Philadelphia they paid 150dol. a year for one telephone; in Montreal 40dol.; and in Charlesville, a little town in Georgia of under 5,000 inhabitants, they only paid 18dol. Generally when an article came largely into use it was cheapened, but in the case of telephones the reverse seemed to be the case, the highest rate being charged in the largest towns.

The Chairman said he would leave Mr. Gavey, who had recently visited the States, to reply to the last question if he could, but with regard to the previous objection, as to the inefficiency of the system in operation in London, it was only right to point out that the instrument exhibited that evening was the very latest development, which had only been perfected within the last few months, and it was quite impossible for a private company, or even a Government department, to replace or renew their apparatus year after year to meet the wishes of an exacting public. He might say that of all the systems he had himself inspected the very worst, from an expert's point of view, was that adopted by the German Government in Berlin; and yet, in spite of that, there was no town in the world where telephony was so popular. He did not say the London system was perfect, though he had inspected exchanges in London which were absolutely perfect according to the knowledge and experience of that time, and yet the public were dissatisfied, and said the system was inefficient. He had over and over again pointed out that the chief source of inefficiency in the telephone service lay with the users, and it was the same with nearly all branches of the public service, such as telegraphs and railways. If an exacting public did not get everything absolutely up to date, they were dissatisfied and grumbled. Anyone who was dissatisfied should not write to the papers and complain, but go to the nearest exchange and asked to be shown the working of the system; the more they understood it the better would they be able to use their own telephone, and the better they would be pleased with the service. He would conclude by proposing a hearty vote of thanks to Mr. Gavey.

Mr. Gavey, in reply, said the newly designed method of automatic working which he had exhibited had only recently been introduced, and at present the demand on the manufacturers was so great that, huge as their factories were in New York and Chicago, they were doubling them in size in order to meet the American demand alone. At the large exchanges they were fitting them up as rapidly as possible, and he believed in this country the National Telephone Company would soon have one fitted up in Bristol. With reference to Mr. Sinclair's question, curiously enough, there was more difficulty where a subscriber had two telephones in his office that if he had 20. In many of the large buildings which were so frequent in American cities there was a private wire exchange in the structure itself, to which all the offices were connected. In St. Louis, when a company erected a large building they provided a private wire exchange, and put a telephone in every office, the use of which was included in the rent. Every tenant could communicate free of charge with everybody in the building. That private exchange was connected with the central exchange, and those who wanted to speak through the central exchange could do so on paying a toll for each call. With a system of that kind the signalling was very simple. Junction circuits were provided between the private wire exchange and the central exchange. Where a subscriber had two telephones alone he believed a method of signalling at both stations from the central batteries was now being evolved by the inventors, and he was told there was every hope of arriving at a satisfactory solution of the problem shortly. With reference to the question of rates in the United States and Canada respectively, he was not prepared to give a very definite reply. In the United States, at all events, the master patents which controlled the telephones were in the hands of one large company, and until the last few years it was the practice to charge "flat rates," which meant the same system as was in vogue here—an annual payment which gave the right to unlimited user. For various reasons very high flat rates were charged, and the result was that the number of subscribers was somewhat limited, but in order to meet the demand of smaller users the various companies in most of the cities introduced what was termed the toll system Under that they charged a moderate rate—say, £20 per annum—which gave the right to 600 or 700 conversations, with an extra charge for each call beyond that number. The result of that was very wonderful. He was told that one company in New York alone had 6,000 additional subscribers in one year. He should imagine that in all probability the charge in Philadelphia was a "flat rate," and in Charlesville a "toll rate."

Mr. Granger said it was a "flat rate" there also.

Mr. Gavey said in that case he could not explain how such a difference arose.

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QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

161. What is the best practical method of calculating the resistance and size of coils required for a motor-starting switch, giving due attention to accuracy and economy?—W. L. G.

162. Discuss the advantages and disadvantages of earthing the neutral in a three-wire system of distribution (*a*) at the station only, (*b*) at various points in the supply area.—E. M.

ANSWERS.

Question No. 155.—Describe in detail how you would carry out an evaporation test on a boiler in an electric light station fitted with feed-water heater.

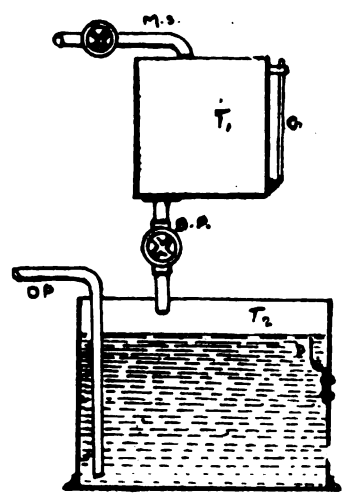
Best Answer to No. 155 *(awarded* 10*s.)*.—It is difficult in a short article of this nature to deal satisfactorily with all the details bearing upon an evaporative test of a boiler. The writer proposes, however, to give a general outline of the method of procedure, going into details only on points of primary importance. The writer having had considerable experience in tests of a general nature, has become firmly convinced of the necessity for thorough organisation prior to the commencement of a test if satisfactory and reliable results are to be expected. In order to specify clearly our meaning, we may mention three very important provisions which should be made: (1) assistants to take observations, (2) forms of entry for observations; (3) convenient arrangement of apparatus.

1. The desirability for accuracy, and the frequent necessity for simultaneous readings, presents reasonable grounds for the assertion that within certain limits the success of the test depends upon an ample supply of assistants.

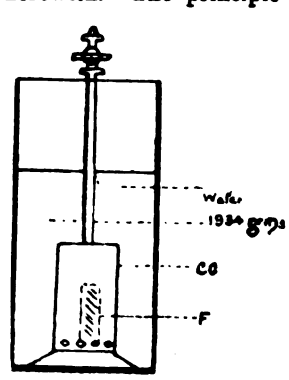
2. Forms of entry should be carefully drawn up beforehand, each prepared for a distinct series of observations. To each of these one observer should confine himself entirely, who, along with others assisting at the test, should previously have had their duties clearly explained.

3. Under the third heading we include all such apparatus as may be requisitioned for the weighing of coal, measurement of feed water, etc. The arrangement of these should be convenient, and conducive to an accurate and expeditious test. Suitable holes should be made in the flues for the insertion of thermometers, and for collecting a sample of the flue gases. The fuel should be fairly large, and clean. During the test it should be carefully weighed, and samples abstracted for analytical purposes and calorific tests. The calorific tests, and also the measurement of feed water, are referred to more fully below. The fires should be cleaned before commencement, and again towards the end of the trial, and all ashes and clinker carefully weighed in the latter instance. The water-level in the boiler or boilers should be as nearly as practicable the same at finish as at start of trial. We may presume the feed-water heater is of the economiser type. Precautions must be taken to prevent unobserved leakage by inserting blanking plates where necessary. Leakage at pipes or safety valve of economiser, or elsewhere, should be allowed for.

With regard to the measurement of feed water, a most convenient arrangement is that of two tanks at different levels, so connected that the upper, whose capacity must be known, may discharge into the lower, a larger tank, supplying the feed pumps direct. This arrangement is referred to by Ewing in his "Steam-Engine," whence the accompanying sketch has been obtained. T_1 is the tank of known capacity, or what is equally as good, may be mounted on a weighing machine, and supplied with a certain weight of water, which is then transferred by branch pipe, B P, to the lower tank, T_2. This operation is continued throughout the test, and by noting the exact time when T_1 is filled and emptied, the number of operations and the quantity of water used may be estimated.



In order to eliminate T_2 from the calculation, the test is started and finished with this tank full, accuracy on this point being procured on the pointer gauge at *p*. If, in consequence, T_1 remains partly filled, the remaining volume of water may be obtained by gauge, G, or if the measurement is by weighing, the weight of this excess must be ascertained and allowed for. The calorific value of the fuel is obtained by a calorimeter or fuel tester, such as that shown in the sketch herewith. The principle upon which



this instrument is founded is as follows: Latent heat of steam = 966·6 B.T.U., say 967, and if we heat 967 parts by weight of water, raising its temperature 1deg. F. we have imparted to the water the equivalent amount of heat necessary to transform one part by weight of water at 212deg. F. into steam at 212deg. F. The same quantity of water raised 10deg. F. in temperature would indicate an amount of heat equivalent to the transformation of 10 parts of water. This gives us directly the calorific value of the fuel, and, as the weights of fuel and water used are directly proportional to the latent heat of steam, we can read the indications of the instrument in terms of any convenient units.

In practice it is convenient to use 2 grm. of fuel, and therefore by using $967 \times 2 = 1{,}934$ grm. of water the ratio remains the same (see sketch). The apparatus consists of an outer glass jar carefully calibrated to indicate the level corresponding to 1,934 grm. The fuel tester, which is immersed in the water after the fuse is lighted, consists of an inner furnace, F, which contains 2 grm. of fuel under test and about 20 grm. to 30 grm. of oxygen mixture (three parts of chlorate of potash to one part nitrate of potash). The furnace, F, fits into strong clips on a metal stand, and over the whole is placed the combustion chamber, C B. This takes the bell-jar form as shown, has several perforations round the lower edge, and is fitted with an upright pipe and stop-cock.

As already pointed out, samples of the fuel should be selected in the course of the test, and should be as repre-

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sentative as possible. These must be ground and mixed and 2 grm. weighed out. This is then mixed with the oxygen mixture and the resulting powder carefully packed into the furnace. A small fuse is placed in the mixture and lighted, the combustion chamber placed over it, and the whole immersed in the water, with stop-cock closed. Initial and final temperature must be carefully noted, and 10 per cent. is usually allowed for absorption of heat by the instrument. Here is an actual test of Welsh coal by Mr. F. W. Hartley, A.I.C.E. :

Grammes of oxygen mixture to 2 grm. of coal	=	26
Time of combustion in seconds	=	65
Degrees Fahrenheit rise in temperature + 10 per cent. for instrument.....	=	14 4
∴ Weight of water which would be evaporated per pound of coal if water received all the heat of perfect combustion	=	14·4lb.
British thermal units per pound of coal=1.934 grm. ×14·4deg. ÷ 2 grm. of fuel.....	=	13,925

The following data must be obtained during test, and while it must suffice for the present to enumerate them, they should, as already stated, be set forth on specially prepared sheets dealing with various sections of the test. These do not include the numerous results which would be arrived at by calculation, but refer only to observations of the test. First, we have general observations regarding date, duration, and place of test, and normal temperature and pressure of atmosphere during test. Dimensions regarding heating surface of boilers and economiser, grate area and its ratio to heating surface, and so on should also be tabulated. The following are the principal observations to be taken during the test: mean steam pressure (by gauge); mean steam pressure (absolute); temperature corresponding to this pressure; temperature of feed water entering economiser; temperature of feed water leaving economiser; total feed water evaporated; total coal used, including ash; total ash obtained from coal; total clinker obtained from coal; temperature of furnace gases at chimney base; temperature of furnace gases entering economiser; temperature of furnace gases leaving economiser; chimney draught.

From these observations and fuel tests already explained in detail the evaporative efficiency and many other results may be calculated.

The issue of the thermal balance-sheet forms a fitting conclusion to such a test. This would involve the following returns (the figures are purely conventional) :

Cr.	Thermal units.
Calorific value of coal as per calorific test.....	15,000
Heat in coal, vapour, and air	150
	15,150

which represents heat available in furnace per pound of dry coal burnt. Temperatures measured, say, from 32deg. F.

Dr.	Thermal units	Per cent.
Heat absorbed by water in boilers.....	10,605	70
Heat absorbed by water in economiser.. ...	757·5	5
Total	11,362·5	75
Heat carried away by products of combustion	1,212	8
Heat carried away by air and vapour, etc.	1,287·75	8·5
Total	2,499·75	16·5
Loss of heat by radiation, ashes drawn from furnace, imperfect combustion, and unaccounted for	1,287·75	8·5
	15,150	100

—A. M. O.

Answer to No. 155 (*awarded* 5*s.*).—In order to obtain reliable results from an evaporation test on a boiler, several preliminaries are necessary. The boiler should be let down some days before the test and thoroughly cleaned, the flues or tubes being swept or scraped inside and out, and all scale and mud removed; all defective joints should be made good, and the steam and water gauges tested. The apparatus required for the test will consist of a weighing machine, which must be placed near the boiler in order that the coal may be conveniently weighed before it is put on the fire; a water-meter, which must be connected to the feed pipe, between the boiler and feed heater, or what is better, two tanks, the capacity of which has been carefully ascertained beforehand. These tanks are connected by cocks alternately to the boiler and feed-water supply, so that one is being emptied while the other is filling. This method is more reliable than using a water-meter, but the meter is less trouble. A good thermometer is required to show the temperature of the feed water. If tanks are used to measure the water the thermometer may be placed in one of them, but if a water-meter is used it must be placed in a tube projecting some distance into the feed-water heater and closed at the bottom end. Cotton wool should be rammed in round the thermometer to prevent the heat escaping.

A draught-gauge will be needed to ascertain the draught in the flue. It consists of a long glass U-tube half filled with water, and having a scale marked off in inches and tenths. One side of the tube is connected by a small pipe with the main flue between the chimney stack and the test boiler, and the draught read off in parts of an inch of water.

In order to measure the temperature of the flue gases a pyrometer will be required. It is placed in the boiler flue just above the damper so that the temperature of the gases may be ascertained just before they enter the main flue. For an ordinary evaporation test these instruments will be sufficient, but if it is desired to measure the percentage of moisture in the steam, a calorimeter will be required—Peabody's throttling calorimeter is the best to use.

For several hours previous to the test the boiler should be fired with the same coal as that about to be used for the test, the water-level should be brought to the height at which it is found the boiler steams best, and the steam kept at the working pressure. The constant attention of a good firemen is necessary for a boiler under test, in order that the steam pressure and water-level may be kept as uniform as possible.

Before starting the test the fires should be cleaned, the ashes taken away, the thickness and condition of the fire noted, and the height of water in the gauge glass marked. The test may then be commenced by noting the reading on the water-meter, or height of water in tanks, the steam pressure, temperature of feed water, temperature of flue gases, and draught in flue. These readings should be taken at least every half hour, and every quarter of an hour if a very accurate test is required. The fires must be fed at a uniform rate, a little at a time, and the amount of coal put on each time carefully weighed and noted. The test should last for six hours at least—eight is better—and the fires must be cleaned at intervals when required, the quantity of ashes and clinker removed being weighed and noted.

At the end of the test the height of water in gauge glass, the steam pressure, and thickness of fire should be as nearly as possible the same as at the commencement; the results of the test may then be worked out from the various readings and tabulated as follows :

Duration of test.
Kind of coal used.
Average steam pressure.
Average temperature of feed water.
Average temperature of flue gases.
Average draught in flue.
Pounds of coal consumed (total).
Pounds of coal consumed per hour.
Pounds of ashes and clinker.
Pounds of combustible (net).
Per cent. of ash.
Per cent. of clinker.
Per cent. of moisture in steam.
Pounds of water evaporated (total).
Pounds of water evaporated per hour.
Pounds of water evaporated per pound of coal under actual working conditions.
Pounds of water evaporated per pound combustible under actual working conditions.
Equivalent evaporation from and at 212deg. F. per pound combustible.

The equivalent evaporation is always worked out in order that the performance of the boiler may be compared

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on an equal basis with that of other boilers. The formula is

$$W^1 = W \times \frac{H + 32 - t}{966};$$

where W^1 = equivalent evaporation from and at 212deg. F., W = the observed evaporation per pound of combustible, H = the total heat of steam at the observed average pressure, t = the observed average temperature of the feed water, 966 = the latent heat in 1lb. pound of steam at atmospheric pressure. The value of H may be obtained from a "steam table" in any book on steam or boilers.

If many tests are taken it is convenient to plot out the results as curves on squared paper, the curves being always drawn on the same basis. The evaporative power of any particular coal or boiler can then be seen at a glance. It is also useful to take note of the quantity of smoke produced, atmospheric conditions, etc.—R. S.

Answer to No. 155 *(awarded* 5*s.).*—An evaporation test of a boiler to be fairly representative must be carried over a moderately extended period, say of eight hours. To begin with, the boiler flues, brickwork, etc., are thoroughly heated up to their normal temperature some time before the test commences, and steam is raised to working pressure. Either the coal used must be of some standard quality whose composition is fairly well known, or if another coal is used a careful analysis of it must be made and its calorific value determined, care being taken that the coal used in the test has no more moisture in it than the sample that was analysed. If it has, then, previous to the trial a small quantity must be taken, weighed, then dried and weighed again, and from the difference in weight the average amount of moisture per pound of coal can be ascertained, and the heat required to evaporate this must be deducted from the calorific value of the sample analysed. The feed water must be measured from tanks which have been carefully calibrated beforehand, its temperature before and after going through the heater being ascertained. If the feed heater is of the live steam type, the amount of steam used by it can be determined by either weighing or measuring the quantity of condensed water from its exhaust. In some instances the total quantity of feed water used by the boiler is taken as a measure of its evaporative performance, but this may sometimes be totally incorrect, as it takes no consideration of the water carried into the steam-pipes by priming. To determine this factor some form of calorimeter test as described in the *Electrical Engineer* of April 7 must be used, and from the percentage of moisture the total quantity of water carried over by priming can be arrived at.

During the trial at definite intervals the temperature of the escaping flue gases must be taken, and, if possible, a sample analysed; from this the heat lost in the escaping flue gases and also by incomplete combustion is determined. The heat lost by radiation is found by noting the quantity of coal used to keep the water up to boiler pressure when the stop valve is closed, care being taken that the safety valve does not lift. At the beginning of the trial the fires used for getting up steam in the boiler must be drawn, and a fresh start made with the coal which has been weighed. At the conclusion they must be again drawn, the combustible matter separated from the clinker and ash, weighed, and deducted from the total coal used. During the trial care must be taken to keep the fires in such a condition, and to regulate the amount of air admitted, so that the best effect is got from the coal; this is best determined by analysing the flue gases as mentioned above. Finally, the quantity of water in the boiler at the beginning and end of the test must be exactly equal. The results of the trial should then be tabulated somewhat as follows:

Results of Test

Duration of test	hrs.
Maximum evaporation	lb.
Steam pressure and corresponding temperature	lb. deg.
Feed water used	lb.
Steam used in heater	lb.
Temperature of cold feed	deg.
Total coal used	lb.
Ashes and clinker	lb.
Coal per square foot of grate per hour	lb.
Evaporative efficiency in pounds of steam per pound of coal	
Deducting amount used in heater	
Equivalent evaporation at 212deg. per pound of coal	lb.
Pounds of steam per square foot of heating surface	lb.
Total thermal efficiency of combination	%

Heat Balance-Sheet.

To calorific value of coal	Q 100	By dry steam	Q_s
		„ steam to heater	Q_{FH}
		„ priming	Q_P
		„ flue gases	Q_F
		„ incomplete combustion	Q_i
		„ radiation	Q_R
		„ unaccounted for	Q_u
	Q 100		Q 100

Total thermal efficiency $\frac{Q_s}{Q}$.

—H. F. E. B.

Question No. 156.—When a dynamo (shunt-wound) is to be rewound to give double its former voltage, how could the rewinding of the field magnets be dispensed with? Discuss the dangers of separate excitation in this case.

Best Answer to No. 156 (*awarded* 10*s.*).—There are three ways of accomplishing this:

1. An extra resistance equal in amount to the resistance of the low-volt shunt may be connected in series with the latter, so that though the terminal volts are doubled, the shunt current and the ampere-turns remain unaltered. The objection to this method is of course that the excitation losses are doubled.

2. The shunt may be separately excited at the old voltage. This will improve the regulation of the machine, reducing the voltage drop from no load to full load at constant speed from, say, 10 per cent. to 5 per cent. or 6 per cent., but just on this account it will also reduce the safety of the machine on accidental short-circuit. When an ordinary shunt machine is short-circuited the current first increases to a certain point, and the terminal volts at the same time fall off, until the armature back ampere-turns due to the increased current just cancel the shunt ampere-turns (which have themselves been greatly reduced by the falling terminal volts), and then, since the unstable part of the saturation curve will have been reached, the machine loses its field and the current drops down to zero. Now, if the short-circuit occurs on a separately excited machine it will be seen that the armature current must increase until the armature reaction so far reduces the magnetic field that only just enough voltage is generated to maintain that current through the resistance of the armature winding. Then the system is quite stable again, and this short-circuit current will pass as long as the dynamo keeps running. This is a very different case to the plain shunt machine, for in the first place the maximum armature current is much larger, since it has to cancel the full field instead of the weakened field, and then also, as there is no possibility of the separately excited machine losing its field, the short-circuit current, instead of being momentary, is continuous, and puts the armature in great danger of burning up. When shunt machines are running in parallel their fields are practically separately excited off the 'bus bars, so that a separately excited dynamo and a shunt one are practically identical as far as parallel running is concerned.

3. The remaining method is to excite the shunt by the third brush arrangement recently patented by Mr. W. B. Sayers. A small carbon brush is arranged to collect current off the commutator at a point about midway between the two main brushes, and the shunt winding (requiring half the terminal volts of the machine for its full excitation) is connected between the extra brush and the main brush ahead of it in the direction of rotation. This arrangement is not only free from all the objections to separate excitation, but has also the useful property of giving the machine an almost level characteristic, for as the load increases and the main brushes are shifted forward

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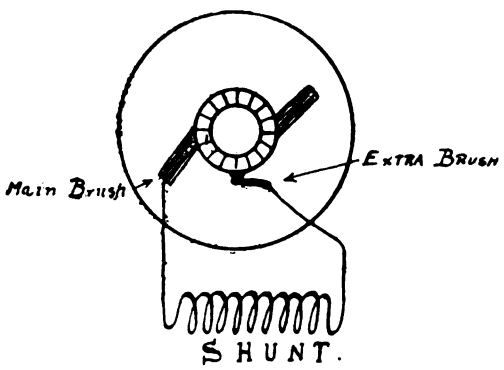
(the extra brush remaining fixed), the voltage across the shunt increases. Though one might expect the small



brush to give trouble by sparking, it is found to work quite satisfactorily in practice.—Q.

Answer to No. 156 (*awarded* 5*s.*).—The answer to this question depends on the conditions under which it is proposed to run the rewound dynamo. If it is a separate machine, running by itself, the only method of dispensing with rewinding the field magnets would be to insert in the field circuit a resistance equal to that of the field, and capable of carrying the normal exciting current. This, of course, assumes that the armature has been rewound with double the number of bars, so as to give double its original voltage when running at the same speed and in the same field. This method cannot, however, be recommended owing to its inefficiency, and as a rule it would be found advisable under these conditions to rewind the field for the increased voltage.

It may be, however, that the rewound machine is to run in connection with others, and that the original voltage of the machine is available for exciting it. The only danger which this method of separate excitation is liable to, which does not equally apply to the self-excited machine, is that the machine may be put on to the mains before its field is excited. This, of course, amounts to short-circuiting the mains, with probably disastrous results. In the self-excited machine, if it is not already excited when put on to the mains, it quickly becomes so, and the worst effect that is produced is that of switching on a motor without any starting resistance. This danger is readily obviated by having an interlocking arrangement so that the main switch cannot be closed until the shunt circuit is made, nor can the shunt circuit be broken until the main switch is off. This arrangement will give perfect safety if the machine is excited off one side of the mains of a three-wire system. Another case, however, may happen—viz., the rewound dynamo may be excited off a separate machine. Under these circumstances it might, of course, happen that the exciting machine is not running, and that although the field switch is closed the field is not excited. An additional safeguard is required under these conditions, consisting of a magnetic arrangement in which not only must the field switch be closed, but the normal current must flow through the field before the main switch can be closed.—R. W.

COMPANIES' MEETINGS AND REPORTS.

CUBA SUBMARINE TELEGRAPH COMPANY, LIMITED.

The ordinary general meeting of this Company was held at the offices, 58, Old Broad-street, on Wednesday.

Mr. C. W. Parish, who presided, said their six months' working had given them very satisfactory returns, after making due allowance for the accounts outstanding with the Spanish Government. The receipts were exceptionally large on account of Government business, and must not be regarded as a normal revenue. He would like to put on record that they were of opinion that the Spanish Government had treated them very fairly. There was, however, a sum still outstanding, which they should not put into the balance-sheet until it had been encashed, but they had practically agreed with the Government as to the amount which was to be paid. The United States authorities were still examining the rights granted to different companies in Cuba. He trusted that at their next meeting he would be able to inform them that their concessions had been duly recognised.

Mr. G. Keith seconded the adoption of the report, which was carried.

ELMORE'S GERMAN AND AUSTRO-HUNGARIAN METAL COMPANY, LIMITED.

The eighth annual meeting was held at Winchester House on Wednesday, Mr. John MacFarlan, chairman of the Company, presiding.

The **Chairman** said he much regretted the failure of the attempted conversion, as it undoubtedly was in the interest of everyone connected with the Company to reduce the rate of interest from 8 per cent. to 6 per cent., but they would ask the debenture-holders to defer the redemption until July 1 of next year. The loans to the Metall Company had increased very considerably, and since Dec. 31 they had taken a further mortgage for £10,000 upon the property at Schladern, bringing up the total amount of mortgages to £50,000. A considerable improvement had taken place in the Metall Company's accounts, but with regard to the sales they must confess their disappointment notwithstanding the improvement. The general expenses in the profit and loss account of the Metall Company were larger than those of last year, and on the other side the general charges of the Austrian Company were less, notwithstanding the greatly increased debenture interest. The result of the trading of the Metall Company was that, with the balance brought forward from the previous year, a net profit of £8,395 was made, and at the general meeting, held last month in Germany, a dividend of 25 per cent. had been declared, which gave this Company about £7,335. Of the balance, they had carried 5 per cent. of the net profit to reserve, paid the commission due to the works manager, and carried forward about £332 to the next account. After deducting the London charges, amounting to £3 235, there was a balance of £4,100, out of which they proposed a dividend of 3s. per share on the preference shares. Their copper purchases amounted to over £5,000 per month. They hoped by the issue of the debenture stock to the full figure of £75,000 to be able to meet the copper requirements for the year. The rise in the price of copper had not so far affected them to any appreciable extent, as they had anticipated it last December and purchased supplies for January and February at an average price of about £57. 10s. per ton, which, of course, was a very favourable price, as copper touched £75 during that period. They had solved, so far as he knew, the problems connected with the process, and for a considerable period had produced copper of a quality that had, he believed, never been equalled when produced on a commercial scale. They were erecting more tanks, which would increase the output by about three tons per week, in addition to extensions and improvements which would add to the more economic working of the process.

The report, etc., were adopted.

CHATHAM, ROCHESTER, ETC., ELECTRIC LIGHTING COMPANY, LIMITED.

The annual meeting of the shareholders of this Company was held at the Sun Hotel, Chatham, on Tuesday.

Mr. H. Jasper, who presided, in moving the adoption of the report referred to the great improvement in the position of the Company, which had made a profit during the year, and gave particulars of the additional plant the directors were erecting for the purpose of meeting the increasing demands of customers, and also for providing an all-day supply.

The report and accounts were adopted, and the retiring directors, Messrs. F. U. Fuller and F. Jasper, were re-elected, also the auditors, Messrs. G. F. Butts and R. Watson.

EASTERN TELEGRAPH COMPANY, LIMITED.

The half-yearly meeting of the shareholders of this Company was held at Winchester House on Wednesday, under the presidency of the Marquis of Tweeddale.

The report and statement of accounts, already published by us, were adopted.

The **Chairman** said nothing had been done as to the alternative cable to Australia *vid* the Cape. These matters were before the various Governments, and would be settled within the next six months. The tariffs over the whole of their Company's system had been reduced, and their charges would compare favourably with any other cable tariffs in the world. Marconi's system of wireless telegraphy would be of use for making short connections, and it was possible the cable companies might employ it as feeders for their main lines and for their connections. That it would ever successfully compete with submarine cables was, in the opinion of the most competent authorities, in the highest degree improbable.

GUILDFORD ELECTRICITY SUPPLY COMPANY, LIMITED.

Directors: Dr. F. R. Russell, Guildford (chairman); A. F. Asher, Esq., Guildford; J. M. V. Money-Kent, Esq., Twickenham; Leonard Ashby Ellis, Esq., Guildford; Charles James Scott, Esq., Guildford; Edward S. Baring-Gould, Esq., Box Grove House, Guildford. Solicitor and secretary: W. J. Perkins, Esq., Guildford.

Report of the directors (with abstract of accounts) for the year ended Dec. 31, 1898:

The directors are pleased to be able to point out that the balance of profit on the revenue account, after taking into consideration the allowance of £150 for depreciation, amounts to £149. 2s. 8d. In the net revenue account the directors have written off £77. 14s. 6d., being 20 per cent. of the amount charged to preliminary expenses, to the end of 1898. Since the general meeting last year the directors have had mains laid in London-road and parts of Edgeborough.

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road and Clandon-road, also in Park-street, Bridge-street, Onslow-street, and Chertsey-street, and they have authorised the laying of further mains in Haydon-place, Martyr-road, York-road, Epsom-road, and further part of Edgeborough-road. This extension of mains has necessitated further expenditure in machinery and plant. There are now 79 contracts with customers for supply of energy for electric lighting, as against 52 in March last year. Some of the old customers have largely increased the number of their lights, and the directors are expecting several new customers shortly. The directors have during the past year reduced the price of current for lighting purposes from 8d. per unit, with varying discounts, to 6d. net, and hope that this change will in the long run prove beneficial to the shareholders as well as to the customers. It will be necessary for the Company to continue spending more capital for mains, machinery, and plant, and for this purpose further capital is required. Shareholders are asked to increase their holdings, in order that the necessity of paying commission for placing fresh capital may be avoided. In view of the probable increased demand for electric energy in the near future, the directors are now applying to the Board of Trade for an extension of the Company's area of supply, and hope to obtain an order during the present session of Parliament adding the rural parishes adjoining the borough of Guildford within a radius of three or four miles to the Company's present area. It is considered most important for the future of the Company that this extension should be obtained. The directors have elected Mr. Edward S. Baring-Gould a director in the place of Mr. Sidney Sharp, who retired in March, 1898. The retiring directors are Mr. Leonard A. Ellis and Mr. Charles J. Scott, both of whom offer themselves for re-election.

REVENUE ACCOUNT.

Dr. Generation of Electricity.	£ s. d.	£ s. d.
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£199 13 3	
Oil, waste, water, and engine-room stores	29 9 5	
Wages and gratuities at generating stations	163 2 2	
Repairs and maintenance	10 7 11	
		402 12 9
Repairs, maintenance, and renewals of apparatus at distributing stations		0 9 0
Rents payable		50 0 0
Rates and taxes	11 7 10	
		61 7 10
Management Expenses.		
Salaries of engineers, secretary, and accountants	124 1 10	
Stationery and printing	13 15 9	
General establishment charges	10 6 7	
Auditors of Company	10 10 0	
Auditor appointed under the provisions of the order	5 0 0	
		163 14 2
Law expenses		2 19 0
Depreciation in respect of works, buildings, plant, machinery, etc.		150 0 0
Insurances		7 10 9
Total expenditure		788 13 6
Balance carried to net revenue		149 2 8
		£937 16 2

Cr.	£ s. d.
Sale of current per meter at 8d. and 6d. per B.T.U., less discounts	831 0 8
Rental of meters on consumers' premises	61 9 2
Sale and repairs of lamps	4 0 0
Rents receivable	11 13 4
Transfer and other fees	0 17 0
Miscellaneous income	28 16 0

GENERAL BALANCE-SHEET.

Liabilities.	£ s. d.
Capital account—amount received	10,792 0 0
Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, etc., to Dec. 31, 1898	560 3 1
Sundry creditors on open accounts	177 8 8
Sundry creditors for house connections	13 0 0
Depreciation fund account	150 0 0
	£11,692 11 9

Assets.	£ s. d.
Capital account—amount expended for works	10,486 7 7
Stores on hand at Dec. 31, 1898: coal, £23. 10s.; oils, waste, etc., £2. 5s.	25 15 0
Preliminary expenses (less 20 per cent. written off)	310 18 3
Sundry debtors for current supplied to Dec. 31, 1898	420 19 0
Debtors on house connections	57 18 4
Insurance paid in advance	7 7 9
Cash at bankers	142 8 0
Cash in hand	17 18 2
Balance from net revenue account	222 19 8
	£11,692 11 9

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY, LIMITED.

Lord Tweeddale presided over the ordinary meeting of this Company, held on Wednesday at Winchester House, and in moving the adoption of the report, already published by us, said (according to the *Financial News*), with regard to wireless telegraphy, it was not surprising that investors, who had hitherto regarded cable securities as among the soundest in the market, should have been startled and alarmed. It was true that messages could be sent without wires between two places not very far apart, and it was hastily inferred that the same could be accomplished equally well over long distances. In consequence, a few shares had been thrown on the market, and this had caused a serious fall, recalling what occurred when electricity became a competitor of gas. Prof. Marconi's system was interesting from a scientific point of view, and in practice would be of considerable value for shipping and lighthouse purposes; but that it would successfully compete with submarine cables was, in the opinion of those most competent to form one, in the highest degree improbable. Since he last addressed the shareholders the newspapers had contained many references to developments in the United States Congress and elsewhere in connection with the laying of cables across the Pacific Ocean. Nothing, however, was settled by Congress before it adjourned last month in reference to the American project, and, judging from replies to questions in the House of Commons, the "all-British" Pacific scheme had not yet advanced beyond the consideration stage, nor had any arrangement yet been come to in regard to the proposal which the Eastern Extension and associated companies submitted to the Imperial and Australasian Governments about two years ago for an all-British alternative cable to Australia *vid* the Cape.

Mr. F. A. Bevan seconded the motion, and it was carried.

CONSOLIDATED TELEPHONE CONSTRUCTION AND MANUFACTURING COMPANY, LIMITED.

The adjourned general meeting of this Company was held on the 20th inst. at Winchester House, Mr. C. Lee Fitzgerald presiding.

Mr. Lawson, a member of the committee, said that they were strongly of the opinion that a change in the management was wanted. The committee proposed that two of the directors should retain their positions, and that room should be made for two new directors. He moved a resolution approving of the report of the committee, and expressing the opinion that the voluntary winding up proposed by the directors was uncalled for and unnecessary.

The **Chairman** said that, leaving out of consideration the question of directors, the committee's report amounted to a recommendation to the shareholders to appoint an electrician and a works manager and to get a traveller, and the proposals which he had himself made in his circular reply amounted to precisely the same. The whole aspect of matters concerning the telephone industry had changed since their last meeting in August in consequence of the action of the Post Office authorities.

An amendment, "That the report of the committee be received and their suggestions carried out in the mode proposed by the chairman in the first five paragraphs on p. 4 of the circular" issued by that gentleman was lost by one vote, and the original motion was carried.

ORIENTAL TELEPHONE AND ELECTRIC COMPANY

The fifth ordinary general meeting of this Company was held on Wednesday, Sir Auckland Colvin in the chair, when the report (already published by us) was adopted.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Reigate.—The Town Council are prepared to receive tenders for the supply and erection of various electric plant. Tenders by May 1.

Edinburgh.—The Council are prepared to receive tenders for the supply of copper strip for electric conductors. Tenders by May 15.

King's Lynn.—The Corporation are prepared to receive tenders for the electric wiring and fittings of the Lynn Technical Schools by May 16.

Derby.—The Corporation invite tenders for the works in the superstructure in connection with the extensions to the electric lighting station by May 8.

London, W.—The Hammersmith Vestry invite tenders for erection of the buildings upon land adjoining the present electric lighting station by May 10.

Epsom.—The Urban District Council are prepared to receive tenders for the supply and erection of various electric plant. Tenders by 12 o'clock noon on May 8.

London, E.C.—The Directors of the Great Eastern Railway Company are prepared to receive tenders for the supply of various stores and materials. Tenders by May 11.

Darlington.—The Corporation invite tenders for the supply and delivery of various plant, together with the fixing of the same, at their electric generating station. Tenders by May 30.

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St. Marylebone.—The Guardians invite tenders for electric light wiring and fittings for the new front blocks of their workhouse, Northumberland-street, W. Tenders by 10 a.m. on May 8.

St. Pancras.—The Vestry are prepared to receive tenders for supplying and fixing additional plant at the Regent's Park electricity works, comprising dynamos, engines, etc. Tenders by 12 o'clock noon on May 16.

Salford.—Tenders are invited for supply of 5,000 tons of steel tramway rails, 7in. deep, 105lb. per lineal yard. Particulars may be obtained at the Borough Engineer's Office, Town Hall, Salford. Tenders by May 9.

Paris.—Tenders are invited for 666,400 yards of electric cable, paper insulated, in 72 lots. Specifications, etc., are to be obtained from, and tenders addressed to, Post and Telegraph Department, Rue de Grenelle, Paris, by 11 a.m. on May 4.

Bolton.—The Bolton Corporation invite tenders for the work required in laying the tramway rails in Lostock and Horwich. Specification, etc., may be obtained from the borough surveyor, Mr. W. H. Brockbank, Town Hall, Bolton. Tenders by May 1.

Almaden del Azogue (Spain).—Tenders are invited for an electric lighting installation, and the preliminary deposit required is £60 to £100. Specifications, etc., are to be obtained from, and tenders addressed to, the Syndaco of the above town by noon on May 19.

Tarifa (Spain).—Tenders are invited for public electric light installation, and working of the same for 20 years. The deposit required is 5 per cent. of the tender. Specifications, etc., are to be obtained from, and tenders addressed to, the Syndaco, Tarifa, Spain.

Teneriffe.—Tenders are invited for the erection and working of an electric tramway between Santa Cruz and San Cristobal. The deposit required is about 776,214 pesetas (about £350). Specifications, etc., are to be obtained from, and tenders addressed to, Public Works Department, Madrid, by 1 p.m. on June 14.

Almodovar del Campo (Spain).—Tenders are invited for the installation of electric light and the working of same for 20 years. The deposit is £100. The annual income is estimated at £400 Tenders may be addressed to the Ministerio de la Gobernacion, Madrid, or to the municipal authorities at the above place, province of Ciudad Real, by May 5.

Southampton.—The Corporation invite tenders for electric lighting, wiring, and fittings for the Municipal Lodging-House, Southampton. Specifications, etc., may be obtained from Mr. W. B. G. Bennett, borough engineer, Municipal Offices, Southampton, on payment of £1. 1s., which sum will be refunded on receipt of a bona fide tender. Tenders by May 5.

Hampstead.—The Vestry invite tenders for the supply, delivery, and erection of electrical plant, including steam alternators and engines, switchboard panels, boilers, feed-water heaters, vertical steam feed pumps, exciter, water-softening plant, air pump and condenser, Green's economiser, and overhead travelling crane. Particulars may be had of Mr. A. P. Johnson, vestry clerk, to whom tenders must be sent by 12 noon on May 18.

Southampton.—The Corporation of Southampton invite tenders for the reconstruction of about 1¾ miles of tramway on the Shirley route. Specifications, etc., may be obtained and plans inspected on or after 20th inst. at the offices of the consulting engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of £3. 3s., which will be returned on receipt of a bona fide tender. Tenders before noon on May 2.

Perth.—Applications will be received at the City Council Office from persons desirous of applying for a concession for the installation and working of a system of electric lighting for the municipal buildings and streets of the city of Perth, as well as house-to-house lighting. Conditions of contract and full particulars may be obtained on application to the Agents-General for Western Australia, 15, Victoria-street, Westminster, London, or Gordon and Gotch, St. Bride-street, Ludgate-circus, E.C. Tenders by May 2.

Fleetwood.—The Urban District Council invite tenders for the following: (Section 1) cast-iron lamp pillars and brackets; (2) street lamps for electric incandescent street lighting; (3) arc lamps and posts; (4) installation of wiring, switchboards lamps, etc., for the electric lighting of the town hall, Fielden free library, public market, and slaughter-houses. Specifications, etc., can be obtained from Mr. Thomas Barton, Ainsworth-street, Blackburn, on payment of £2. 2s., which sum will be returned after a bona fide tender has been received. Tenders by May 16

Prestwich.—The Committee of Visitors of the Prestwich County Lunatic Asylum invite tenders for steam-pipes, condensers and cooling tower, steam dynamos for 274 kw., mains, switchboards, storage batteries, and wiring for an electric light installation. Firms desiring to tender are directed to send their names, with a statement of the parts of the work they desire to quote for, to Mr. Charles Hopkinson, M.I.C.E., 29, Princess-street, Manchester: or to Messrs. Hopkinsons and Talbot, 26, Victoria-street, London, S.W. They will then be informed when the specifications are ready for issue.

London, S.W.—The Vestry of St. Mary, Battersea, invite tenders for the supply and erection and the carrying out of work in connection with the electric lighting of the parish to specifications as follows: (Specification No. 1) feeders, distributing mains, and arc light leads, including laying and jointing; (2) water-tube boilers; (3) steam dynamos and engines. Specifications, etc., may be obtained from the Vestry Clerk at the Municipal Buildings, Lavender-hill, S.W., on payment of £3. 3s. for each specification, etc., which sum will be returned after the receipt of the specification, etc., accompanied by a bona fide tender. Specifications and drawings can also be seen at (but not obtained from) the office of Prof. Alex. B. W. Kennedy, 17, Victoria-street, Westminster. Tenders by 12 noon on June 7.

RESULTS OF TENDERS.

Chatham.—The Town Council have accepted the tender of Messrs. Stevens and Barker, at £827. 10s., for the electric wiring of the new town hall and for providing electrical fittings.

Basingstoke.—The Town Council have accepted the tender of the National Telephone Company, amounting to £65, for establishing a system of electric bells between the station and the members of the fire brigade.

Brighton.—The Corporation have accepted an offer from the Tudor Accumulator Company, Limited, who will purchase the lead of the old battery and supply a more modern battery of a capacity of 400 amperes. The price of the battery is £727 net. The old material is estimated to bring in £250 to £300.

Bangor.—The City Council have accepted the following tenders for electric lighting plant:

British Insulated Wire Company, mains and branches	£3,858	0	0
J. Hamilton and Son, buildings	2,920	0	0
J. Fowler and Co., steam dynamos, etc.	2,143	0	0
R. Hornsby and Sons, boilers	1,490	15	0
Mirrlees, Watson and Yaryan Company, steam-pipes, etc.	1,157	0	0
Chloride Electrical Syndicate, accumulators	920	0	0
Dobson and Curtis Bros., switchboard, etc.	563	11	7

BUSINESS NOTES.

Exeter.—The City Council intend to borrow £10,000 for extensions.

Leicester.—The Town Council have made a net profit of £645 on electricity during the past year.

Taunton.—The Town Council have decided to borrow £10,000 for condensing plant and extensions.

Eccles.—The Board of Trade have issued a provisional order to the Corporation under the Tramways Act, 1870.

Woking.—The question of purchasing the electric light installation has been definitely negatived by the Council.

Chelmsford.—We understand that the Council intend to offer £24,000 for the electric lighting company's undertaking.

Parliament.—The Mansfield and the Wath-upon-Dearne electric lighting orders have passed the examiners of private Bills.

Eastbourne.—A meeting of ratepayers was held on Monday to protest against the introduction of tramways into the town.

Personal.—Mr. S. Kirkwood, of Edinburgh, has been appointed assistant electrical engineer to the Lancaster Town Council.

Redruth.—The Urban District Council has asked the Lighting Committee to draw up a report as to the electric lighting of the town.

Lovenshulme.—The Corporation are busy with the electric supply plant. Cables have already been laid along Slade-lane and up Park-grove.

Ilfracombe.—The Council have decided themselves to carry out the work of electric lighting. Mr. Trentham will be the consulting engineer.

Wallsend.—We learn that the Wallsend Gas Company are giving careful consideration to the matter of using the refuse for the production of electricity.

Croydon.—A new arc lamp is to be erected in Dennett-road, and four existing ordinary gas lamps in the same road are to be changed to incandescent electric lights.

Dollar.—The Burgh Commissioners have agreed in principle to approve of the introduction of the electric light pending a scheme being paid before the Commissioners by Mr. Purvis.

Ross.—The Urban District Council have decided to obtain expert advice *re* an application made by a syndicate anxious to obtain a provisional electric lighting order for the district.

Worksop.—In connection with the electric lighting order of the Urban District Council, it is reported that the final proofs are now lodged with the Board of Trade, and everything is complete.

Newcastle.—We are informed that the London Chamber of Commerce, who had petitioned the Newcastle Tramways and Improvement Bills, have now asked leave to withdraw their opposition.

Glossop.—The clause giving the Corporation permission to transfer their electric lighting powers, which had been struck out of the provisional order by the Board of Trade, has now been reinstated.

Luton.—The Town Council on Tuesday rejected the offer of a company to purchase the electric light provisional order, and adopted a scheme for undertaking the work themselves at a cost of £20,000.

Johannesburg.—We learn that the employ of white men as stokers for the electric power company has resulted in considerable saving of fuel, more uniformity in steam pressure, and better working of the whole plant.

Carlisle.—The current was turned on at the electric lighting station this week, and the light produced was of a steady and

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satisfactory description. The arrangements for lighting the city are being rapidly completed.

Hawick.—The Board of Trade have issued a provisional order to the Urban Electric Supply Company, Limited, authorising them to supply electrical energy for public and private purposes within the whole of the burgh.

West Hartlepool.—Mr. R. H. Bicknell held a Local Government Board enquiry on Wednesday into the application of the Town Council to borrow an amount including £10,272 for purchase of refuse destructor in Burn-road.

Dawlish.—Mr. Taylor, electrical engineer, attended the last meeting of the Council, and said he considered that Dawlish was favourably situated for an installation of the electric light, for which he estimated the cost at £2,700.

Appointments Vacant.—An electrician is required to take charge of colliery lighting and motors.—A foreman is wanted in winding-shop in North of England. Particulars of these and other vacancies will be found elsewhere.

Wimbledon.—The charge for electricity for motive power has been fixed at 3d. per unit. Applications have been received for current for private lighting amounting approximately to an equivalent of 5,500 to 6,000 8-c.p. lamps.

Lynmouth.—A new turbine has just been put down in the electric lighting station at Lynmouth for driving the pump which forces the water up to the high-level reservoir. The turbine is of the Girard type, and hails from America.

Durham.—At their meeting on Wednesday the County Council refused to allow the Imperial Tramways Company to lay an electric cable from Stockton along the main road to Darlington for the purpose of supplying power to the proposed light railway.

Rotherhithe.—The proposal to the effect that the Vestry apply to the Board of Trade for a provisional order to enable them to supply electricity for private and public purposes within the parish has been postponed for 12 months, in view of the London Government Bill.

Nuneaton and Chilvers Coton.—The Nuneaton Electric Company have been approached with a view to the disposal of their undertaking now instead of at the expiration of 10 years, and a committee has been appointed by the Urban District Council to consider the matter.

Aberdeen.—The terms of the provisional order obtained from the Board of Trade authorising the Corporation of Aberdeen to proceed with various works in connection with the tramways undertaking, chiefly the laying of the new electric line to Woodside, have been published.

Maidenhead.—The report of the Electric Lighting Committee referred to in our last issue has been adopted, and a ballot of the ratepayers will be taken to ascertain whether they are in favour of the electric lighting scheme being undertaken by the Corporation or by a private trading company.

Swansea.—The British Electric Traction Company intend to apply for powers to extend their electric tramways from their Morriston terminus through Woodfield-street and across Morriston to Clydach and Pontardawe, and very probably right through the valley. The different local bodies are giving their support to the scheme.

Drake and Gorham.—We are informed that owing to the increased demand for the Jandus arc lamp Messrs. Drake and Gorham have taken the Hartham-road Works at Holloway. The special plant erected by the Company at the works hitherto leased by them from Messrs. Johnson and Phillips will be removed from Charlton to Holloway.

Halifax.—The Tramways Committee of the Town Council received deputations last week from the Queensbury and Northowram District Councils, who made application that the Corporation tramway system should be extended to their respective districts. The Tramways Committee promised to view the districts, and give an early answer.

Shropshire Electric Light and Power Company, Limited.—The Corporation of Shrewsbury having purchased this company's undertaking, and entered into possession at the commencement of this year, the voluntarily winding up of the company has now been decided upon, and Mr. Naunton (secretary) has been appointed liquidator for this purpose.

Wigan.—We understand that Mr. Bishop H. Collings, late resident engineer at Leyton, has resigned his position, and been appointed borough engineer of Wigan. He is now preparing a comprehensive scheme of electric lighting and traction, which will be submitted to the Municipal Council before very long. We wish Mr. Collings every success in his new position.

Durham Electrical Power Distribution Company.—This Company has been registered, with a capital of £100,000 in £10 shares (5,000 preference), to carry on the business of electrical engineers, electricians, contractors, suppliers of electricity, manufacturers of electrical apparatus, mechanical and chemical engineers, tramway and light railway proprietors, carriers of passengers and goods, etc.

Islington.—The Electric Lighting Committee have been instructed to report as to the desirability of extending the electric light to the following roads: Hornsey-road (to parish boundary), Stroud Green-road, Crouch-hill, Blackstock-road, Gillespie-road, Drayton park, St. Paul's-road, Newington Green-road (to parish boundary in Newington Green), Mildmay-road, Mildmay-park, and Ball's Pond-road, and to bring up estimates of the respective costs to the Vestry.

Bath.—The Town Council have adopted a report of the Electric Light Committee recommending extensions of mains for public and private lighting, at an estimated cost of £8,000. The report also dealt with the subject of electric trams, and though advocating that the Council should have control of any installation of these trams, pointed out that now no application could be made until November. No steps are to be taken towards obtaining powers until the Council has been consulted.

Brighton.—The application of the National Telephone Company requesting the Corporation to reopen negotiations with the National Telephone Company to permit them to place wires underground in Brighton on the twin-wire system has been refused. A resolution has been passed to the effect that it was inexpedient to express any opinion on the subject of the telephone service, and the view was expressed that the Government should buy out the Telephone Company at once, and give the whole country a new service.

Ormskirk and Southport Electric Light Railway.—The British and Foreign Light Railway Syndicate has been registered with a capital of £5,000, and we understand that one of its first undertakings will be the electric light railway between Ormskirk and Southport. The engineer is Mr. R. H. Scotter, C.E., M.I.Mech.E., who first worked out, early in last year, the details of the light railway, together with a collateral scheme for the erection of a refuse destructor and the supply of electric power for lighting and other purposes in the Ormskirk district.

Bermondsey.—At the last meeting of the Vestry the Chairman of the Electric Lighting Committee reported that the Board of Trade had granted the Vestry an electric lighting provisional order. The Bill introduced by the Board of Trade into the House of Commons for the purpose of confirming this order was read a first time on March 28, and stood referred to the examiners of petitions for private Bills. In the event of the Bill being opposed in committee after second reading, it would be necessary to brief counsel to support the order. The necessary permission was given.

Norwich.—No definite arrangement has as yet been arrived at with regard to permission being given to the Norwich Electric Tramways Company to make a tramway in St. Stephen's-street. A discussion took place at the Town Council meeting last week upon a resolution to the effect that a special committee be appointed from the Council to confer with the National Telephone Company with a view to a settlement of differences now existing between the company and the Corporation, and for a modification of charges. In this matter also nothing was decided when the Council adjourned.

Shoreditch.—At the last meeting of the Vestry the Lighting Committee recommended that the orders for the arc lamp columns, carriers, lamps, and switches be placed with the contractors who had previously supplied the Vestry, provided they agreed to supply them at the prices previously paid. The question of supplying and laying the necessary conduits and cables will be further considered. An amendment to delete the words "arc lamp columns" from the report, inasmuch as under the contract existing at the present time the columns could be supplied at the old price, was carried.

Exmouth.—A special meeting of the District Council was held on the 20th inst. to hear Mr. F. H. Taylor, A.I.E.E., of the firm of Taylor and Field, consulting electrical engineers, of Westminster, express his views concerning the installation of the electric light in Exmouth. All the members were present Mr. Taylor considered they might put down an electric station with plant to supply, say, 3,000 8-c.p. lamps for about £5 000 or £6,000. He also promised to send in writing to the Council the facts and figures contained in his verbal statement, and the whole Council in committee will consider these on their arrival.

Greenock.—With regard to the offers by the tramways company and by Mr. W. M. Murphy, and the report by Mr. Young, referred to in our last issue, we hear that the Police Board have agreed to recommend to terminate the lease with the tramway company next May, and to acquire at the same time that portion of the tramways within the burgh of Greenock belonging to the tramway company; and also to apply to the Board of Trade for power to purchase and work the tramways according to Section 43 of the Greenock Corporation Act of 1893. The question of municipalising or leasing is left open.

Huddersfield.—Mr. E. A. Sandford-Fawcett, Local Government Board inspector, has held an enquiry into the application of the Corporation for power to borrow £50 000 for electric lighting purposes. The Chairman of the Electric Lighting Committee said that the reason of the application was the rapid increase in the number of consumers. They had had recently to decline a number of applications because they had not the necessary plant and no further money to spend. The profit on the undertaking during the year ended Dec. 31, 1898, was £2,437. 1s. 3d, and the whole of this amount was transferred to depreciation and contingencies fund.

Edinburgh.—The Electric Lighting Committee of the Town Council have resolved to recommend that the Council make no change on the charge for electric energy for the year from May 15, 1899, to May 15 1900. Since May 15, 1898, the equivalent of 70,500 8-c.p. lamps have been joined on to their system. In addition, there were fittings for 22,215 8-c.p. lamps waiting to be connected. They calculated that the output for private lighting for the coming year would be 4,500,000 units, and with 1,200,000 units for public lighting, they would have for the next year an output of 5,700,000 units. They expected to have a clear surplus of £14 000.

Worcester.—It is reported that the directors of the Worcester Tramways Company have secured the co-operation of the British

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Electric Traction Company, with a view to the extension of the tramways in the city and the adoption of electricity as motive power. It is intended to reconstruct the existing 3ft. lines on a 3ft. 6in. gauge, and to largely extend the same. The Corporation are at present considering the advisability of taking over the tramway system in the city, and an engineer has been employed to advise whether negotiations should be at once opened with the tramway company, or whether the Corporation should wait until the expiration of the lease in three years' time.

Beccles.—At the last meeting of the Town Council the Public Lighting Committee reported that they had considered Mr. Medhurst's report as to the adoption of the electric light in Beccles, but were not prepared at present to recommend the Council to adopt a scheme. The Mayor said it must not be understood that the committee had shelved the matter. The scheme provided for a system of mains for street-lighting, distinct from the private lighting system, at an estimated cost of £12,487. There was a probability of a fair demand for electrical energy by private residents and others. The committee were instructed to meet at an early date to arrange for the public lighting, whether by gas or otherwise.

British Electric Works Company, Limited.—This Company has been formed with a share capital of £135,000, divided into 50,000 6 per cent. cumulative preference shares and 85,000 ordinary shares of £1 each, to take over the recently-completed engineering works of R. F. Hall, Limited, at Aston, Birmingham. The Company's plant is mainly automatic, and is driven by electricity generated on the premises. It is the intention of the directors of the Company to pay special attention to telephone work. It is also stated that the Company acquire various patents for improvements in the manufacture of electric lampholders, switches, and arc lamps, and a special department of their work will be the making of an improved type of roller bearing for reducing friction in traction machinery.

Blackpool—It is expected that the overhead trams will be in working order for Whitsuntide. A deputation waited on the Electric Lighting and Tramways Committee last week respecting the proposed new tramroad between Blackpool and Poulton. The committee suggested that the promoters should arrange for their tramroad to leave Blackpool by the New-road route. If that course were decided upon they would be willing to grant a 14 years' lease of the lines within the borough at a rental of 12½ per cent., and respecting the supply of electricity, they would charge for it at whatever rate the Corporation paid for the electricity used on its own overhead lines—the rate the St. Annes and Lytham Company had also agreed to pay whenever they adopted the overhead system.

Leeds.—It has been decided by the Sub-Lighting Committee to recommend that North-street, as far as Sheepscar police station, should be lighted by means of electricity, and that the electric light should also be extended along Wellington-street to Wellington-road. The estimates for the ensuing year have been approved of. A year ago the estimated expenditure was £27 210. 17s. 1d., and the actual sum expended was £28,358. 17s. 10d. The estimate this year shows an increase of £1,657. 5s. 9d. as compared with last year, the amount being £28,868. 2s. 10d. The income 12 months ago was estimated at £1,007. 10s. 10d., the actual amount received was £1,091. 16s. 10d., and the estimate for this year is £1,050. 14s. 5d. The Britannia Mills will probably be taken over by the Corporation with a view to the extension of the electricity works.

Manchester.—The Electricity Committee estimate that the amount available for transfer to the city fund in the present year will be £10,000, as against £12,000 last year. A committee of the House of Lords, consisting of the Earl of Lauderdale (chairman), the Earl of Cork and Orrery, Lord Digby, Lord Napier, and Lord Glenesk, has been appointed to consider a batch of Bills, including several from Manchester and district. These Bills are largely dependent upon one another, and all have reference to the scheme for replacing the Manchester Carriage and Tramways Company when the lines it owns come into possession of the various local authorities. The following are the Bills to be considered: Manchester Corporation Tramways Bill, Moss Side Urban District Council Tramways Bill, Oldham Corporation Bill, Stretford Urban District Council Tramways Bill, Salford Corporation Bill, and the Withington Urban District Council Tramways Bill.

Wrexham.—Messrs. W. H. Trentham and G. L. Peers have submitted their report to the Town Council. The estimated expenditure for lighting is £18,758, or at the rate of £50 per kilowatt. The estimated annual income is—186,000 units at 5d., £5,875; meter rents, £90; arc lamps, £500, or a total of £4 465; against which is placed as expenditure 214,000 units at 3d, £2,675; carbons and attendance on public lamps, £100; interest and repayment of £20,000 at 5¾ per cent., £3,925, leaving a profit of £540. The Council is advised to take the Willow Brewery site, to provide power for electric traction, to combine a dust destructor with the works whenever they decide to erect the former, and to start with 25 arc lamps in the street, adding others when mains are being extended. The engineers express the opinion that in a short space of time the electricity supply works would not only be self-supporting, but an assistance to the town's finances.

Southwark.—The Electric Lighting Committee recommended at the last meeting of the Vestry that the National Telephone Company be informed that the Vestry would consent to the company laying its wires underground subject to the company agreeing to pay to the Vestry 5s. per annum for each exchange subscriber now or hereafter connected within the company's system within the parish; that the company fix and maintain, free of charge, a central telephone at the vestry hall, with exchange connection, private connections from the vestry hall, with telephones at the vestry stables and depôt, and extensions from the central telephone to the offices in the vestry hall of the vestry clerk, surveyor, and medical officer of health; also that the work of laying the underground wires be carried out according to specified conditions. The question was adjourned for three months pending the action of the Government with regard to the telephone system.

Artistic House-Lighting.—An exhibition of artistic electric lighting as applied to houses was opened last week at the galleries of Messrs. H. and J. Cooper, Great Pulteney-street, W.C. The object of the exhibition is to show how electric light may be used in lighting rooms without the uncomfortable glare which is a disadvantage of the present style of lighting. Several rooms are shown with the new arrangement, in which the lights are run along the ceiling and screened from the eye by artistic woodwork screens, so that the pictures on the wall are shown up without the glare of the lights spoiling the effect. In the same way lights are sunk in the mantelpieces, effectively lighting pictures placed above them. In the rooms also hang some fine electroliers and electric lampholders. The exhibitors admit that these methods of artistic lighting could more easily be carried out if they could have been provided for by the architect when planning the house, but much might be done by careful readjustment.

Hornsey.—At the last meeting of the Urban District Council it was proposed that it be referred to the Works and General Purposes Committee to consider the most suitable position for a central station for the generating of electrical energy and the cost of the necessary buildings, machinery, equipment, distributing and feeder mains, etc., with power to obtain expert advice and to report fully to the Council. After discussion, an amendment that the question of the supply of electricity in the district be referred to a special committee, consisting of four members of the Lighting Committee and four members of the Works Committee, with power to take expert advice, was unanimously agreed to. The Hornsey and Finchley District Councils have now decided to apply to the Light Railway Commissioners for sanction to construct light railways along the Archway-road and Great North-road, connecting with the London County Council tram system at the Archway Tavern, Upper Holloway.

Bradford.—The Bradford staff of the National Electric Wiring Company were entertained to dinner on Friday night at Messrs. Spink and Sons' Restaurant, Mr. Frank Little, district manager, presiding. The Chairman proposed "The Electricity Department of the Bradford Corporation," to which Mr. C A. L. Pruemann replied. The toast of "The National Electric Wiring Company" was honoured, on the proposition of the Chairman. Mr. H. Addison submitted "The Staff," and in reply Mr. Little said that they wanted to lift the electrical trade in Bradford out of the gutter. It was at present in a very bad condition, because unqualified and inefficient men were employed at a low rate of wages. He hoped the Electrical Trades Union would succeed in their endeavour to make the Bradford firms pay the standard rate of wages, but, at the same time, he contended that all members of the union ought to go through a thorough examination as to their efficiency. There were men in the union who were practically labourers.

Hendon.—The promoters of the Hampstead, Finchley, and Edgware light railway have written to the Rural District Council stating that they proposed to renew their application in May next. The scheme submitted would be a modified one, and they would be glad to have an opportunity of discussing the matter with the Council. The County Council also wrote enclosing copies of resolutions passed with reference to light railways in the county. It was pointed out that the county surveyor had been instructed to prepare a scheme for light railways, and when the scheme was being considered by the Parliamentary Committee, the district councils would be asked to appoint representatives to confer with the committee on the subject, so that any action taken by the County Council might, as far as possible, be in accordance with their wishes. Finally it was decided to wait until the County Council had discussed their scheme before meeting the promoters. It was mentioned that the Edgware Parish Council favoured the introduction of a light railway, owing to the isolated condition of that part of the district.

Stratford.—Colonel A. C. Smith, R.E., held an enquiry recently into the application of the West Ham Corporation to borrow £51,000 for purposes of electric lighting, and £10,000 under the West Ham Corporation Act, 1898. The Deputy Town Clerk asked that the money might be borrowed for as long a period as possible. The £51,000 was applied for under the Electric Lighting Act for extension, and the £10,000 under the West Ham Corporation Act for the purpose of free wiring. The Electrical Engineer stated the electric lighting scheme was inaugurated on Dec. 10, 1898, and the Council were now supplying 12,000 8-c.p. lamps, although they had laid down machinery for supplying 15,000. The engines, exciters, and alternators were estimated to cost £17,000, and three boilers, condensers, and piping, £8,500. The Council had now 80 arc lamps, but they intended to increase them to 160, which would be placed along the High-street, Stratford, and the Woodgrange Estate, and in Victoria Dock-road. It was explained in regard to the £10,000 that the Council wished to have that sum in reserve for purposes of free wiring when necessary.

Theft of Electric Cable.—On Saturday, John Wroath Williams, of Sharratt-street, Old Kent-road, James Smith, of Kender-street, New Cross, William Clark, of Mawbry-road, and Alfred Gunning and Francis Rodd, of Chatham-street, Old Kent-road, committed from Greenwich Police Court, were indicted at the County of London Sessions for stealing a quantity of electric light

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cable, value £170, the property of the Crystal Palace Electric Supply Company, from their depôt at Westwood-road, Sydenham. Mr. Cohen prosecuted, and Mr. Warburton defended Gunning and Rodd, and Mr. Leycester appeared for Williams. The case for the prosecution has been reported. The chairman decided that there was no evidence against Gunning and Rodd to go to the jury, and they were discharged. Clark, Williams, and Smith were found guilty, the jury recommending the last-named to mercy. Clark was sentenced to 12 months' imprisonment, Williams to eight months, and Smith to four months. The chairman and the grand jury commended Detective-inspector Fox and Detective-sergeant Grey, who were instrumental in bringing about the arrest of the prisoners.—*Kentish Mercury.*

Wembley.—At the last meeting of the Urban District Council a letter was read from the promoters of the Hampstead, Finchley, and Edgware Light Railway informing the Council that they intended to make another application to the County Council, and asking whether the Council would be willing to receive a delegation from them on the subject. There was also a communication on the same matter from the Middlesex County Council, enclosing a copy of a resolution recently passed by them, and stating that they intended to call another conference of delegates from urban district and other councils to discuss the question. Mr. Harper said that he had attended the previous conference of delegates, and that, with the exception of the representative of the Hendon Urban District Council, who supported the opposing scheme, every delegate was in favour of opposing the various light railways throughout the county, and, with only that one dissentient, it was carried. It was resolved that the County Council should carry out this opposition in such a way as to secure a continuous and co-terminous system for the benefit of the districts affected. A resolution that the promoters of the scheme be informed that the Council do not feel disposed at present to grant them an interview, and that a reply be sent to the County Council to the effect that the Council fell in with their views entirely, was carried.

Dudley.—Mr. H. Percy Boulnois, C.E., held an enquiry on the 21st inst. into the application of the Corporation for the sanction of the Local Government Board to the borrowing of £8,500 for purposes of electric lighting, etc. Mr. Morris (deputy town clerk) said the Corporation had obtained an electric lighting order in 1897, and in March, 1898, unanimously decided to carry out its provisions. In 1897 the British Electric Traction Company, who were the owners of the tramway from Dudley to Stourbridge, sought to obtain powers to construct a light railway within the borough, and also to interfere with the Corporation's rights under the Tramways Act in respect of the question of purchase. This was opposed by the Corporation, but afterwards an agreement was entered into between the Corporation and the company, by which the Corporation secured the right of supplying the electrical energy required for the tramway and the light railway within the limits of the borough. The first outlay was mainly for the electrical equipment for the supply of energy for the two miles of the tramway to Stourbridge within the borough; but the Corporation had under consideration the construction and equipment for a complete scheme of electric lighting for the borough, to which the Board of Trade had given their approval. The sum of £7,500 was required for the provision and equipment of the electrical generating station, and the remaining £1,000 was for the purchase of the site, which was freehold property. The Corporation also retained powers of purchasing the whole length of tramway in the borough at the expiration of the present lease in 1902. The price for the supply of the electrical energy would be determined by an arbitrator appointed by the Board of Trade unless it was mutually agreed upon by the Corporation and the company. Mr. R. Wilson gave details respecting the electrical equipment of the power station, stating that it would include two engines of the Weston type of 100 h.p. and 200 h.p. respectively, and generators capable of producing 500 volts.

London County Council.—Telephonic communication is to be established between the undermentioned fire stations: Manchester-square and Great Marlborough-street stations, £9. 10s.; Clerkenwell and Shoreditch stations, £10. 10s.; New Cross and Old Kent-road stations, £14s. 15s.; Whitechapel and Bishopsgate stations, £4. 10s. The Council on Feb. 28 last approved the plans submitted by the engineer of the Baker-street and Waterloo Railway Company, showing the mode of construction and the position and level of the two tunnels which the company proposes to drive under the Victoria Embankment to the south of Charing Cross railway bridge. The company's engineer has since intimated that the plans as approved will have to be altered, as the Metropolitan District Railway Company has, in the exercise of its rights under the above-named Act, called upon the Baker-street and Waterloo Railway Company to provide a station on its line at this point, and this will necessitate an enlargement of the tunnels and other additional works. The company's engineer has now submitted three amended plans of the proposed works, and the Council has been recommended to approve the course taken by the Highways Committee in this matter. The following notices to lay cables under Electric Lighting Acts and Orders were received: London Electric Supply Corporation; Kensington and Knightsbridge Electric Lighting Company; Metropolitan Electric Supply Company; Notting Hill Electric Lighting Company; the County of London and Brush Provincial Electric Lighting Company, under the Wandsworth Order, 1892 (3); Westminster Electric Supply Corporation; the Vestry of St. Pancras; the Vestry of Hampstead, under the Hampstead Order, 1892; and the South London Electric Supply Corporation, under the Lambeth Order, 1892. In the two latter cases the Council has no power to approve or disapprove the works. The former were granted under certain conditions. The Council have agreed to lend the Hammersmith Vestry £4,820 for electric lighting purposes, and the Battersea Vestry £8,540 for purchase of land for electric lighting purposes.

Llandudno.—The following resolutions were passed recently by a sub-committee of the Urban District Council, subject to confirmation by the Council: "That the committee do elect to supply the energy required for working the Llandudno and Colwyn Bay light railway in accordance with the terms of the agreement and at the following rates, such rates to be subject to revision at the end of the first three years and every third year afterwards, if either party so desire—namely, 2½d. per unit for every unit up to 250 000 units, 1½d. per unit for every unit over 250,000 up to 500,000 units, and 1d. per unit for every unit above 500,000 units. That the supply be delivered at constant pressure at a switchboard at the generating station, the division of responsibility to be at the switchboard. The directors were also asked to state in their reply (1) what allowance they propose to make to the Council in case the company are not ready to take current which has been provided by the Council in pursuance of notice from the company; (2) what sum as a *quid pro quo* the company are prepared to pay to the Council in the event of the Council waiving their right to supply the required energy." At a subsequent meeting a letter was read from the company stating that if the Council themselves elect to undertake the supply of electrical energy required for working the light railway, the company are willing to leave the question of price to be settled by arbitration. The directors of the company desired to point out that the rates suggested by this committee are quite impracticable and not at all likely to be supported by any arbitrator whom the Board of Trade may nominate. They are, however, prepared to take the current at the section boxes at the following rates: 1¾d. per unit for every unit up to 100,000 units; 1½d. per unit for every unit up to 250,000 units; and 1d. per unit for every unit over 250,000 units. If, on the other hand, the Council elect to waive their right to supply the current, the company would be prepared to pay the Council as from the date of commencement of traffic a way-leave at the rate of £100 per annum. Consideration of the matter was adjourned, and Mr. Morton was asked to work out and present to the sub-committee a complete estimate of probable receipts and expenditure in relation to the matter so as to enable the committee to arrive at a definite conclusion. The clerk was also requested to write and enquire whether the sub-committee are to understand that the directors demur to the division of responsibility being at the switchboard, and also whether the scale they propose is intended to be a sliding scale, practically meaning an all-round charge of 1d. per unit, taking into consideration their engineer's own estimate that the quantity of units required in one year will exceed 300,000 units. These minutes were passed at the last meeting of the Council.

Ilford.—At a meeting of the Ilford School Board on Monday night Mr. W. G. Faulkner moved: "That the clerk be instructed to write to the Ilford Urban District Council asking whether, if the Board decided to wire the Christchurch-road Schools now being built, and the Park Higher-Grade Schools, about to be built, the Council would supply the necessary electrical energy, and, if so, whether the Council would at the earliest possible moment state the price per Board of Trade unit proposed to be charged, and if any, and if so, what terms would be charged to large consumers, in order that the Board may consider the advisability of lighting all the schools by electricity." In doing so, he said that if the Board passed the motion they would not be committing themselves to anything. The Urban District Council had obtained their provisional order some time ago, and had, moreover, carried through Parliament in 1898 an Act which gave them power to light the district. Mr. Hawtayne, their electrical expert, had presented several reports, but in none of them, so far as he (Mr. Faulkner) was aware, was there any mention of the price proposed to be charged. For a long time past the Board had not been satisfied with the incandescent gas lighting of the schools, there being no proper method of supervision; and, further, it had been found impossible to get any firm to take upon itself the duty of maintenance for a certain sum. The mantles were continually breaking and the chimneys got very dirty, so that often the light given was less than that which could be got from a naked gas light. Before, however, the Board went into the question of wiring, they desired to know the price which they would have to pay for electricity. He understood that day from an electrical expert that the schools could be wired for about 15s. per light. If that were so, or if the amount reached 20s. per light, it would still be less than the sum expended on gas fittings and incandescent gas lamps with mantles, chimneys, and globes in the Cleveland-road Schools. If the electric light could be supplied at a reasonable price, say at 4½d. or 4d. per unit, then it would compare very favourably indeed with the present price of gas, which was 3s. 8d. per 1,000 cubic feet, especially when purer atmosphere and cleanliness were taken into consideration. If the terms were such as would induce the Board to take the light they would very soon become large consumers, as it was almost certain that within 10 years the Board would have some 9 or 10 large schools with over a thousand lights. Mr. H. Gilbey seconded the motion, observing that if the light cost a little more than gas they should have it on the score of health alone. Mr. Church deprecated undue haste. The schools now being built must be fitted with gas fittings, and it would be a piece of extravagance to wire the buildings as well. He was inclined to favour a proposal which had been made in the Works Committee, that the architect should enquire and report upon the cost of the Board generating its own electricity in the basements. Other members having spoken, Mr. Faulkner,

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referring to Mr. Church's proposal in regard to the Board generating its own electricity, said that in the only case he knew in the City where that had been done in a building of similar size to one of their schools, it had proved so costly and so unsatisfactory that the management had been obliged to discontinue it, and to resort to the supply from the City of London Electric Lighting Company, dear as it was. The motion was then carried unanimously.

P. R. Jackson and Co.—We have received from this Manchester firm of steel and iron founders, millwrights, and electrical engineers, their general catalogue and price-list for 1899. We have seldom seen a price-list issued by a manufacturing firm over which greater care has been taken in order to give intending purchasers useful information to enable them to decide what they actually require. The first part of the catalogue is devoted to the steel and iron specialities made by the firm and to their millwright work. In connection with this, a large number of gear wheels for every class of work is listed. To judge from this list, worm and wheel gear is the great speciality of the firm, and this should enable them to manufacture and supply electrically-driven plant more quickly than most manufacturers. The first 90 pages, out of a total of about 400, are devoted to this section, and the rest of the book is taken up with the electrical plant manufactured by the firm. This work is described in various sections, which may be enumerated as follows: over-type dynamos and motors with drum armatures, and dimensions, prices, and weights; over-type dynamos for electrolytic work; under-type dynamos and motors with drum armatures; dynamos and motors for central-station working, of the Jackson-Sayers patent type; enclosed dynamos and motors with slotted armatures for power work; multipolar dynamos and armatures also of the Jackson-Sayers type. We next come to sections devoted to the application of electricity to driving machinery, such as electric cranes, electromotors complete with a single reduction gear, electric fans and blowers, electrical coal-cutters and electrical drills. Special sections are also devoted to electrical haulage and winding machinery, and to electrical pumping machinery. There follows on this eight sections devoted to electrical accessories, such as switchboards, arc lamps, engines, boilers and turbines, accumulators, wires, etc. In this connection there are a number of pages of useful electrical information of a kind which is not to be found even in some standard text-books As an example of this, we would refer to a diagram given on p. 235 to show the comparative cost of isolated electrical plants when driven respectively by turbines, gas engines, simple steam-engines, oil-engines, and compound engines. These results are given in the form of curves, and when turbines are used four curves are given for heads of water varying from 12ft. up to 200ft. Of course such curves are only approximate, but for a general comparison they are very interesting. Again, in the section devoted to electrical pumping machinery, which is very clearly illustrated by a number of pumps already supplied by the firm, full details are given as to how the power required for pumping should be collected. In the section called "O" some useful notes are given as to the supervision for dynamos and motors, and also instructions for erecting and working the same. In this way some useful hints as to the location of common faults are given which will be appreciated by steam engineers taking charge of dynamos for the first time. In connection with the distribution of power for factories, we notice that the firm have standardised a number of useful appliances, such as liquid starting switch for motors, and also some automatic regulators, which will be found very useful when dynamos are being driven from large engines which vary considerably in speed. The firm also supply a combination of motor-starting and regulating switch of an enclosed type, in which the resistances are carried in the base of the apparatus. It is exceedingly difficult to do more than briefly skim such a well-prepared work as is now before us, but the book should find a place on the shelf of every electrical engineer. The illustrations do credit to the firm, and are a great assistance, showing exactly what they are doing.

PROVISIONAL PATENTS, 1899.

APRIL 17.

8012. Economic carbon for electric arc lamps, electric furnaces, or the like. Maurice Patrick McInnerny, 29, Falkner-street, Liverpool.

8015. Improvements in electric incandescent lamps. Francis Harrison, Fernley Villa, Kempton New Town, Bedford.

8022. An improved form of plate for electric accumulators. Carl Tunstill John Oppermann, 2, Wynyatt-street, Clerkenwell, London.

8039. An improved polarised telegraphic relay. Alfred Lyster Shepard, 8, West Kensington-gardens, London.

8040. Improvements in dynamo-electric machines. Arthur Francis Berry, 46, Lincoln's-inn-fields, London.

8052. Improvements in means for controlling electric circuits which will allow a circuit to be broken and completed from another circuit. Henry Edmunds, 47, Lincoln's-inn-fields, London.

8044. Improvements in metallic conduits for electric wires. Edwin Truman Greenfield, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Dec. 12, 1898, being date of application in United States.) (Complete specification.)

8045. Improvements in and relating to the manufacture o armoured electric cables. Edwin Truman Greenfield, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Dec. 15, 1898, being date of application in United States.) (Complete specification.)

8053. A new or improved device for automatically effecting the breaking of an electric circuit after a predetermined time. Henry Edmunds, 47, Lincoln's-inn-fields, London.

8054. Improvements in or connected with what are known as dry-air insulation electric cables or conductors. Henry Edmunds, 47, Lincoln's-inn-fields, London.

8056. An electric current-controlling handle for use in motor cycles, carriages, and automotor cars. Eugene Hermet, 18, Buckingham-street, Strand, London.

8060. Improvements in electrical furnaces. Denis Lance, Raphael Louis Emmanuel de Bourgade, and Leon Schmi'z, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

APRIL 18.

8065. Improvements in electrolytic apparatus and processes. August Dittmar, 11, Palace-street, Buckingham-gate, London.

8074. Improvements in the making of joints in connecting electricity distribution boxes and cables. Thomas Alfred Mackereth, jun., Thornbarrow-road, Bowness, Windermere.

8075. Improvement to an electrical double-pole fused lamp-post (or bracket) watertight switch to prevent fusing of main fuses. Frank Carter, 2, St. James's-street, Brighton.

8078. Improvements in electric arc lamps. Herbert Hampton Hall, 12, Gardner-road, Tue Brook, Liverpool.

8097. Improvements in apparatus for regulating the arc in electric arc lamps. Percy Newton Chatterley, 7, St. Martin's-row, Broad-street, Birmingham.

8104. Improvements in or relating to electric furnaces for the manufacture or production of carbide of calcium and other metallic oxides. John Kemp Starley and Joseph Bastick, 50, Wellington-street, Leeds.

8140. Improvements in electricity meters or measuring apparatus. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske, Aktien-Gesellschaft, Germany.) (Complete specification.)

8156. An improvement in electromagnets. Adrien Louis Augustin Charles d'Arlincourt, 53, Chancery-lane, London.

8168. Improvements in mounting incandescing electric lamp bulbs. Herbert Moul and Andrew Lind, Clun House, Surrey-street, Strand, London.

8171. Improvements in telephones. Ernest Wilson, Charles John Evans, and Herbert Godsal, 64, St. John's-park, Blackheath, London.

8172. Improvements in electric railway systems. Henry Barringer Cox, 46, Lincoln's-inn-fields, London.

8174. Improvements relating to electromotors. Gregor Blanck Augustus Pelham Brooke Loftus, and Kenneth Robison Stuart, 323, High Holborn, London.

APRIL 19.

8183. Improvements in thermo-e ectric generato-s. Rankin Kennedy, 89, Gathorne-terrace, Leeds.

8188. Improvements in rheostats or electric resistance switches. James Marr, William Cranswick Laidler, and the Sunderland Forge and Engineering Company, Limited, 3, St. Nicholas-buildings, Newcastle-on-Tyne.

8191. Improvements in wireless telegraphy. Alfred Charles Brown, 129, Algernon-road, Lewisham, London.

8192. The joining together of the various parts of lightning conductors by electro-deposition. Alfred John Hands, The Laurels, The Drive, Walthamstow, London.

8223. Improvements in apparatus for testing and firing electric primers and testing batteries and cells. Gordon Colquhoun Fraser and George Keith Buller Elphinstone, of the firm of Elliott Bros., 101, St. Martin's-lane, London.

8240. Improvements in safety devices for use in connection with electrical distributing systems. Gerald William Partridge and the London Electric Supply Corporation, Limited, 46, Lincoln's-inn-fields, London.

8243. Improvements in or relating to electrical arc lamps. Ferdinand J. Barberowski, 18, Buckingham-street, Strand, London.

APRIL 20.

8287. Improvements in electric wire conduits. David Harry Shuttleworth-Brown, Belle Vue Villa, South Wimbledon, London.

8296. Improvements in apparatus connected with telegraphic signalling. John Ambrose Fleming, the Electrical Laboratory, University College, Gower-street, London.

8312. Improvements in resistance coils. Cowan's, Limited, Edward Woodrowe Cowan, and Alfred Still, 47, Lincoln's-inn-fields, London.

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8302. Improvements in and relating to kettles and like vessels for heating liquids by the aid of electricity. Charles Waley Cohen, 11, Southampton-buildings, Chancery-lane, London.

8325. Improvements in electric railways. Robert Lundell, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

8340. Improvements in electric welding or metal-working apparatus. Arthur Francis Berry and Reginald John Wallis-Jones, 46, Lincoln's-inn-fields, London.

APRIL 21.

8358. Improvements in electric storage or secondary batteries. Job Thomas Niblett and Malcolm Sutherland, 61, Chandos-street, Strand, London.

8360. Improved electrical device for controlling the pressure of small currents. Frederick William Smith, 126, Sussex-road, Southport.

8365. An improvement in connection with electric fuse cut-outs. Joseph Gershom Childs, 33, Myddleton-square, London.

8399. Improvements in electricity meters. Charles Denton Abel, Birkbeck Bank-chambers, Southampton buildings, Chancery-lane, London. (Société Anonyme Continentale pour la Fabrication des Compteurs a Gaz et Autres Appareils, France.)

APRIL 22.

8468. Improvements in arc lamps. Ernest William Bohle, Hermann Bohle, and John Alfred Phillips, 77, Colmore-row, Birmingham.

8482. Improvements in alternating-current motors. Max Déri, Birkbeck Bank chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

8483. Improvements in electrical signalling apparatus. Erwin Lavens and Edward Joseph Lavens, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

8497. Improvements in bulbs for electric incandescence lamps. Curt Bartenstein, 45, Southampton-buildings, Chancery-lane, London.

8498. Improvements in electric elevators. Edward Hibberd Johnson, 45, Southampton-building, Chancery-lane, London. (Gustaf Rennerfelt, United States) (Complete specification.)

8505. Improvements in or connected with the application of electromotors to propulsion. William Thomas Carter, John Alexander Dawson, and Thomas Gray, Norfolk House, Norfolk-street, London.

SPECIFICATIONS PUBLISHED.

1894.

8607.* Electrical exchanges. (Amended.) Thompson. (Keith.)

1898.

7179. Telephone posts or stations. Germain (Date applied for under International Convention, Sept. 1, 1897.)

7407. Means applicable for use in operating electrically-illuminated signs, advertising media, or the like. Bell.

8273. Electric bells. Oppenheimer.

8275. Annunciators for telephone systems. Oppenheimer. (Aktien-Gesellschaft Mix und Genest.)

8276. Primary batteries. Oppenheimer.

8277. Keys or switches for multiple switchboards. Oppenheimer. (Aktien-Gesellschaft Mix und Genest.)

8371. Electromagnets. Bouchet.

9677. Swing joints or ceiling connections for carrying suspended electric light fittings. Verity's, Limited, and Ebbutt.

10236. Electric arc lamps. Sandy, Bate, and Geer.

10450. Construction of dynamo-electric machines and motors. Mackie.

10965. Electrical switches. Gifkins and Hill.

12190. Chemical composition intended for the manufacture of mantles or blocks for use in electric arc lamps. Mersch.

12562. Electric motors and the transmission of power therefrom. Fawcett, Preston, and Co., Limited, and Matthey.

21524. Electromagnetic variable speed and clutch gearing. Wollaston and Kennedy.

23183. Electrical switches. Sturge.

26649. Apparatus for simultaneously actuating from one point the controlling switches of the several electrical motorcars of a train. Siemens Bros. and Co., Limited. (Siemens und Halske, Aktien-Gesellschaft.)

1899.

2174. Commutator brushes for electrical machines. Siemens Bros. and Co., Limited, and Siemens.

2358. Arrangement for exciting the magnets of dynamo-electric machines. Déri.

3587. Non-magnetic course indicator. Van Overklift.

3734. Process for electric smelting or reducing. Borchers.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1899.	Corresponding week 1898.	Increase or decrease.	Total receipts for half-year. 1899.	1898.
		£	£	£	£	£
Birmingham Tramway	April 22	4 119	3 606	+ 513	61,292	57,494
Blackpool and Fleetwood Tramroad	,, 22	301	—	—	3,647	—
Bradford City Trams	Feb. 5	145	—	—	6,733‡	—
Bristol Tramways and Carriage Co.	April 21	2 618	2,609	+ 9	—	—
City and South London Railway	,, 23	1,025	998	+ 27	18 326	17,769
Dover Tramways	,, 22	160	126	+ 34	2,421	1,821
Dublin U.T., elec. cars	,, 21	1,029	864†	+ 165	14,536	11,742†
Dublin S.D. Electric Tramways	,, 21	868	560	+ 308	10,592	6,813
Halifax Corporation Tramways	Mar. 29	312	—	—	10,712*	—
Liverpool Overhead Railway	April 23	1,352	1,452	- 100	22,746	23,483
South Staffordshire Tramways	,, 21	606	566	+ 40	9,810	9,504

* Since June 30, 1898. † Including horse cars. ‡ Since July, 1898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	24½-25½
Bournemouth and Poole Electric Supply, Limited, Ord.	10	12½-13½
—— 4½ per cent. Cum. Pref.	10	10½-11½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	18½-19½
—— 6 p. c. Cm. Pf., 30,001-40,000 (all paid)	10	13½-14½
—— 5 per cent. Perpetual Debenture Stock	100	126-129
Brush Electrical Engineering, Limited, Ordinary	2	1½-2½
—— Non. Cum., 6 per cent. Pref.	2	2½-2¾
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	102-105
Callender's Cable Company, Debentures	100	114-117
—— Ordinary	5	12½-13
Central London Railway, Ordinary	10	9½-10½
——	8	7½ 8¼
—— Pref. Half-Shares	3	3½-4
—— " "	5	4½-4¾
Charing Cross and Strand	5	10½-11½
—— 4½ per cent. Cum. Pref.	5	5¾ 6½
Chelsea Electricity Company	5	7½-8½
—— 4½ per cent. Debentures	100	114-116
City of London, Ordinary	10	17½-18½
—— " 90,001-100,000	10	17½-18½
—— 6 per cent. Cumulative Pref.	10	15-16
—— 5 per cent. Debenture Stock	100	124-129
City and South London Railway, Consolidated Ordinary	100	68-70
—— Ordinary	3	4¾-5½
—— 4 per cent. Debenture Stock	100	133-135
—— 5 per cent. Pref. Shares	10	14½ 15½
—— " " '96	10	13½-14½
County of London and Brush Prov. Elec. Light Co., Ord.	10	11-12
—— " " No. 30,001-40,000	10	11-12
—— 6 per cent. Cum. Pref.	10	14-15
Crompton and Co.	3	3½ 3¾
—— 5 per cent. Debentures	—	96-101
Crystal Palace District, Ordinary 5 per cent. Stock	100	130 135
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2-2½
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	96-98
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5½-5¾
Electric Construction, Limited	2	2-2½
—— 7 per cent. Cumulative Pref.	2	2-2½
—— 4 per cent. Perp. 1st Mort. Deb.	100	103-106
W. T. Henley's Telegraph Works, Ordinary	10	23½-24½
—— 7 per cent. Preference	10	18-19
—— 4½ per cent. Debentures	100	113-115
House-to-House Company, Ordinary	5	8½-9½
—— 7 per cent. Preference	5	9-10
Imperial Tramways, Limited	6	24½-25½
India Rubber, Gutta Percha, and Telegraph Works	10	21½-22½
—— 4 per cent. Debentures	100	101-105
Kensington and Knightsbridge Ordinary	5	12-13
London Electric Supply, Ordinary	3	3½ 3¾
—— 6 per cent. Pref.	5	6¾-7
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	106-108
Metropolitan Electric Supply, Limited, Ord., No. 1-62,500	10	16½-17½
—— " " No. 62,501-85,000	4	12½-13½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-121
National Telephone, Ordinary	5	4½-5
—— 6 per cent. Cum. First Pref.	10	11-13
—— 6 per cent. Cum. Second Pref.	10	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	4½-5½
—— 3½ per cent. Deb. Stock, Red.	100	99-102
Notting Hill Electric Lighting Company, Limited	10	16½-17½
Oriental, Limited, 1879	1	1½-1¾
—— £5 Shares	5	7¼-7¾
—— £4½ Shares, New	4½	6¼-6¾
Oriental Telephone and Electric Company	1	¾-1
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6½-7
Royal Electrical Company of Montreal	1½	166-186
—— 4½ per cent. First Shares Mortgage Debentures	100	106-107
South London Electric Supply, Ordinary	3	3½-3¾
St. James's and Pall Mall, Limited, Ordinary	5	17-18
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	34-38
—— 5 per cent. Bonds	100	106-108
Waterloo and City Railway, Ordinary	100	109-112
Westminster Electric Supply, Ordinary	5	15-16

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NOTES.

Society of Arts.—We understand from the *Journal* of the Society of Arts that the St. Bride's Foundation Institute has entered into union with the above society.

Automobiles in America.—A number of companies with large capitals, varying from £100,000 to £5,000,000, have been recently formed in the United States to manufacture and sell self-propelled vehicles. A certain number of these will supply electric vehicles, but others are working with compressed-air systems. The total nominal capital of these companies exceeds £50,000,000, but this is not called up to any great extent. We trust that the American companies will be run more largely as manufacturing concerns than on company-promotion lines.

Electric Lighting and Whisky.—We understand from the *Scotsman* that good business was done last year at the Hill-of-Beath "Gothenburg." This interesting public-house in the Dunfermline district of Fife, which is conducted on the Gothenburg system, showed a net profit, after paying all expenses, of £563. Out of that sum and the balance from the previous year the electric light has been introduced into the parish, a bowling-green is being formed, the reading-room has been maintained, and several other sums spent for the public benefit.

Ozone.—Sir J. Levy asked the First Commissioner of Works in the House of Commons on Tuesday last whether it was possible to disinfect the house each night by means of ozone. The suggestion was backed by others asking for a fumigating chamber for members and for open windows. In reply, Mr. Akers Douglas said the methods and practical merits of the process for the manufacture and introduction of ozone did not appear to him to be as yet sufficiently established. The cost of a complete installation at the Houses of Parliament would be some thousands of pounds.

German Atlantic Cable.—President M'Kinley has now given permission for the landing of a cable to be laid direct from Germany to the United States. The occasion of the permission being given has been celebrated by telegrams between the German Emperor and the President, in which great hopes are expressed as to the effect of the new cable in binding the two nations together. In consequence of this move, the German Atlantic Telegraph Company at Cologne will at once proceed with the erection of a factory at Nordenhamm, where the cable is to be manufactured.

Advertisers' Exhibition.—Claiming attention at the exhibition, and illustrating to a still further degree the application of electricity to advertising purposes, is an arrange ment sent by the advertisement firm of Messrs. Walter Hill and Co., by which a lay but exceedingly lifelike figure is made by the aid of a tiny electric motor of $\frac{1}{3}$ h.p. to alternately select and display a series of advertisement bills. Other exhibits included a large lithographic printing press from the Avenue Press, an ingenious machine for producing delicate woodcut illustrations from Messrs. Swain and Co., and a linotype machine, all of which are worked electrically. A Dutch printing firm shows a bold poster for advertising electric lighting works.

Electric Galvanising.—We understand from the *Scientific American* that the company formed some two years ago in New York to exploit the electrical system of depositing zinc on to iron goods has now got its works in order. The present plant is said to have a capacity of about two tons per day, and we take it by this is meant that two tons of zinc can be deposited. Our contemporary gives particulars of the various articles which have been galvanised by the company, which claims a reduction in cost over the hot processes. One great advantage of this electric galvanising is that movable parts are not soldered together by it, as is the case when articles consisting of several parts are dipped into the melted zinc.

Volta Commemoration.—In reply to a communication from the Italian Minister of Posts and Telegraphs, the Duke of Norfolk has authorised his department to contribute a sum of £40 towards the expenses of the conference which is to meet from May 31 to June 3 in Como. His Grace has also notified that he is prepared to grant special leave for a fortnight to a limited number of telegraphists in the United Kingdom to attend the conference. The leave will only be granted to one telegraphist from each office, and the total number is not to exceed six. There should be lively competition for the privilege amongst provincial towns. We understand that Mr. C. H. Garland has been selected to represent the London telegraph clerks, and that his expenses will be defrayed by his *confrères*.

Wireless Telegraphy.—We are informed by the daily Press that the apparatus for signalling from Dieppe to Newhaven by the Marconi method is to be erected at once, and that in addition to the signalling stations on either side of the Channel, apparatus will be provided on steamers as well. The distance between Dieppe and Newhaven is 75 miles. The paper abstract we have before us goes on to state that if the system should enable steamers to steer a bee-line in a fog, by finding their bearings, as Signor Marconi's representative stated that it will, the value of the system will be incalculable for all passenger steamers, and particularly to those crossing the Channel. From what we know of the Marconi system, there is nothing to prevent the bee-line ending anywhere but at the part from which the signals are sent.

Telephones in the United States.—The *Electrical World* raises the question as to how far the present rapid development of the telephone industry in the United States may tend to the business being overdone. Statistics are given to show that the ratio of telephones to the whole population of the United States is much smaller than it might be, even on the basis of existing possibilities. There are probably to-day in connection with exchanges in that country from 750,000 to 800,000 subscribers, of whom about 475,000 are on the Bell system. This gives a proportion of, say, 1 to every 100 people, which is about the ratio for New York City. But in the Boston Bell system the ratio runs about 1 in 60, while in Sweden and Norway it runs as high as 1 in 25. At the Boston figure, there should now be 1,250,000 subscribers in America, and at the Swedish figure not less than 3,000,000.

Concert.—A grand Bohemian concert, given by the combined staffs of the City of London, the Metropolitan, and the London Electric Lighting Companies, took place last Friday at the Freemasons' Tavern, Great Queen-street, W.C. Mr. J. Cecil Bull, of the London Electric Company, presided over the gathering. The committee and stewards included Mr. R. A. Chattock (hon. treasurer), Messrs. D. Wilson and H. Saunders (secretaries), and Messrs. F. Aspinall, F. Dew, C. Davies, H. Bacon, J. Dyson, H. Masson, E. Seckington, H. S. Moore, E. Albert, and F. J. Wray. Much really good music was rendered, amongst the artistes being Mr. Dalgety Henderson, Miss J. Hotine, and the Field-Fisher Quartette. A duet by Messrs. A. and E. Field-Fisher brought in very humorously the name of the chairman and other gentlemen connected with the three companies. In the interval between the two parts Mr. Bull congratulated the committee upon having brought their concert to such a successful issue.

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A Visit to Switzerland.—Mr. J. W. Swan, presiding at the meeting of the Institution of Electrical Engineers on the 27th ult., announced that the Council had under consideration the question of a visit by members of the Institution to Switzerland. There were, he remarked, a great many interesting things in connection with electrical engineering to be seen there, and it was felt—he thought unanimously felt—that it would be both an agreeable and a useful visit to make. With a view of ascertaining the feeling of the members on the point, a letter had been drafted and would be duly sent by post to the members of all grades, explaining what the project was and giving a general outline of it. The idea was that this Swiss meeting, if carried out, should begin on Sept. 1 and terminate on or about Sept. 10. But there were certain possibilities of making the time elastic, and within the discretion of the individual members.

Vertical Electric Tramways.—The progress of electric traction in the horizontal direction has been referred to again and again in our columns, but in England the absence of exceedingly high buildings, and the great development of hydraulic power, has prevented the great increase in electric lifts which is characteristic of American towns. Some interesting figures in this respect were recently given by Mr. R. P. Bolton, the electrical engineer of New York. In our contemporary the *Electrical World*, Mr. Bolton estimates that in New York the vertical travel by electric elevators in the southern end of the Island below Canal-street was at least 150 miles in every day of 10 hours. The elevator travel might easily run up to 1,000,000 people a day for the city. There were 60 down-town skyscrapers alone, and each of these had a travel of from 5,000 to 15,000 passengers daily—*i.e.*, 2,500 to 7,500 up and down. This feature of travel is often overlooked in estimating the movement of population.

Institution of Electrical Engineers.—At the meeting of the Institution on Thursday, the 27th ult., the President (Mr. J. W. Swan) announced that the Council had made the following nominations to fill the various posts which in the usual course had become vacant: As president—Prof. Silvanus P. Thompson D.Sc., F.R.S.; as ordinary members of the Council—Major P. Cardew, R.E., Mr. John Gavey, Mr. Robert Hammond, Mr. A. J. Lawson, and Mr. R. Percy Sellon; as associate members of the Council—Mr. Roger W. Wallace, Q.C., and Mr. Arthur Wright; as hon. auditors—Mr. F. C. Danvers and Mr. E. Garcke; as hon. treasurer—Prof. W. E. Ayrton, F.R.S.; and as hon. solicitors—Messrs. Wilson, Bristows, and Carpmael. Considerable applause greeted these announcements, and this prompted the President to remark that he was glad to notice that the names he had read out had met with such evident approval. The new names thus selected mean new blood on the Council, but it seems to us that both the associate members nominated should belong to the higher class.

Electric Pumps for Canals.—We notice in the *Revue Industrielle* a full description of the electrical installation for providing water for the Bourgogne Canal. It seems that in certain seasons of the year the natural water supply to the high-level reaches of this canal are deficient. In consequence, a number of electrical pumping plants have been provided at the different locks to raise water from the low to the high levels during those seasons. To admit of this, a waterfall near the canal has been used, and power is transmitted from this to the pumping stations by means of three-phase currents at 2,000 volts. Centrifugal pumps driven by motors on the same axles are used to raise the water. Our contemporary illustrates in detail the electrical and civil engineering works at the generating station and at one pumping station. It also gives figures as to the cost of the working. That of pumping the water at the locks comes out at one-tenth of what it would cost to provide extra water in the main reservoirs. The actual expenditure of raising a cubic metre of water is said to work out at about ·033d.

Induction Motors.—On Friday, April 28, Prof. C. A. Carus-Wilson delivered a lecture at the Royal Institution on "Some Features of the Electric Induction Motor." At the outset he showed that when a conductor carrying a current was placed in the magnetic field there was a force excited on the conductor which tended to move it across the lines of that force. To illustrate this by experiment, he excited a magnet into whose neighbourhood a suspended filament had been introduced, and on using an alternating current the vibration of this filament was at once reproduced on the screen, the alternating force caused by the current having tended to displace it first in one direction and then in another. By using the remarkable instrument shown by Mr. Duddell at the last meeting of the Institution of Electrical Engineers, he was able to illustrate the same phenomenon more easily. Commencing with these elementary principles, Prof. Carus-Wilson proceeded to develop step by step their application to the construction of the modern induction motor. In so doing he showed other experiments, all of which were greatly appreciated by the audience.

Dynamo Insurance.—It has been customary for years for owners of boilers to insure these with one of the many policy insurance companies in order that they may be safeguarded against accidents, both as regards compensation and actual damage. Perhaps the greatest advantage from such insurances lies in the fact that the boilers are regularly inspected by experts, and as a result accidents are prevented. We notice that the National Boiler Insurance Company of Manchester are now issuing the same class of policy for dynamos and electric motors as they have previously done for boilers only. The company insures such electrical machinery against breakdown, and couples with this insurance a regular supervision, which, although undertaken on behalf of the company, is exceedingly valuable to the owner of the machinery. This kind of policy should be useful in those places where isolated plants are run with comparatively unskilled attendants. In this way any defects developing in the dynamos or other electrical machinery will be discovered in many cases before they have developed to such an extent as to cause interruption of working.

Electrical Street Sweeping.—We notice in the columns of the *Sheffield Daily Telegraph* that Mr. Jackson, the new cleansing superintendent of the Sheffield Corporation, is working on an electrical street-sweeping apparatus. The idea consists in having a sweeper which will run on the electric tramlines and receive its power from the trolley wire. The front brush, which will be fixed in an oblique position, will project from the horse track to the channel on one side of the road. It will leave the refuse swept up in a ridge near the middle of the road. A second brush in the rear, which will be just wide enough to cover the tramway track, will then drive its own refuse and that left by the front brush into a receiver. From this the refuse will be carried into a large bin by means of an elevator. The front brush will be made to swing, in order that it can be adjusted to the varying width of the road, and also drawn to one side to enable carts to be passed. The idea of Mr. Jackson seems a good one, but its practicability will be largely determined by the width of the street to be negotiated, and the period of the day chosen for sweeping.

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As far as cost is concerned, it should very much reduce the expenses of the scavenging department.

Electric Lighting of the City.—At the sitting last week of the Court of Common Council of the City of London the Streets Committee presented a further report with regard to the electric contracts. The committee state in their report that they have obtained a joint opinion from Mr. C. S. Eady, Q.C., Mr. C. M. Warmington, Q.C., and Mr. Danckwerts on the various contracts with dates, and also the dates at which Alderman Sir Joseph Savory and Mr. MacGeagh, C.C., were financially interested in the Brush Company and in the City of London Electric Lighting Company. After examining these, the counsel state that they have no doubt that the two Brush contracts and the Laing-Wharton contract with the Commissioners, which were transferred to the City of London Company, are null and void. At the same meeting a letter was read from the City of London Company suggesting a meeting between the Streets Committee and the directors of that company. After considerable debate as to the advisability of the proposed conference, it was decided to leave the matter in abeyance for one month until the report on behalf of the Board of Trade had been presented.

Doubtful Inventions.—We have several time pointed out that the Patent Office system of the United States is based on the idea that the officials ascertain both the novelty and the practicability of an invention before granting letters patent. The attempt to carry this principle out has led to a number of disgraceful results, as good inventions have been condemned as impracticable and doubtful inventions have been held over for investigation so long that when finally granted their life has been extended some 10 or 12 years. We notice in the *Electrical World* that the Patent Office have just granted a patent for a lightning conductor which our contemporary describes as follows: "the rod terminates in a sphere surrounded by a plurality of points. It is stated that the electricity accumulates in great quantities on the spherical surface, and thus increases the absorbing power of the conductor." The illustration given shows a brazen serpent with the end of his tail projecting skywards. The ball at the end of this is surrounded by a number of points, and we should much like to see the report of the Patent Office examiner who could prove on theory that this conductor did what its inventor claims for it. To stamp such an invention as an improvement in electrical science is an absurdity.

Telegraph Rates to India.—In the Indian Budget debate, Lord Curzon described the tariff for telegrams for Europe as being "inimical to trade, a barrier to the ever-growing intercourse between India and the mother country, and obsolete and anomalous in itself." The *Times* in a long article on Saturday last says that strong facts will be required to justify such words from a viceroy. The article then proceeds to most amply prove the statement by showing that the rates, although profitable to the company, have practically prevented any increase in the messages sent to India during the past 15 years. As an example of what can be done with cheap rates, it is pointed out that messages can be sent to Australia *vid* India for 4s. 9d. a word, as against 4s. a word to India alone. Since the great reduction in the cost of cabling to Australia has been made, the traffic has gone up by leaps and bounds. Thus, during the past seven years the total net value of the Australian telegrams sent *vid* India has risen from £284,427 up to £512,017. The question is raised as to whether the Indian Government should guarantee the company against loss and insist on a radical reduction, or whether the construction of the Pacific cable and the new competition it will create for Australian traffic will induce the Eastern Company to reconsider its policy of unprogressive resistance and avert the necessity for more drastic remedies.

Lightship Signalling.—The Prince of Wales, as president of the Royal National Lifeboat Institution, presided on Monday last at a dinner in aid of the London Lifeboat Saturday Fund. After the dinner a number of speeches were made, and it fell to the Prince of Wales to propose the toast of the evening. In doing so, he referred to the great importance of having electrical communications between lighthouses, light-vessels, and lifeboat stations. In this respect the Royal Commission, which was appointed in 1893, had issued five reports, and a number of the recommendations of the Commission had been carried out. The Prince of Wales proceeded to explain the reason why in their last report they did not feel justified in recommending the establishment of more cables between light-vessels and the shore. This was because they wished first to test the ethereal system of telegraphy, which under the superintendence of Signor Marconi would seem to solve great difficulties which had been encountered in maintaining communications with light-vessels. With respect to the telegraphic and telephonic connections which have been established by the institution, their utility each year had been increasingly demonstrated, both for calling out lifeboats when required and for preventing unnecessary launches.

Electric Lighting of Warships.—At the dinner of "The Nameless Dining Club," of Philadelphia, referred to in another note, Mr. C. J. Dougherty, the chief electrician at Cramp's shipbuilding yard, made an interesting statement as to the use of electricity on board modern men-of-war, speaking primarily of the good results obtained in the war with Spain. He then went on to show how electricity is approved of in the Russian navy, and described the various plants to be installed by Cramp's on the battleship and the cruiser they are now building for the Czar. These plants will be the largest that have ever been installed on any warship in the country. On the battleship, motors will be installed for the following work: capstan, drainage turbines, hull ventilation, blowers for fire-rooms, winches for boats, shop motor, ash hoist motors, ammunition hoist motors, and the operation of the turrets and steering gear by electricity. There will be installed on this ship alone about 89 motors, and the generating units for supplying power for these motors, for 1,000 electric lights and for six searchlights will be: four 66-kw. generating sets, each set consisting of a triple-expansion engine directly connected to two 33-kw. dynamos, two generating sets of 132 kw., each set consisting of a triple-expansion engine directly connected to two dynamos of 66 kw. The total amount of current which can be supplied by the above dynamos is, roughly, 5,800 amperes. This is a large installation of electric power, and it will be noticed that the Russian navy has plenty of faith in electrically-operated machinery.

Magnetism in Bricks.—The *Canadian Architect and Builder* states that Prof. Lawrence, of the University of Rochester, New York, has made some important observations on an unsuspected property of bricks. Some two years ago he noticed certain unaccountable movements of a sensitive magnetometer which he had placed for steadiness on a brick pier in the basement of the university laboratory. Last year while visiting at Ann Arbor he was told that a similar phenomenon had been noticed there, and his informant half jokingly said that the bricks in the walls must have affected the needle. Prof. Lawrence, remembering that in his own experiment the instrument rested on a brick pier, thought more seriously of the matter, and, on his return to his own laboratory,

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began a series of experiments to determine whether bricks really could be magnetic. Collecting a large number of samples of bricks of different kinds, and testing them with a delicate magnetometer, he found that nearly all red bricks, and some white ones, were appreciably magnetic, a brick of the strongest sort, a brownish variety made near Rochester, giving a power equal to that of wire as large as a knitting needle, and 1in. long, completely saturated with magnetism. The only brick which was absolutely free from magnetic power was a white one, also made near Rochester, but a yellowish one, from some place not specified, was also nearly free from it, while another white one, from Washington, was very nearly as magnetic as the Rochester brown one. It will be interesting to know if the professor has had an analysis made of the bricks in question to see how far the presence of oxides of iron in the clay is responsible for the effects he noticed.

Royal Institution.—The annual meeting of the Royal Institution was held on Monday last, the Duke of Northumberland presiding. After the annual report had been read, the following were unanimously elected officers for the ensuing year: President, the Duke of Northumberland; treasurer, Sir James Crichton-Browne; secretary, Sir Frederick Bramwell; managers, Sir Frederick Abel, Sir William Crookes, the Duke of Devonshire, Lord Salisbury, Lord Halsbury, Dr. W. C. Hood, Prof. D. E. Hughes, Lord Kelvin, Mr. A. B. Kempe, Mr. H. Leonard, Sir Andrew Noble, Mr. A. Siemens, Mr. B. W. Smith, Mr. W. H. Spottiswoode, and Sir Henry Thompson; visitors, Mr. W. H. Bennet, Mr. A. Blyth, Mr. M. Horner, Mr. E. Kraftmeier, Lieut.-Colonel L. W. Longstaff, Mr. F. McClean, Mf. H. F. Makins, Mr. L. Mears, Dr. R. Messel, Mr. L. M. Rate, Mr. J. C. Ross, Mr. W. J. Russell, Mr. A. G. Salamon, Sir James Vaughan, and Mr. J. J. Vesey. The president afterwards announced that the institution proposed to celebrate the hundredth anniversary of its existence by the delivery of two commemoration lectures in June. It seems that the first meeting of the members in the building in Albemarle-street was held on June 5, 1799. The first commemoration lecture will be delivered on Tuesday, June 6, at 3 p.m., by Lord Rayleigh, when the Prince of Wales will preside and receive the honorary members. The second lecture will be delivered the next evening at 9 o'clock by Prof. Dewar, when the president of the institution, the Duke of Northumberland, will preside. After the lecture on Tuesday, June 3, a reception will be held at the Mansion House, at which the Lord Mayor of London will receive the members and foreign guests.

Murphy Third-Rail System.—We have just seen full details of the system invented by Captain J. McL. Murphy for running electric tramways with a sectional conductor laid between the track. The public trial of this system at Manhattan Beach was made on April 12, when some 400 guests were invited to inspect the system. After the paper given by Mr. Miles Walker at the Institution of Electrical Engineers, it is useless to recall the essentials for a system of surface contacts, but we are interested in seeing how far the Murphy system complies with these. In it a solenoid switch is used to throw the sections of rails into circuit. On this solenoid there are two windings. The first of these is a high-resistance winding, the end of which is connected normally to the rail, and the other to earth. The thick-wire circuit conveys the main current to the rail when the switch is closed. In starting up, a current at the normal line voltage, obtained by a small continuous-current transformer from a battery of accumulators on the car, is used to energise the high-resistance winding. Immediately this switch moves, this winding is broken, and the current taken by the motor maintains the contact. As soon, however, as the collector passes over the section, the current ceases, and the switch returns into its open position, at the same time closing the fine-wire circuit. From experiments actually made with salt and water, the leakage current through the thick-wire winding is not sufficient to keep the switch on when the car has left the section. The chief fault in the system in our opinion is that immediately the current is switched off, all contact with the supply main ceases unless the auxiliary continuous-current transformer is kept in circuit. This would seem to seriously handicap the system in a hilly district, where there are a number of grades which can be coasted down, using the motors as electric brakes or to return current to the lines.

Electric Eddy Currents.—On Tuesday afternoon Prof. Silvanus P. Thompson gave the first of the usual course of Tyndall lectures at the Royal Institution, when a number of experiments illustrating the heating effects of eddy currents and the methods of preventing them by appropriate lamination of the metal in which they occur were shown. He began, says the *Times*, by showing how electric eddy currents depended on induction, and defining them as alternating currents occurring in sheets and masses of metal and circulating in a closed path which was not necessarily prescribed by insulating material. Their study, he pointed out, originated in rather an obscure way from an observation made in 1824 by Arago, who found that an oscillating compass needle came to rest more quickly if the bottom of the box containing it was of copper than if it was of other materials. Arago pursued his experiments for a few months, in the course of which he discovered that a rotating copper disc tended to make a magnetic needle suspended above it move in the same direction, and then apparently discontinued his investigations Other men, however, such as Barlow, Christie, and Babbage and Herschel, took them up, and soon there was a whole literature on the subject. Babbage and Herschel reversed Arago's experiment and rotated a magnet below a copper disc, with the result that it also rotated, and by substituting other metals for the copper Herschel seized upon the crucial fact that those metals succeeded best in the experiment which were the best conductors of electricity. Still the phenomenon remained a complete mystery until Faraday gave the explanation in 1831, when he was engaged on his famous experiments regarding the possible production of electricity from magnetism. He showed that the movement of the magnet necessarily set up currents in the copper, and that these, having themselves magnetic effects, must react on the magnets, thus producing the phenomena observed.

Municipal Traction.—Detroit, which already owns and operates its electric lighting plant, is now arranging for the acquirement and control of the street railway lines of that city, presumably with a view of working them as municipal enterprises. No legal difficulty appears to stand in the way of their acquirement, since the right of the municipality to effect such purchase was ensured by the recent passing through the Michigan Legislature of what is known as the McLeod Bill. This experiment of municipal ownership of street railways in Detroit will be watched with considerable interest. Our New York contemporary *Electricity* is not very sanguine, however, as to the success of the venture, notwithstanding that Detroit is probably freer from political corruption and machination than most large cities in the United States. In support of this view, it reproduces a statement which was communicated by Mr. Robert Crawford, of Glasgow, a strong advocate of municipal ownership, to the representative of a Chicago journal. This statement is all the more interesting as coming from a stranger with unbiassed views. If what is attributed to

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Mr. Crawford be true, it would appear that with the conditions that exist in American cities to-day municipal ownership is utterly impracticable. He says: "It can never be a success until the system of political rewards is entirely divorced from city government—a condition of affairs which is not claimed to exist, so far as I can learn, in any American city at the present time. Unless the municipal government is conducted with an eye single to the welfare of the city, and unless the city officials are prompted by the same unselfish patriotism that impels a man to volunteer in time of war, municipal ownership is bound to be a disastrous failure." Our contemporary is of opinion that, should this attempt fail to prove satisfactory in Detroit, it is safe to assert that municipal ownership would never prove anything but a failure elsewhere in the United States, since nowhere are the conditions more favourable.

Electricity and Bridge Building.—We notice from the columns of the *Electrical World* that on April 12 the inner circle of the well-known Art Club of Philadelphia, called "The Nameless Dining Club," held a meeting at which electrical subjects were discussed. Among the speakers was Mr. G. S. Dunn, who referred to the vexed question of the Atbara contract being placed in America. Having given particulars of the work to be done, and of the short time in which the Pencoyd Ironworks succeeded in turning this out, Mr. Dunn held that the explanation lay in the fact that Americans had been quick to adopt every improvement in methods in which electric power is probably the most important. He stated that "the Pencoyd works were operated wholly by electricity, and that remarkable economies result. The saving in power over that which would be required to operate the cranes and other machinery of the works by scattered steam-engines is a large and important item, but it is insignificant compared to the indirect gains in convenience and flexibility which the electric system permits. For instance, by the introduction into the bridge department of the electrical methods of handling a girder, which formerly required nearly half a day to be turned over to permit work upon its other side, is now turned in half an hour. The direct attachment of motors to the large tools has permitted the removal of overhead gear and belting, and given such added clear space that the problems of handling are no longer difficult. It has also greatly simplified the manipulation and adjustments that were extremely awkward when power had to be carried to semi-portable tools by means of belts. Portable tools are now carried to work which previously had to be brought to the tools. The net result of the introduction of these and other improvements due to electrical methods, is that the tonnage of output for the same number of hands, tools, etc., has actually been doubled, or the time required for a given output halved with the corresponding effect on the cost of labour."

Electricity in the Italian Navy.—In the last article of the excellent series written by Mr. Giulio Martinez for the *Electrical World*, the electrical steering gear used on the cruiser "Calapria" and the battleship "Ruggero di Lauria" is described. The apparatus in question is the outcome of some suggestions made by Mr. Pasqualini. The apparatus in question is used to control the steam steering gear from the bridge or from some other part of the vessel. As for electrical steering itself, a motor of from 40 h.p. to 50 h.p. would be required, which would form a large load for the electrical machinery in the ship. The general idea of the arrangement is somewhat as follows: Suppose the steering wheel on the bridge to be moved through a definite angle; this causes the electromotor actuating the steam steering gear to commence revolving. This motor only stops when it has made a number of revolutions proportional to the amount of motion of the steering wheel, because only at that moment can it have transmitted a sufficient number of impulses over the circuit to cause the shaft in the transmitting gear to take up its normal position relative to the steering gear. Only four wires are required between the sending and receiving stations, and by a neat arrangement of lamps in the transmitting gear it can be easily seen from the bridge if the apparatus is in order. Two lamps are used, which are normally alight. As soon, however, as the motor commences to move, one lamp is extinguished, and it is only relighted when the sending and receiving gears are again in synchronism. The article concludes with a brief description of Mr. Pasqualini's improvement on Marconi's apparatus, or wireless telegraphy. The author states that this gentleman, who is the chief electrician of the navy, is convinced that Hertzian waves are not employed in such transmissions, but that it is merely a case of induction telegraphy. We must admit, however, that after reading the author's description of the apparatus employed by Mr. Pasqualini, we do not think his conclusions are correct. We notice that he still uses the vertical conductors, which are such an essential feature of the Marconi system.

Electrolysis of Calcium Chloride.—The following is an abstract from the *Journal* of the Chemical Society of a useful contribution by Messrs. H. Bischoff and Fritz Foerster to the *Zeitung fuer Electrochemie* (1898, iv., 464), in which the authors confirm Oettel's statement that a better yield of chlorate is obtained in the electrolysis of calcium chloride than in that of potassium chloride. Measurements of the gases evolved during the electrolysis give the percentages of the current employed (*a*) in the formation of hypochlorite, chlorate, and perchlorate, (*b*) in reducing hypochlorite at the cathode, (*c*) in decomposing water. When a solution of 74·3 gr. of calcium chloride in 500 cubic centimetres of water is electrolysed with 6·7 volts, and current densities of 9·1 amperes per square decimetre at the anode and 13 amperes per square decimetre at the cathode, 85·7 to 90·4 per cent. of the current yields oxygen compounds of chlorine, mainly chlorate 1·4 to 2·9 per cent. reduces hypochlorite, and 7·8 to 12·8 per cent. decomposes water. With a solution of 100 gr. of potassium chloride + 7·5 gr. of potash in 500 cubic centimetres of water, the E.M.F. being 4·8 volts and the current densities the same as before, the corresponding values were 50·9 to 61·9, 12 to 19·9, and 20·8 to 29·6. Both solutions were cooled with ice. A solution of barium chloride gave results very similar to those obtained with potassium chloride. The small reduction observed with calcium chloride is probably due to a layer of calcium hydroxide on the cathode which acts as a diaphragm; the greater part of the calcium hydroxide formed combines with chlorine, but part of it remains undissolved, free hypochlorous acid existing in the solution and volatilising with the gases evolved. Further experiments show that at 20deg. to 25deg. the best yield of chlorate is obtained from solutions containing at least (preferably much more than) 10 per cent. of calcium chloride, and with a current density of 10 amperes per square decimetre at the anode and at least double that amount at the cathode; the yield is nearly 90 per cent. The deposit of calcium hydroxide on the cathode considerably increases the E.M.F. required; at 50deg., however, 4 55 volts suffice, and the yield is but slightly reduced (80 to 87 per cent.). Determinations of oxygen in admixture with hydrogen should not be made in the phosphorus pipette, but by means of copper in presence of a solution of ammonia.

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ELECTRIC LIGHTING OF COVENT GARDEN THEATRE.

We have referred in brief notes in our previous issues to the great alterations being made at the Covent Garden Theatre by the Royal Opera Syndicate, which has taken over this historic house.

Anyone acquainted with the theatre in question, which until now has been lighted entirely by gas, will agree that there was a necessity for the changes which have been made, and particularly for the change in the illuminant used. In fact, the increased public interest in grand opera made it an imperative necessity that what was practically our only opera house in London should be equipped in a way which will enable masterpieces to be staged effectively.

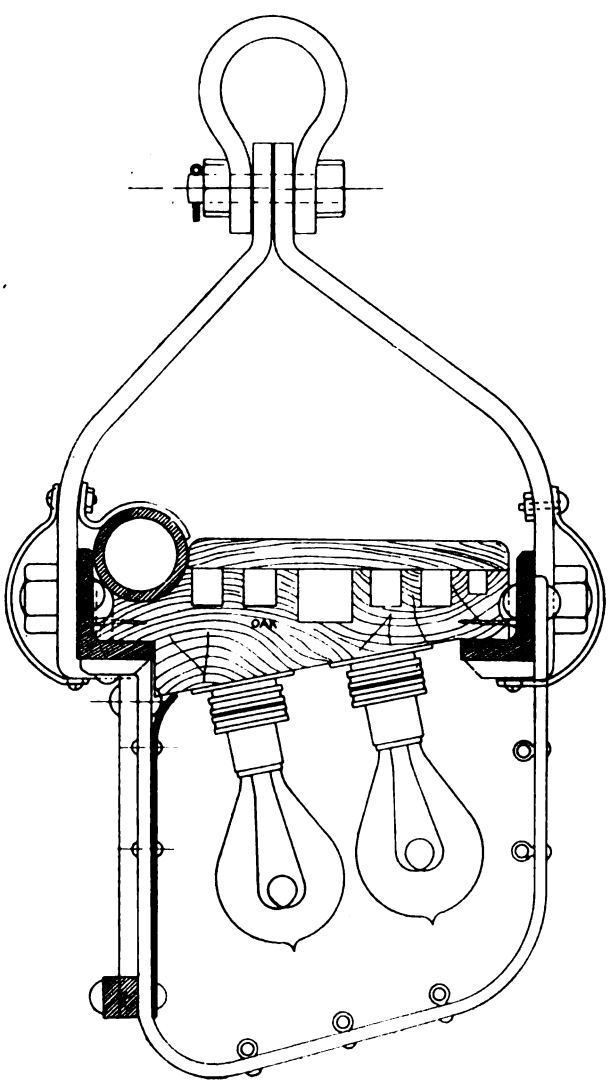

FIG. 1.—Section of the Battens used at Covent Garden.

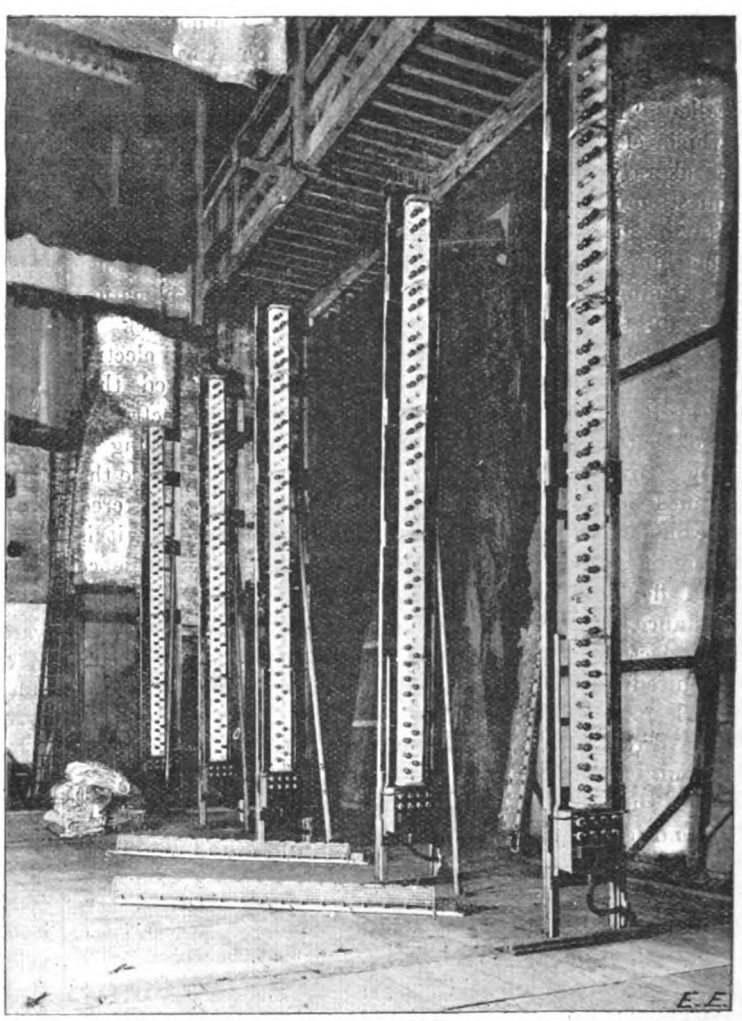

FIG. 2.—The Five Traversable Wing Lights used on the O. P. Side.

As an example of the antiquated means of lighting which until now have been used at the theatre, we may point out that the old gas battens had neither pilot lights nor flashes. The want of these entailed hand lighting, which was cumbersome and exceedingly dangerous. Again, there was absolutely no provision for producing coloured effects in the lighting, except with limelights, which for such a large stage as that of Covent Garden could give but a very local colour. The management, therefore, decided to place the whole of the electric lighting of the stage and auditorium in the hands of Mr. Wingfield Bowles, who, in his capacity as consulting engineer, has made theatre lighting his speciality. Owing to the large amount of work to be done in the limited time available between the closing of the fancy dress ball season and the commencement of opera, the stage-lighting only has been completed in time for the latter. The work had thus to be done in less than six weeks, and our readers will accordingly understand the need there was for careful and detailed organisation. The grand saloon has already been lighted, and some five arc lamps have been placed outside, but apart from this, the auditorium lighting is not being at present proceeded with. In the stage-lighting as a whole Mr. Bowles has introduced several distinctly novel features. The first of these is in the provision of four colours respectively—white, red, blue, and orange—for obtaining stage effects. It is, we believe, the first time that orange-coloured lamps have been used for stage work in this country, these effects being previously obtained by burning white lamps at very low candle-power. By this means the good effects obtainable at Covent Garden are not arrived at, while the method is also extremely wasteful. The other radical departure consists in placing the switch gear below the stage in a fireproof room, from which the electrician-in-charge can obtain a full view of the scene as lighted. This procedure, while excellent for a repertoire theatre like Covent Garden, would not be recommended by Mr. Bowles for smaller theatres, or for those theatres in the provinces which are used by touring companies. In such cases the stage-manager requires to be more in touch with the electrician-in-charge than is the case at Covent Garden.

In describing the lights at present installed on the stage of Covent Garden Theatre we will commence with those used high up and gradually descend. In the first place, there are seven battens, six of which are 61ft. long, and one 40ft. long which is used to light the back cloth or the extreme back wall. These six battens are, we believe, the largest in use in this country, and they each contain 220 lamps of 16 c.p. divided up into colours as follows: 80 white, 40 amber, 50 red, and 50 blue. In the smaller batten the numbers are 50 white, 20 amber, 25 red, and 25 blue. For these battens no less than 28 regulators with liquid resistances are provided, so that the illumination can be easily varied and changed in colour without causing any flickering. At the same time, as there is one regulator for each colour in each of the battens, they can be varied independently. The construction of these is shown in Fig. 1, from which it will be seen that they are built up with a steel lattice back filled with a grooved plank of English oak,

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which is used to contain the necessary cables. These cables are led to the end of the batten, where tail-ends are provided to connect them to an iron box placed below the fly-rail. The cables are carried in a hand-sewn leather hose, which is bound to trumpets on the end of the battens and on the special connector boxes. The boxes, which are all Mr.

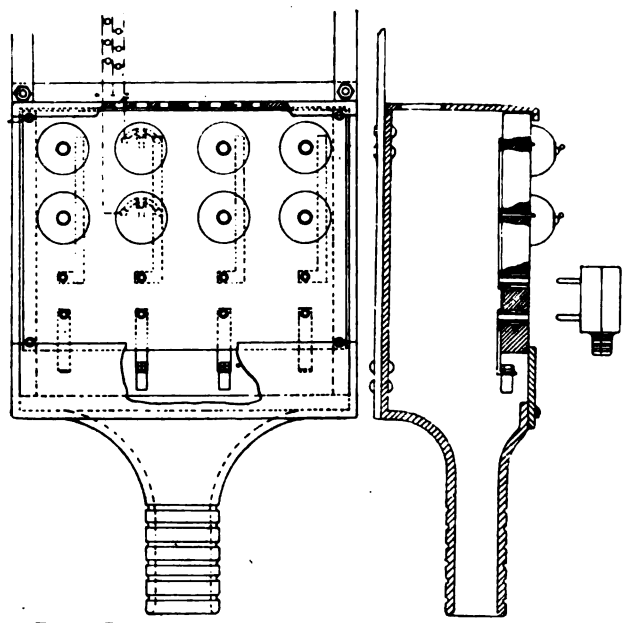

FIG. 3.—Details of the Iron Boxes and Switches for the Wing Lights.

Bowles's own design, will be described later on. They are so arranged that the cables can be quickly disconnected in case the batten has to be lowered or removed. They contain some eight contacts in all. The battens are provided to have a rise and fall, when connected, of 12ft. In each of them four pilot lamps have been installed, which can be

width of 2ft. 3in. From a glance at the illustration (Fig. 1) showing the section of them, it will be seen that all the projecting nuts have been carefully shielded, in order that they may not work loose or cause damage to the scenery. The 61ft. battens weigh practically 16cwt., and are suspended by six ½in. steel ropes, an insulated support being placed between these ropes and the bridle chains to the battens. The reflectors used are of sheet steel ⅛in. thick, which is flint-enamelled on the reflecting side. With the connections used in the switch-room, every other batten is connected to a different supply station. Thus the numbers 1, 3, and 5 are on one station, while 2, 4, and 6 are on another.

The arrangement of wing lights at the Covent Garden Theatre will be seen in the illustration (Fig. 2). There are five of these on each side of the theatre. The framework of the reflecting part is much the same as that of the battens, it being supported by lattice steelwork, and provided with an oak filling to carry the cables. The use of oak for this purpose has been found in every way more suitable than the adoption of metal tubing. The worst fault that can occur will only cause the oak to smoulder, and a small fault is not so likely to blow the fuses as when metal tubing is used. In each of these wing lights there are 75 lamps of 16 c.p., of which 30 are white, while 15 are coloured respectively amber, blue, and red. The wing lights are supported on ladders, which run on wheels in the mezzanine floor. By this means the wings have a travel of 16ft.—*i.e.*, 8ft. either way from their normal position. These ladders also act as supports for the wings or other scenery required at either side of the stage. At the bottom of each wing light there is a cast-iron box, seen in Fig. 2 and also in Fig. 3, which gives details of its construction. By them the lights can be extinguished in eight sections if desired. In this way half colours can be obtained by switching off—for example, one half of the red lamps. In the same manner one half of the white lamps can be extinguished in one wing, and

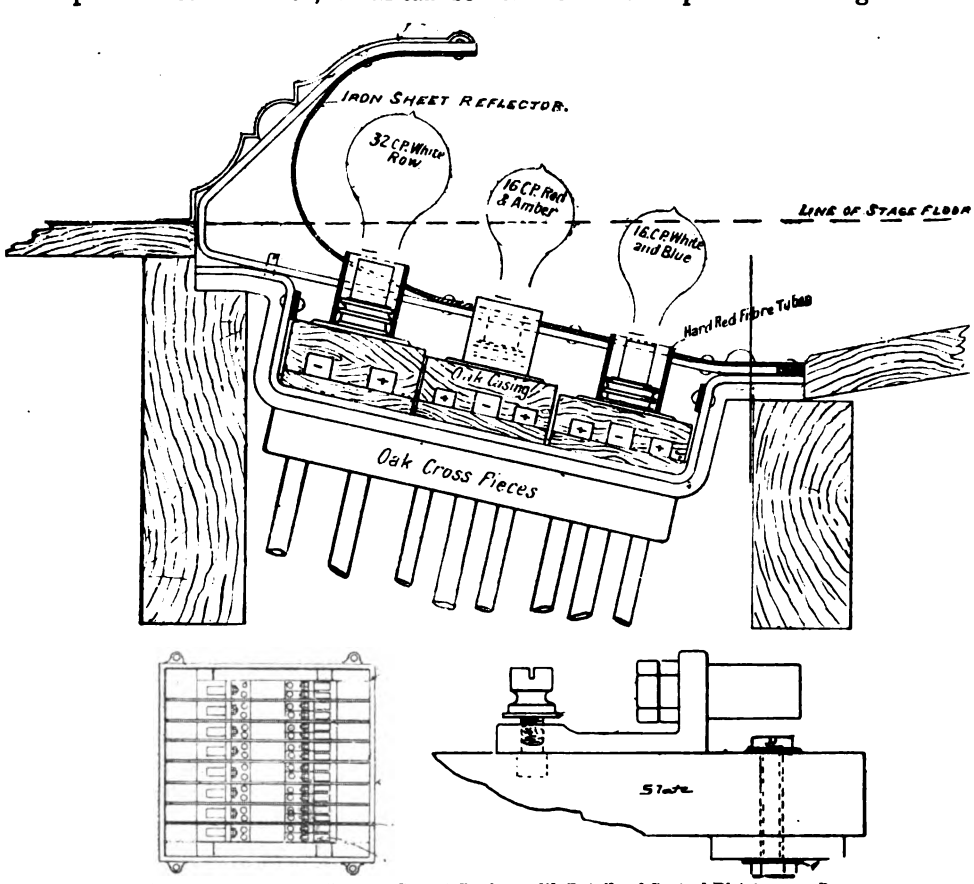

FIG. 4.—Section of the Float at Covent Garden, with Details of Central Distributing Box.

controlled from a small special switch on the stage switchboard. These are used to give sufficient light for the master carpenter or other stage official to work by without the electrician having to operate the main switchboard. One great advantage in the use of the electrically-lighted battens will be gathered from the fact that they are only 8½in. wide, whereas the old gas battens absorbed a total

the others can be maintained burning while the other wing lights are varied; also by intercepting blocks it is possible to insert local resistances into any of the circuits. The connections for these wings are obtained by the hose-pipes seen in Fig. 2, which contain the wires on their way to a special iron connecting box in the cellar below the stage. They are fed by a complete double ring main, controlled by

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eight resistances and regulators. The proscenium lights, which are placed just inside the frame of the stage, each contain 50 white lamps, 30 blue, 30 red, and 25 amber. They are similar in construction to the wing lights, but separate resistances are provided for the two—these consisting of four regulators, one for each colour. A section of the float is shown in Fig. 4, from which it will be noticed that three lines of lamps have had to be used. The back row consists of 50 white lamps, each of 32 c.p., which are used for general work. In the other rows some 50 16-c.p. white lamps are placed, and will be used as auxiliaries when strong light is required. Besides these, there are 50 lamps of 16 c.p., of each of the following three colours—red, blue, and amber. Five regulators are used for this float, which are led to a disconnecting box in the centre, from which feeders run in either direction. In this way the float, which is 35ft. long, can easily be broken up into two halves by the electrician if required, so that one half is dimmed while the other is strongly lighted. The design of the float is such that the upper part can be easily removed to enable the stage flooring to be continued over it when required, as is the case when the well-known fancy dress balls are being held.

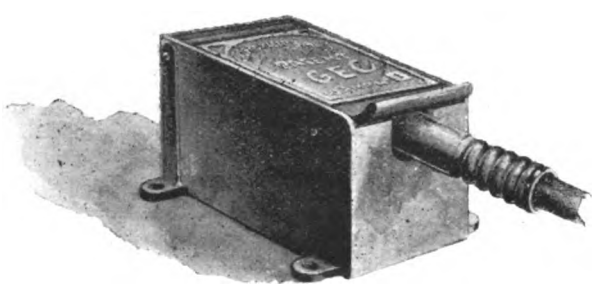


FIG. 5.—The Wingfield-Bowles Plug Box Closed.

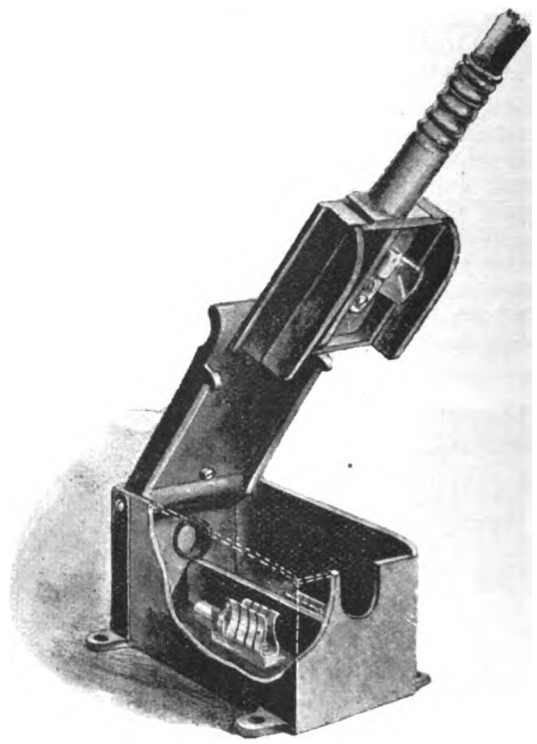
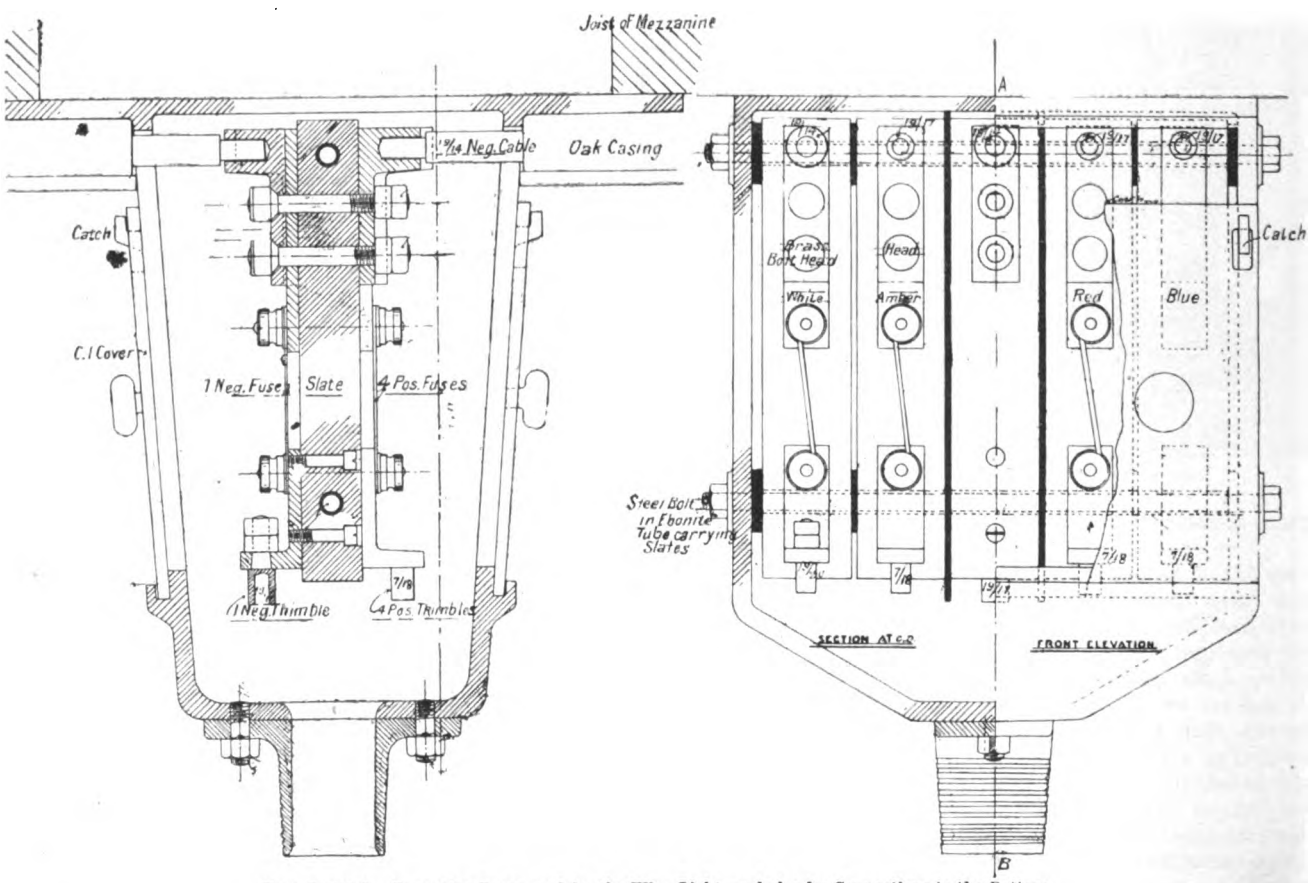


FIG. 6.—The same Box when Opened to insert Plug.

In addition to the above fixed lights, two circuits are run round the stage and connected with plugs in various parts from which portable lengths can be supplied to light ground rows, transparencies, etc. These portable lengths contain from 10 to 15 lamps, and their wires are run in canvas hose, which by flattening out on the stage is the least liable of anything to cause accidents. Mr. Bowles informs us that heavy scenery can be run over such hose with ease without damaging it or the cables inside. Two of these portable lengths can be seen on the floor in Fig. 2. Some 30 of the plug boxes have now been fixed, and when the stage has been finally altered the total number will be increased to 50.

The plug boxes used at Covent Garden are of the type designed and patented by Mr. Bowles, and manufactured by the General Electric Company. Two views of these boxes are given in the illustration herewith, of which Fig. 5 represents the box closed, and Fig. 6 shows it open, with the cable end right for insertion. The lid, which automatically closes itself on account of its weight, has a lip at the lower end, against which the plug at the end of the canvas hose can be placed. In this way the lid



FIGS. 7 AND 8.—Connector Boxes used for the Wing Lights and also for Connections to the Battens.

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is opened, and the plug is then slipped up under the grooved edges of the lid. When pushed up to its greatest extent the lid is closed, and the contacts on the plug slip into the flexible jaws seen in Fig. 6. An ebonite slip divides the terminals both in the box and in the plug. The great beauty of the design lies in the fact that no mechanical strain comes in contact, and that it is impossible to reverse the poles, owing to the fact that the plug can only be inserted in one way. Again, if the plug is not first slipped into the grooves of the lid the box cannot be closed. These boxes are placed beneath the stage flooring, through which small traps are left, which can be closed round the canvas hose when the plugs have been inserted.

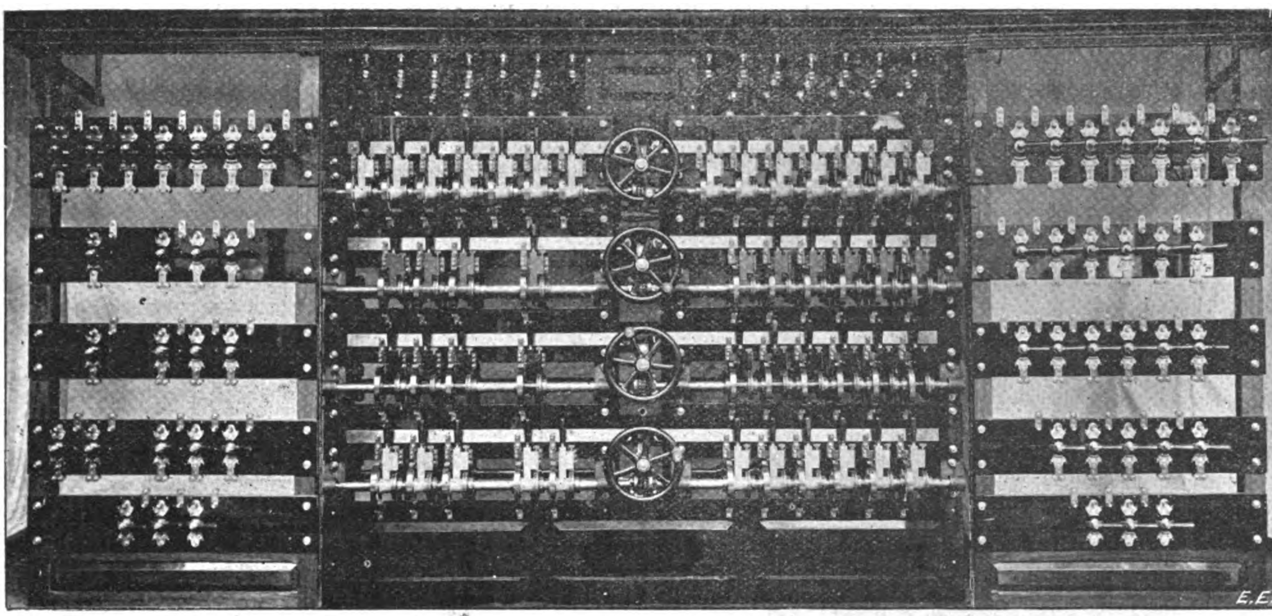

FIG 9.—View of the Regulating Switchboards used at the Covent Garden Theatre.

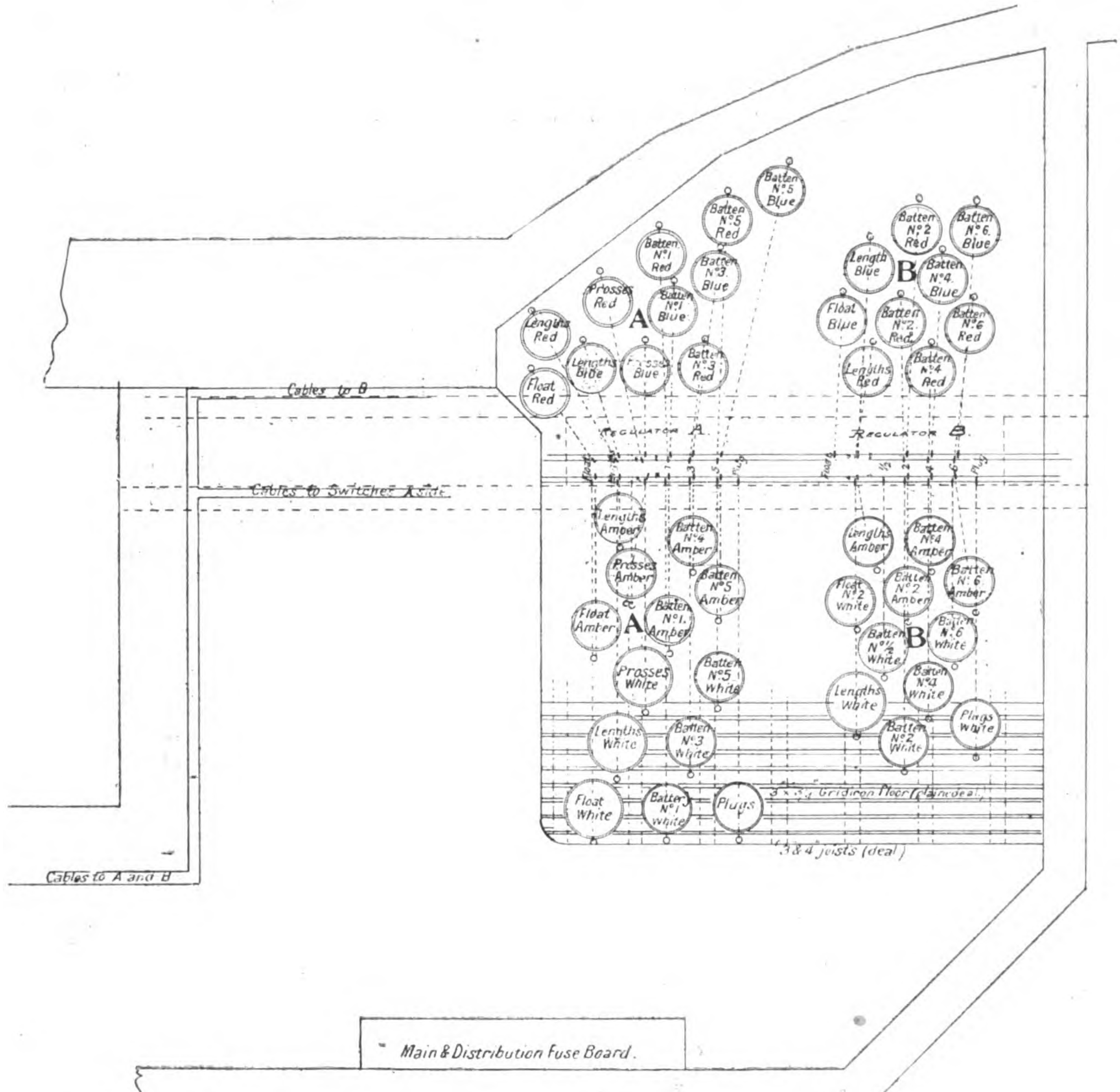

FIG. 11.—Plan of the Resistance-Room.

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The switch-room, which is mentioned above, and which is placed below the stage at one side, is built up of iron plates. Access is obtained to it by means of an iron door in the mezzanine floor, from an iron door in the orchestra, and by

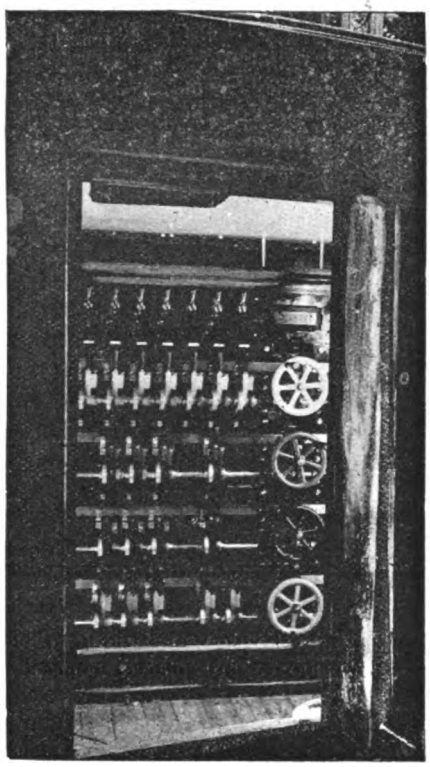


FIG 10.—View of Switchboard taken through Doorway to Orchestra.

means of a trapdoor and ladder from the stage. Fig. 9 shows the whole of the boards used in this room, but it has not been possible to get them quite in the same line as shown, one of them being placed at right angles to the centre board. A view taken from the orchestra through the iron doorway is shown in Fig. 10, but the space inside it is insufficient to enable a complete photograph to be taken. The main receiving switchboard and fuse-boards are placed two floors below, in the resistance room, which is shown in plan in Fig. 11. The general diagram of connections used on the switchboard are shown in Fig. 12, from which it will be seen that all the switching and regulating gear in the switch chamber beneath the stage is connected to the middle wire of the third-wire system only. The board in the centre of the diagram takes the six incoming mains, which give a duplicate supply to the theatre from two separate supply stations. These two stations both belong to the Charing Cross and Strand Company, and by the large throw-over switches, seen in the

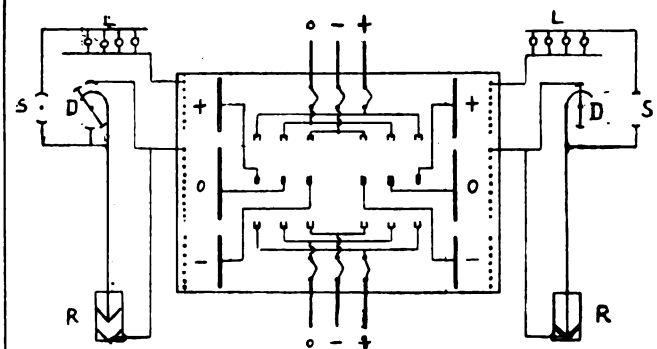
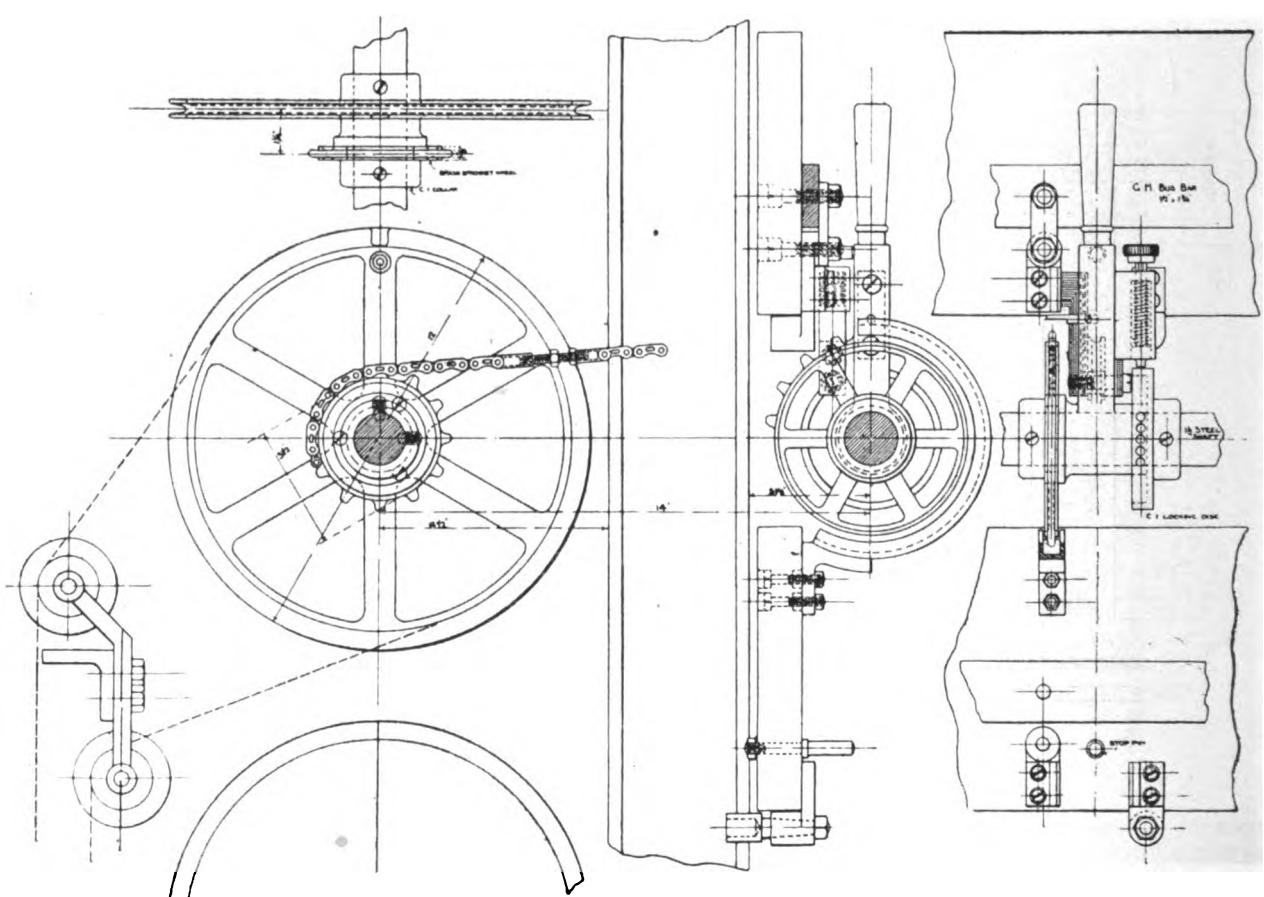


FIG. 12.—Diagram of Connections to Lamps

centre of the diagram, the whole of the load can be quickly put on to one station in the event of the other breaking down. Great care has been taken to keep the stage wiring in two complete halves, and to so arrange the lamps that the failure of one half of the lights will not cause serious breakdown in the general lighting effect. From the main board, which is placed in the resistance chamber beneath the switch-room, the distributing wires on the zero side go up to the switch-room. The liquid resistance, marked R in the diagram, is actuated by the dimmer, marked D; and it will be seen that when the cone in the cell is at its lowest point, the liquid resistance is entirely cut out. The switches used control the lights in the usual way. The great feature in Mr. Bowles's system of stage-lighting is the centre switch-board seen in Fig. 9. The four hand-wheels seen



FIGS 13 AND 14.—Front Elevation and Section of a Dimmer Switch and Gear.

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in the illustration each control one colour, or as many of the circuits of that colour as may be required. The details of the switches by which this is done will be seen in Figs. 13, 14, and 15. Each regulating switch or dimmer works round the main axle, which is operated by the worm-wheel. These levers can be thrown into gear with a disc on this axle by means of a spring pin, seen in Fig. 14, which keys into holes in this disc. When this pin is up, the individual circuits can be dimmed by hand. The arrangement of the dimming gear is seen in Fig. 13. The switch-handle drives a large wheel by means of a bicycle chain, which raises or lowers the cone in the liquid-resistance jar in the cellar. One great feature of this arrangement is that when the lever is right home it short-circuits two contacts, which cut out the liquid resistance entirely. It will be seen that with this arrangement the locking pins can be thrown into gear at any point on the disc, so that either or all circuits can be dimmed alike, or one or two of them extinguished more rapidly than the others. Perhaps, however, the greatest advantage of the arrangement is that while the white light is left, for instance, on one particular batten, the other battens can be gradually changed into colours, giving in this way good sunset or dawn effects. What strikes one most when inspecting this board is its fireproof construction and the engineering skill shown in its design. The resistance room shown in Fig. 16 is also fireproof, and from this illustration a good idea can be obtained of the construction of the lifting gear. It will be seen that the tracer wires are insulated from the cones which are immersed in the liquid resistance, and that the insulated cables are attached to terminals on the copper rods coming from these lead cones. The liquid used in the jars is zinc chloride. The tubes for bringing the wires through the floor, and the pulleys for the tracer wires, are shown in Fig. 17.

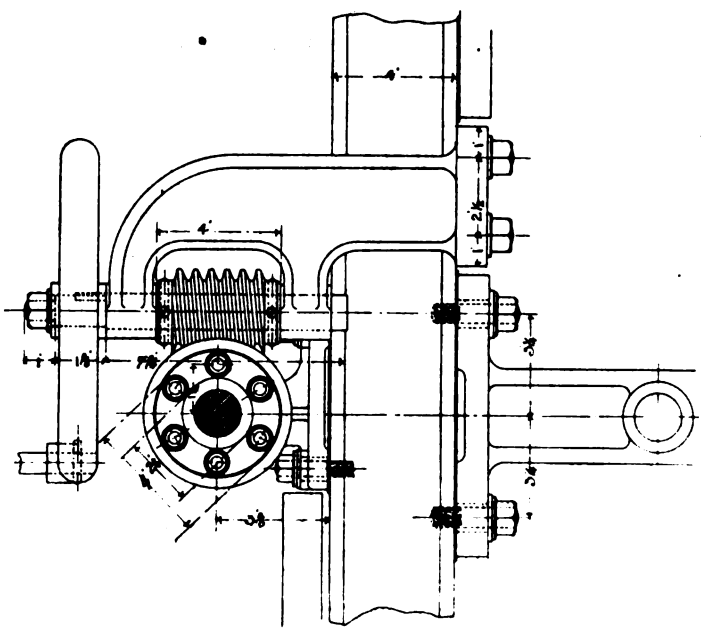

FIG. 15.—Section showing Hand-Wheel.

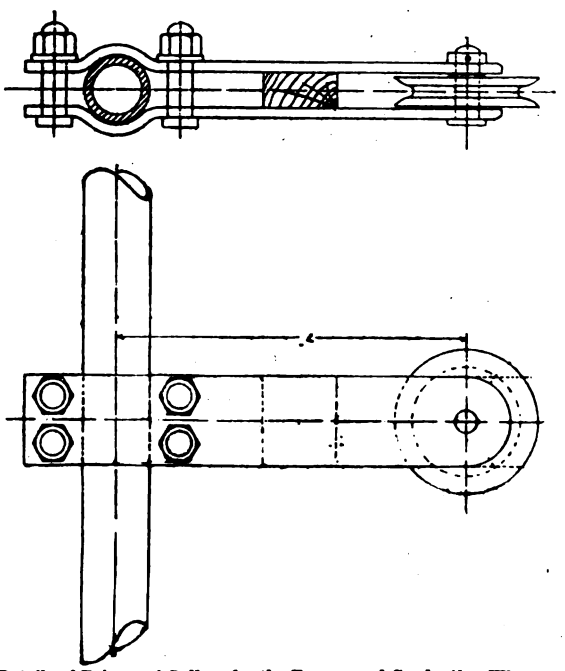

FIG. 17.—Details of Tubes and Pulleys for the Tracers and Conducting Wires.

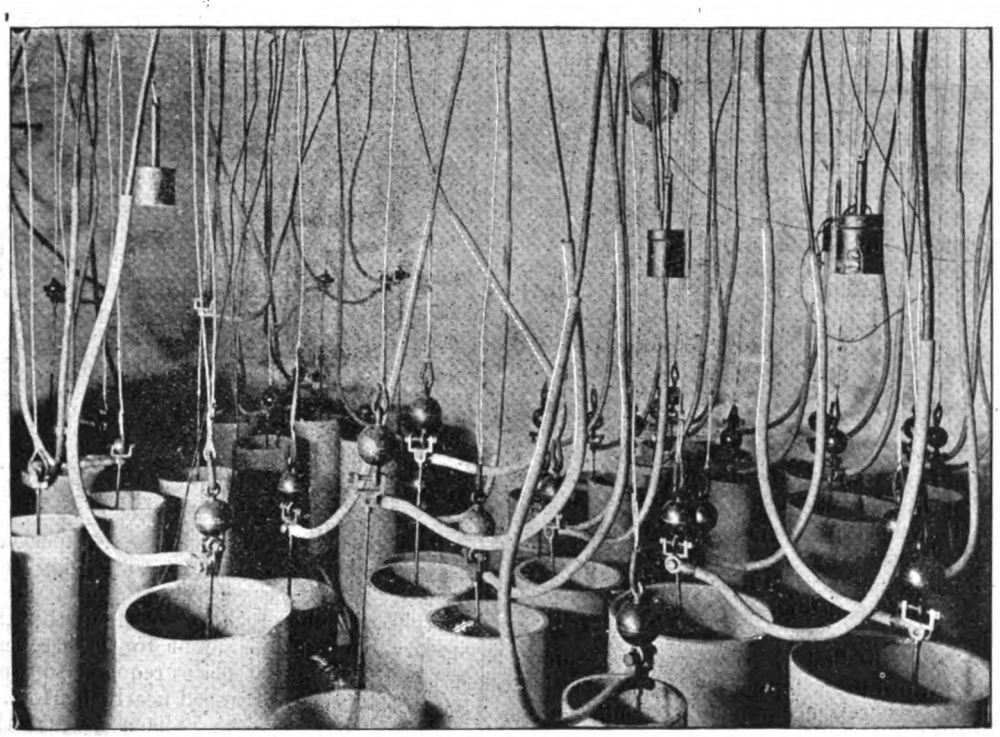

FIG. 16.—View of the Resistance-Room, showing Method of Suspending the Cones in the Liquid Resistances.

In the construction of the main switchboard for the two large change-over switches, which are of 1,000 amperes capacity, special attention has been paid to insulation. Steel H-girders are used to support the slates, but all the details for the supporting bolts are bushed with vulcanite, and sheets of this are placed between the slate and the

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steel. It is also to be noticed that on all of the switch-boards used at Covent Garden all the connections are on the surface, which is a very essential feature.

In addition to the stage-lighting, all the dressing-rooms, passages, and corridors, the gridiron, and the cellars around and beneath the stage have been provided with electric light. For these parts duplicate circuits have been run, alternately giving on each circuit. The energetic manager and secretary of Covent Garden Theatre—Mr. Neil Forsyth—is largely responsible for the improvements Mr. Bowles has been able to make in the lighting in the house, and we have to thank him for kindly allowing us to view the theatre at the present time. The contractors for the work have been Messrs. Townsend, Tamplin, and Makovski, Limited, of Victoria-street, who have worked at schedule rates throughout. Mr. H. Pemberton has acted as clerk of the works, and in this capacity has ably assisted Mr. Bowles in getting the work completed so quickly. The electrical engineer for Covent Garden Theatre is Mr. W. G. Crawshaw, who will be responsible for obtaining good scenic effects with the electric light during the coming opera season. In conclusion, while offering our congratulations to the proprietors on the perfect system of stage-lighting they have secured, we have to thank Mr. Wingfield Bowles for his great courtesy in placing such full details of his work at our disposal.

NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

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CLXVIII.

Storage batteries of quasi-novel form or composition are the order of the day. Italy now contributes the Pescetto accumulator. Some details as to the construction of this cell, and very extended information as to its performance, have quite recently been published in this country. The construction involves a grid with comparatively large, square apertures, the bars of which are cut so as to produce eight prongs extending into each aperture. These grids are pasted with oxides of lead in admixture with an agglutinating substance, termed by M. Pescetto *ulmate* of *ulmin*, produced by boiling sugar in dilute sulphuric acid. This substance, there can be no doubt, is ultimately eliminated by reason of its solubility, and, in the case of the peroxide element, by oxidation. Assuming that the superiority of this battery as set forth in the catalogue published by the Società Italiana di Elettricità can be substantiated under working conditions, this superiority would probably be due to the peculiar porous character of the active material rather than to the form of the grid. Besides these, there are no other points of novelty, so far as I can ascertain. The catalogue, embodying an immense amount of detail, is quite a new thing in its line.

As in the case of the Valls accumulator (CLXIV.), there are three forms of the Pescetto cell—viz.: "P," stationary accumulators to be worked at normal rates of charge and discharge; "P.R.," stationary accumulators to withstand high rates of discharge; and "R.P.R.," portable (traction) accumulators to be worked at high rates of charge as well as of discharge.

The capacity of the "P" form is given under six different conditions in regard to rate of discharge; the rate of charge being invariably for this cell ·41 ampere per pound of cell.

Stationary Batteries "P."

Rates of discharge—amperes per pound of cell complete.	·164	·205	·256	·307	·359	·410
Corresponding periods of discharge	h. m. 13 40	h. m. 10 42	h. m. 8 24	h. m. 6 51	h. m. 5 54	h. m. 5 0
Corresponding capacities—ampere-hours per pound of cell complete	2·26	2·19	2 13	2·10	2 07	2·05

The "P.R." class of cell is much lighter and less durable, being adapted for a higher rate of charge—viz., ·789 ampere per pound of cell as a maximum—and for much higher rates of discharge. It is specially intended for the distribution of electric energy, and for a regulator in central stations. In this case, also, the capacity is given for six different rates of discharge.

Stationary Batteries "P.R."

Rates of discharge—amperes per pound of cell complete.	·657	·789	·920	1·05	1·18	1·31
Corresponding time of discharge	h. m. 4 0	h. m. 3 16	h. m. 2 45	h. m. 2 23	h. m. 2 5	h. m. 1 52
Corresponding capacities—ampere-hours per pound of cell complete	2·63	2·58	2·53	2·50	2·46	2·14

But at the present moment the main interest must centre in the "R.P.R." or rapid charge and rapid discharge (traction) cell. Never before have the results of such extreme variations of the rate of charge and of discharge been set forth in a price list, or even in a set of time curves. And, I may observe, by such curves alone can they be expressed otherwise than in a most cumbrous manner. This is obvious when the table relating to these cells is glanced at, or when it is stated that it applies to seven batteries (1 R.P.R. to 7 R.P.R.), and that for each of these four different results are specified under nine different conditions as regards rate and time of charge, and under five different conditions as regards rate and time of discharge. Each battery of from one to seven sets of plates can thus be studied under 45 aspects. Besides this, the table gives the utilisable watt-hour capacity per kilo of plates, the weight of plates necessary to give one kilowatt-hour (energy), and the weight of plates necessary to give 1 kw. (power).

In these cells the ratio of weight of plates to total weight of battery complete is about ·76. The rate of charge per pound of cell varies from ·69 ampere to 6·9 amperes. The period of charge varies from 7 hours 30 minutes to 15 minutes. The rate of discharge per pound of cell varies from ·86 to 1·55 amperes. The period of discharge varies from 5 hours 36 minutes to 50 minutes. The utilisable capacity per pound of cell varies from 8·85 to 2·28 watt-hours. The weight of battery necessary to supply the kilowatt-hour (B. of T. unit of energy) varies from 113lb. to 424lb. (when the specific watt-hour capacity is a minimum). The weight of battery necessary to supply the kilowatt varies from 634lb. (when the specific capacity is a maximum) to 358lb. (when the capacity is a minimum).

To show the effect of rate of charge—without going to either extreme—upon the capacity subsequently developed at various rates of discharge, I will take two cases as follows:

Traction Batteries "R.P.R."

CASE I.—Specific rate of charge (amperes per pound of cell), 1·38. Time of charging, 2 hours 45 minutes.

Rates of discharge—amperes per pound of cell complete	·86	1·035	1·207	1·38	1·55
Corresponding periods of discharge	h. m. 4 0	h. m. 3 16	h. m. 2 45	h. m. 2 23	h. m. 2 6
Corresponding useful capacities—watt-hours per pound of cell	6·24	6·217	6·13	5·92	5·85

CASE II.—Specific rate of charge, 4 14 amperes. Time of charging, 35 minutes.

Rates of discharge amperes per pound of cell	·86	1 035	1·207	1·38	1·55
Corresponding periods of discharge	h. m. 2 24	h. m. 1 57	h. m. 1 39	h. m. 1 26	h. m. 1 15
Corresponding useful capacities—watt-hours per pound of cell	3·79	3·73	3·68	3·55	3·51

The loss and recovery of some 40 per cent. of capacity, in a cell charged each time to gassing point, would have been regarded not very many years ago as a somewhat inexplicable phenomenon. And in the extreme case the apparent loss may amount to 74 per cent., or, in other words, the weight of plates required to generate a kilowatt would have to be increased nearly fourfold.

Now that the Società Italiana has set the example, the manufacturers of storage batteries will no doubt be expected to give far more information than heretofore with regard to the ascertained capabilities of their cells under various rates of charge as well as of discharge. The company certainly deserve credit for their new departure in the way of price-lists, and will be still more commendable if their traction battery realises in practice the expectations based on their tastefully got up and carefully compiled catalogue.

CLIX.

An examination of the Fulmen cells which were used in last year's (1898) electric cab competition at Paris has

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given the following results relative to their construction: There were six peroxide plates, each containing 4·83oz. avoirdupois of metallic lead and 12·14oz. of paste. There were seven spongy-lead plates, each with 4·83oz. of metallic lead and 9·11oz. of paste. The area of positive surface was 325 square inches. The containing vessel and separators weigh 21·43oz.; and the total weight of the cell with electrolyte is 16½lb. The normal rate of discharge of the cell is 21 amperes; time of discharge, five hours; mean voltage, 1·9. The specific rate of discharge (amperes per pound of cell) is thus 1·28, and the specific capacity at this rate is 6·4 (ampere-hours per pound of cell). Unless the Fulmen accumulator should prove to be very deficient in durability (which is probable), this is what competitors have to beat.

CLX.

A M. Riker has taken up the question of the practicability of zinc-lead accumulators, over which Emile Reynier expended so much endeavour. Twelve watt-hours per kilogramme of cell is stated ("Science Abstracts" for April, p. 252) to be the highest figure given by any European or American maker of accumulators. This would be 5·45 watt-hours or about 2·37 ampere-hours per pound of cell, which is by no means a high figure for a lead accumulator. With a lead peroxide plate and a negative electrode of zinc-coated copper the mean E.M.F. is 2·3 and the maximum 2·5 volts; and the specific energy in watt-hours per pound of cell is stated to be 16·55 when the time of discharge is 10 hours, or 13·25 when the time of discharge is four hours. These are high values assuredly; but my experience of the difficulties attending the use of zinc-lead accumulators prevents me from being altogether confident in the ultimate success of the endeavours in this direction.

(CONCLUSION.)

INSTITUTION OF ELECTRICAL ENGINEERS.

Capacity Measurements of Long Submarine Cables.

BY J. ELTON YOUNG, MEMBER.

The following paper has been prepared both as a *résumé* of researches in a problem which, when pushed to defineement, possesses some intricacy, so that others may be saved the labour of repeating them, as well as with the object of submitting to the Institution of Electrical Engineers some conclusions reached with reference to one or two outstanding questions in the domain of electrical measurements of submarine cables.

If progress in this department were gauged merely by the results appearing in the *Proceedings*, it would be very poorly and unfairly represented. For example, with the exception of a very brief but important communication from Mr. J. Gott (vol. x., p. 278), not a single paper bearing on the present subject of capacity measurement is to be found in the *Journals* since Lord Kelvin's classical contribution to their first volume. But, although frequently unpublished, a great deal of patient advance has been made of recent years in perfecting the testing of submarine cables, all leading to increased accuracy in the localisation of faults.

Of the various investigations which have thus been followed up, with a view to eliminating every residual source of error, none has presented a more curiously persistent elusiveness than the exact determination of the electrostatic inductive capacity of a long cable, though its approximate measurement has been fairly easy. There are four factors which have contributed to this want of finality—viz.: (1) insufficient definition of the quantity sought for, which is, in fact, a function of the time of charge; (2) difference between rates of electric absorption of the cable and the balancing condensers; (3) variations of absorption of both cable and condensers with time of charge and with temperatures involving virtual variations of their capacities; (4) leakage error, which on long submarine cables is often large, and affects measurements more than any other cause.

With respect to definition of electrostatic capacity, two remarkable results of mathematical theory may be quoted from a paper by Dr. John Hopkinson and Prof. E. Wilson (*Phil. Trans*, vol. 189, pp. 109-136), though probably they are also to be found elsewhere. In this they demonstrate that, calling Y the total quantity of electricity coming out of a condenser which has been charged for time T to potential X and writing w for the symbol of variable time,

$$Y = X \int_0^T \psi(w)\, dw,$$

or the capacity is a function of the time of charge, increasing as the time increases. The other result is that the time-integral of current, or the electric displacement, through a condenser can be expressed in the form—

$$y_t = K x_t + \int_0^\infty x_{t-w} \{\psi(w) + \beta\} dw,$$

where the first term represents "instantaneous" capacity, the second residual charge or absorption, and the third conductivity of dielectric, separated for convenience, but really all parts of a continuous magnitude.

What the latter formula indicates, with this addition that in a cable we have retardation of charge by conductor resistance, may be exhibited diagrammatically, I believe, as in Fig. 1, which illustrates what happens when a long cable, with its distant end insulated, is charged continuously. The horizontal shading shows constant leakage current to earth; the vertical shading, P Q R S, represents a portion of the charge that has entered the cable during a period of battery contact of 10 seconds, p P S s the quantity added to it after 15 seconds have elapsed; whilst after 30, 45, and 60 seconds respectively, small additional increments, p s s p, etc., have flowed into the cable.

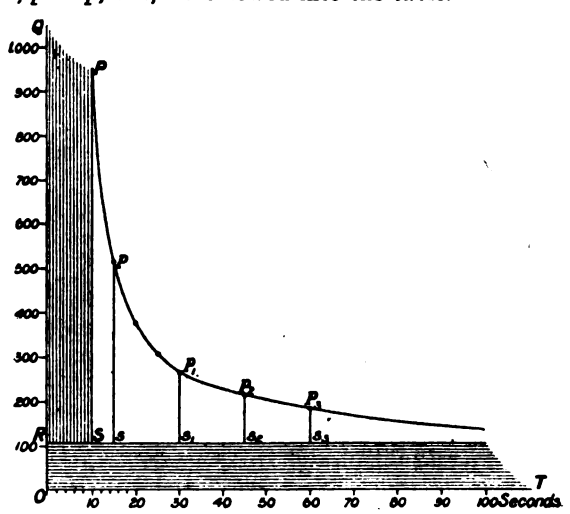

FIG. 1.

This takes place by virtue of the well-known phenomenon of absorption, or residual charge, which commences at the same instant as the true or surface charge (as it may be termed), and continues long after the latter has ceased, disappearing logarithmically with the prolongation of battery contact, and leaving the true leakage current, O R, on which it was superimposed.

Thus the surface charge of the conductor and the residual charge due to dielectric absorption forms part of one continuous magnitude, varying with time, which must be regarded as the capacity of the cable, though theory divides the two. The same is true of any condenser except one having a dielectric of air, the absorption of which is negligible. If a paraffin-mica condenser be measured by an air standard its value may be raised some 5 per cent. by prolonging the time of charge.

Now in balancing a cable against a paraffin condenser, if they both have the same rate of absorption, there will be no apparent variation of results with the time of charging. This, however, is not the case in general, for not only do the specific absorptive capacities of paraffin and guttapercha differ, but the conductor resistance of a long cable greatly modifies its rate of absorption—at all events, near the beginning of charge or discharge. Thus there will be a

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divergence of results with different times of charge—quite independently of that due to true leakage effects. (I am assuming that comparisons are made by the usual "Thomson" or "Gott" methods.) This is sufficiently illustrated by the appended tests of two long ocean cables, where due correction was made for the leakage in the manner described further on. See tables (appended).

Besides this effect of time, there is, moreover, one of temperature to be noticed. The absorptive capacity of both guttapercha and paraffin is augmented by fall of temperature, thus causing an increase in their apparent capacities. This variation is of a smaller order of magnitude than the former, being, in fact, the increment of an increment. Thus in the case of paraffin the temperature effect is to increase the capacity by only 0·025 per cent. per fall of 1deg. C. The rate at which it affects that of guttapercha, whilst in the same direction, is still smaller, and has eluded determination altogether hitherto. Still, it cannot be regarded as negligible when we are seeking the maximum accuracy attainable, and dealing with cables of many hundreds of microfarads submerged at depths such that their temperature falls by some 20deg. C. below the standard 24deg. C. of the factories. In the case of ordinary paraffin condensers when employed for accurate measurement it is a factor requiring careful allowance to be made for it; though in the compensated standards constructed by Dr. Muirhead, partly of paraffin and partly of shellac, the opposite behaviour of the shellac neutralises their temperature variation.

There appears to be no secular change in the capacity of paraffin condensers when moisture and air have been expelled by heat during manufacture. An apparent secular change has, however, been encountered in the capacity of certain G.P. core, the origin of which deserves to be known

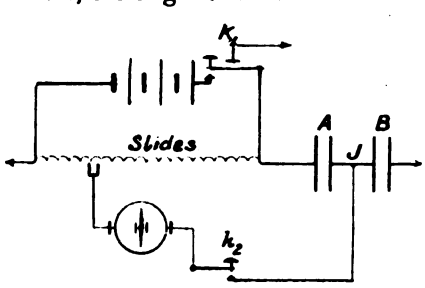

FIG. 2.

amongst telegraph engineers, as it may occasionally explain otherwise anomalous measurements. This was traced to the absorption of water by the G.P. after it had been rendered porous by alternations of wetness and dryness. Water has the highest specific I.C. known of any substance (I believe), and samples of G.P. containing low and high percentages of water have been found to show marked differences of inductive capacity, those with the higher percentage having the larger I.C. This circumstance somewhat further obscures the search for a coefficient of temperature variation.

Leaving aside the subject of temperature corrections, which are to be made by means of proper coefficients, I pass on to the methods proposed for the elimination of the discrepancies and indefiniteness introduced into comparisons of long cables with condensers by reason of their difference of rates of absorption. For this purpose Dr. Muirhead has given us his correction of Gott's test, applicable perfectly to comparisons of condensers with one another or with short sections of cable, but of little or no use on very long ones, presumably on account of their C.R. retardation. This has been often described, and consists essentially in (1) raising the potential of the junction, J (Fig. 2), of the two condensers from zero to a value v by application of the charge "in cascade" (by Gott's connections), and then permitting absorption to proceed whilst balance is being found on the slides, which changes v to v_1 by the time balance has been arrived at; (2) lowering the potential of J by earthing k_1, from v_1 to $(v_1 - v)$; (3) observing the amount $(v_1 - v)$ of this residual potential, and evaluating its effect on the slide reading. By means of such a correction, if A (Fig. 2) be an air standard, and B a condenser of paraffin or other dielectric having absorption, whilst A has none, we can arrive at a value of B which is independent of the time of charging, and may be regarded as its constant capacity, eliminating a certain variable part due to absorption. Now if B, substituted for A, be balanced against a want of core C, substituted for B, and the same method of correction applied, we similarly get a value for C, in terms of the above constant value of B, practically independent of time of charges which may be taken as the constant capacity of C. So that for a laboratory or factory determination of the I.C. of a condenser or a cable core this plan ought to, and does in short, leave nothing to be desired for the elimination of difference of rates of absorption and the establishment of the constant value of the capacity.

When, however, we come to measurements of 1,000 or 2,000 nauts of cable, Dr. Muirhead's method ceases to yield correct results, apparently on account of the extra retardation of discharge by the resistance of the conductor. Abandoning it, therefore, we have, when using either the Gott or Thomson balances, values of the I.C. of the cable varying more or less with the time of charge (apart from leakage effect), and are led to seek some other means of getting at our constant or quasi-constant capacity. Dr. Muirhead has suggested for consideration that we should take the varying values of the condenser, determined by reference to his air standard when absorption is not eliminated, and use these for the different times of charging employed on different cables. This would give us the total increment due to the absorption of the cable, in place of the difference of the cable and condenser increments, and

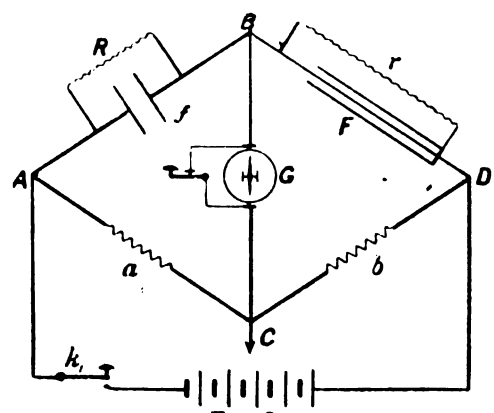

FIG. 3.

thus cause the results of tests by the usual Gott or Thomson methods to rise with time more rapidly than they otherwise do, though more consistently.

A more satisfactory solution of the difficulty has been arrived at, which I will describe presently. Before doing so, however, it is necessary to deal with the important factor of leakage. Referring to Fig. 1, we see that, as distinction has been made between the surface or "instantaneous," and the absorbed or residual charges, so the ultimate conductivity of the dielectric (shown in the diagram by the horizontally shaded area) may be treated as a separate factor in the problem under consideration.

Without entering into a description of the three well-known methods of I.C. measurement applicable to long submarine cables—viz., the Siemens fall of charge, the Thomson parallel charge, and the Gott "cascade" charge—let us examine the effect upon the capacities under comparison of their respective insulation resistances in the two latter methods. In Siemens's there is, of course, no leakage error, because the D.R. enters into the formula, an advantage which would place this test above the others beyond dispute were it not that it is incorrect for other reasons. Leakage on the battery, a matter of vital importance in the Thomson method—though not so in Gott's—we may assume to be absent, but it must on no account be forgotten when joining up for the former test. Its vitiating influence on results has indeed been one of the chief reasons for preferring Gott's method.

Both the Thomson and Gott are null methods or balances differing essentially in the circumstance that in the former the two capacities are charged in parallel, and in the latter in series or "cascade." For the purpose of investigating the leakage error, the diagrams of connections

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may be conveniently drawn as a bridge system. See Figs. 3 and 4, which represent the conditions during charging, f being the condenser capacity, F that of the cable, R and r their respective insulation resistances. In Fig. 4, balance is observed by closing k_2 without discharging. In Fig. 3 it is observed after mixing the charges by an arrangement of keys not shown, but it will be found that for the determination of the leakage error it is

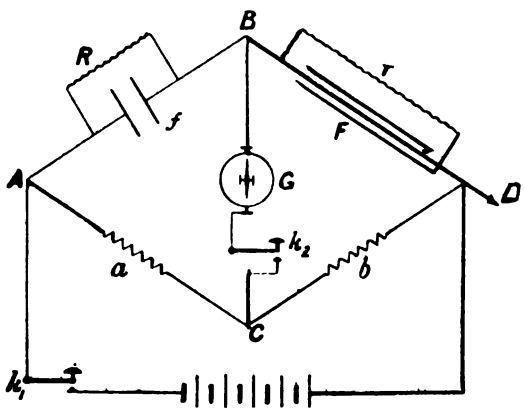

FIG. 4.

practically sufficient to examine the conditions during charging only.

(To be continued.)

DISCUSSION.

Mr. W. J. Murphy said the paper dealt with a thing which had bothered most of those who had had much to do with submarine cables, and he proceeded to refer to the difference existing between the modified Thomson test and the method which Mr. Young recognised as the best. Glancing at Gott's method, he remarked that this was usually adopted now as being better than the original Thomson method, owing to the fact that it lessened the influence of battery leakage upon the results. But in introducing his improvement with respect to leakage, Mr. Gott unfortunately led to the existence of a greater disturbance, due to the further charging of the condenser and the discharging of the cable through the dielectric of the latter. Mr. Murphy then reviewed in detail several points suggested by the paper, mentioning in the meantime that the author and he had originally intended to prepare the paper jointly, but that this was found impracticable, as they were in different regions and could not communicate with each other sufficiently to enable them to carry out their intention. He finally referred to some tests of a 150-naut length of cable he had assisted in laying into deep water, made with a view of ascertaining if temperature and pressure had any influence upon capacity. The conclusion he came to was that no effect could be detected so far as the true or "free-charge" capacity of the cable was concerned, but thought it possible the absorptive capacity of the dielectric may undergo some change, as certainly its resistance does.

Mr. Alexander Siemens said he would like to say a few words on the formula given in the paper. It was stated in this that "the time integral of current, or the electric displacement through a condenser can be expressed in the form

$$y_1 = \mathrm{K}x + \int_0^\infty xtw \{\psi(w) + \beta\} dw,$$

where the first term represents instantaneous capacity, the second residual charge or absorption, and the third conductivity of dielectric, separated for convenience, but really all parts of a continuous magnitude." Now, this appeared to be a subject which it would be well for young students to take in hand, to see how they could separate the three components of capacity. If a Leyden jar was charged a large spark would be got at first, and after some little time more sparks would be obtained. Something of the same kind of thing took place in connection with submarine cables when an impulse was sent through, but which made it difficult that the cables should be charged and discharged at a rapid rate. The usual formula to express this speed was K R, where K stood for capacity and R for resistance. But this was not quite correct, because the usual explanation of capacity had come to regard the insulating conductor as a tube and electricity as water which was to be run into the tube and then out of it. But you had not only to fill the tube in order to get water to the other end, but you must also saturate the spongy material. The great problem which the cable makers had before them was to reduce this spongy capacity—if he might so call it—as much as possible. That this was possible was clearly demonstrated by a table of cable speeds published some time ago by his firm, in which all the cables, and not only those manufactured by Messrs. Siemens Bros., showed that they did not follow the law of K R. Now, how very important it was to pay attention to this spongy factor. If they compared the two latest Atlantic cables made in England, they would find that the speed obtained on the "Commercial" cable, which was of 500lb. of copper and 320lb. of guttapercha to the mile, was something like 36 or 40 words a minute; while the speed on the other, the "Anglo-American" cable, which was of 640lb. of copper and 400lb. of guttapercha per mile was about 47. They were aware that the speed of speaking varied inversely as the square of the length of the cable, and after making all allowances he showed that the speed of the Commercial cable, if it were as short as the Anglo-American cable—viz., 1,850 naut-miles—would be equal to that of the latter cable; or, in other words, by attending to the spongy factor of the capacity they could increase the speed to such an extent that with a cable of 500lb. of copper and 320lb. of guttapercha per mile, it would be as quick as that of the 640lb. of copper and 400lb. of guttapercha to the mile.

At the meeting of the Institution of Electrical Engineers on April 27, the following were the candidates balloted for:

Members.—Captain J. N. C. Kennedy, R.E., S.M.E., Chatham; H. W. Young, 12, Camomile-street, E.C.

Associate Members.—H. G. Andrews, 8-10, Palmerston-road, Boscombe, Bournemouth; E. R. Hill, Bromley (Kent) Electric Light and Power Company, West-street, Bromley; W. Johnston, National Telephone Company, Lichfield-street, Wolverhampton.

Foreign Member.—E. Rasmussen, superintendent State railway telegraphs, Christiania, Norway.

Associates.—F. C. Dafforn, 62, Hampden-road, Hornsey; T. Heffernan, Courtlands, Holland-road, Kensington, W.; H. V. James, Croft-street, Pendleton, Manchester; L. H. Lander, Thorncliffe, Kingswood-road, Moseley, Birmingham; R. E. Parker, 19, Beaumont-road, Leicester; T. Plummer, Engineer-in-Chief's Office, G.P.O., London; G. E. M. Stone, 2, Holly-street, Sheffield.

Students.—W. Banner, 181, Ecclesall-road, Sheffield; A. A. Harris, 33, Grosvenor-park-road, Walthamstow, Essex; F. W Hewitt, B.Sc., 16, Clarence-road, Birkenhead; J. N. A. Houblon, 51, Moulsham-street, Chelmsford; A. M. Coombs, J. T. Irwin, K. C. Jacobsen, C. W. Marshall, and E. J. Morrah, Faraday House, Charing Cross-road, W.C.; J. G. Pointon, O'Reefe-street, near Gabba, Brisbane; C. H. Steele, 51, Moulsham-street, Chelmsford, Essex.

At last night's meeting of the Institution the following were the candidates balloted for:

Member.—W. H. Vincent, Corporation Electricity Works, Ashton-under-Lyne.

Associate Members.—E. E. Eccles, Fenton House, Lancaster; W. Hepworth-Collins, managing director and engineer-in-chief, Clondalkin Works, Clondalkin, near Dublin; W. J. Hill, Eastern Telegraph Company, Winchester House, Old Broad-street, E.C.; A. H. Johnson, 23, Grand-road, Wellington, New Zealand.

Foreign Member.—F. J. Sprague, Sprague Electric Company, 20, Broad-street, New York.

Associates.—C. H. Brandreth, West Mead, Fawdry-street, Wolverhampton; R. A. Buchanan, Dunfillan, Helensburg, N.B.; S. Crookes, Thanet-street, Claycross, Chesterfield; C. M. Davis, 60, Westborough, Scarborough; C. E. Goad, Corporation Electricity Works, Blackburn; J. Phillips, 81, Wood-lane, Treeton, Rotherham; A. F. W. Richards, Electric Supply Works, Reading; A. J. Wray, 163, Drummond-street, Carlton, Victoria.

Students.—F. Fletcher, 30, St. Thomas-road, Victoria Park, N.E.; F. H. Goodall, Lucknow-avenue, Nottingham; L. E. Sitzler, Faraday House, Charing Cross-road, W.C.; S. M. Tyson Cadeby Hall, North Thoresby, S.O., Lincolnshire.

FORTHCOMING EVENTS.

FRIDAY, MAY 5.

Iron and Steel Institute.—At 10.30 a.m., reading and discussion of papers; 9.30 p.m, reception at the Royal Mint.

Institution of Junior Engineers.—At 8 p.m., "Gun Construction," by Mr. W. H. Owston.

SATURDAY, MAY 6.

Institution of Electrical Engineers.—Students' visit to Messrs. Siemens Bros. and Co.'s works, Woolwich. Train leaves Charing Cross for Charlton at 9.20 a.m.

TUESDAY, MAY 9.

Royal Institution.—At 3 p.m., "Electric Eddy Currents," by Prof. Silvanus P. Thompson, D.Sc., F.R.S., M.R.I.; second (Tyndall) lecture.

WEDNESDAY, MAY 10.

Institution of Electrical Engineers.—At 7.30 p.m., "Electricity Meters," by Mr. H. M. Donsett (students' meeting).

FRIDAY, MAY 12.

Royal Institution.—At 9 p.m., "Magnetic Perturbations of the Spectral Lines," by Prof. Thomas Preston, M.A., D.Sc., F.R.S.

North-East Coast Institution of Engineers and Shipbuilders.—Closing business meeting of the session, Newcastle-upon-Tyne.

SATURDAY, MAY 13.

Institution of Electrical Engineers—Students' visit to the Telegraph Works of Messrs. Henley and Co. Train from Fenchurch-street to North Woolwich at 9.40 a.m.

Institution of Junior Engineers.—Visit to the Royal Arsenal Woolwich. Train leaves Charing Cross at 9.20 a.m.

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TO CORRESPONDENTS.

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IRON AND STEEL INSTITUTE.

The presidential address of Prof. Sir W. Roberts-Austen at the meeting of the Iron and Steel Institute yesterday, possesses an importance and an interest of wider scope than is usual in such addresses. The keynote of his address was the intimate connection with science and practice, and he exemplified his text by summarising the immense strides which have taken place in the manufacture of iron and steel during the century. He truly pointed out the immense influence the foundation of the institute has had in getting rid of trade jealousies, and in the bringing together of those interested to discuss questions and to give information freely on phases of manufacture of the utmost importance to the progress of the world. The scientific metallurgist has worked hand in hand with his practical colleague, with the result that progress has been, and is, extremely rapid. As Sir W. White pointed out in seconding the vote of thanks to the president for his able and valuable address, the user of the material is almost as much interested as the manufacturer in the progress; and often the user gives a fillip, as it were, to progress in that he demands from the manufacturers material of a kind differing somewhat from that offered. The value of the work of such an institution as the Iron and Steel Institute is not only in what it does, but what it suggests; and it is the suggestive part that takes the fancy of the user, inducing him to ask for something he thinks more suited to his wants than has been obtainable before. Although the address touches but indirectly upon electrical matters, it is none the less interesting. Restricting attention to the electrical use of iron and steel only — indeed, we might restrict attention still more to their magnetic properties, and suggest a vast field of work open to the student. Might not the micrographic experiments so closely allied with the names of the President, of Mr. Stead, and of Prof. J. O. Arnold in this country be extended to the examination of iron and steel used for magnetic purposes, and might we not by such means determine the mechanical structure of the most magnetic forms of the metal, and so aid manufacturers in supplying a material largely required in the industry? Without too much dreaming, it is just possible that there is a greater similarity in metallic conductivity than at present recognised, and that the differences are caused by means which will be henceforth determined by a micrographic or some other method. It may probably be stated without much danger of contradiction that both the crystalline construction and the composition of the steel alloy ought to differ when used for different purposes. At present we shall not be contradicted when we state that the best iron for transformer plates and other electromagnetic work is selected on the trial and error method, coupled with attention to chemical composition. But mechanical construction may well be more important than the exact chemical composition. Thus the material most suitable for bridge work is not the most suitable for use in building armatures or field magnets, and, so far as we know,

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no experiments of the kind described by Stead and Arnold as carried out for other purposes have been made having an electrical end in view.

THE TELEPHONE QUESTION.

Mr. Hanbury's speech to the deputation on this question on Wednesday will be read with some degree of amazement. The Government seems to have completely lost its head on matters of finance, and is evidently running in a direction that is fanatically socialistic. Our views on the telephone question have been too often expressed to be recapitulated again. It is quite certain that if they persist in the course in which they have embarked, at the next general election will come a rude awakening. There is no honesty in their policy, and the sentiment contained in the following sentence will cause a general secession of support: "The Government would establish such a rate in London as would cover the 10 per cent. royalty, as in other cases, and pay them a fair return for their money." The Government have nothing to do with profit; and if working for a profit is not indicated herein, it never was more clearly indicated. The Government has to consider the general welfare, and in no case to tax the users of an apparatus to the benefit of non-users. Either cheap and efficient telegraphy is for the benefit of the whole community or it is not. If not, the Government ought never to have purchased the telegraphs. The only consideration they have is to pay expenses, interest, and, in addition, the capital embarked, repaying the latter over as long a period as possible. The telephonic charges should be reduced to a point which ensures the due performance of these payments, and profits, outside of splitting pence, ought to be avoided. The taxpayers will prefer to keep their money and use it in their own businesses, rather than hand it over to a Government department to be used in competition with private capital and to make a profit to swell the revenue. We can understand waiting till 1911, but we cannot understand the present policy. It is perfectly evident that Mr. Hanbury does not understand what at any rate we mean by nationalisation, nor is it conceivable that he understands the teaching of statistics; but, of course, figures can be made to prove everything, and Mr. Hanbury would use his figures to prove his case, though those selfsame figures might be used to prove another case. Let us take an example of what we mean. The cost of transmitting a million telephone messages taken indiscriminately might be a certain number of pounds, or a part of a penny per message. If one man sent a thousand messages and another only one message, it might be argued by one that the large user was taxed to help the smaller, while it might also be argued that the men in either case paid the just amount for the service rendered. We are inclined to the latter view, while Mr. Hanbury evidently holds the former.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

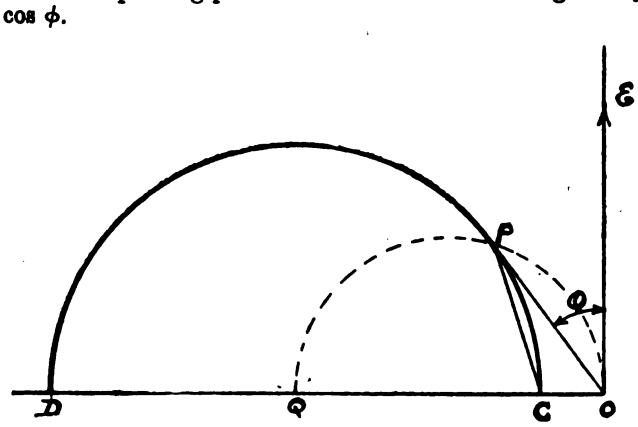
THE CALCULATION OF TWO-PHASE INDUCTION MOTORS.

SIR,—In accordance with your request of the 26th ult., I have pleasure in sending you the solution to Mr. Wilson's difficulty regarding the design of polyphase motors. The method of calculating the rotor quantities given below is a practical method, and, therefore, of course, not absolutely accurate, but I have found it to be quite good enough for all commercial purposes. Omitting explanations for the sake of brevity, the mode of procedure is as follows:

1. Let v_1 represent the stator leakage factor—that is, it is the ratio of the total magnetic flux produced by the stator ampere-turns to the flux that actually enters the rotor and cuts the winding, *when this latter is open.* Similarly, let v_2 be the rotor leakage factor—that is, the ratio of the total flux produced by the rotor ampere-turns to the flux actually entering the stator and cutting its windings, *when these are on open circuit.* Then write—

$$\text{Magnetic constant of the motor} = M = \frac{1}{v_1\, v_2 - 1}.$$

2. Referring to the annexed figure (which is the diagram of the polyphase motor), set off the line O E to represent the phase of the applied E.M.F. per phase of the stator, draw the line O D at right angles to it, calculate the magnetising current per phase from the known magnetic data of the motor, and mark it off to scale as O C. Now multiply the value of O C, so found by the motor constant, M, and set it off as C D. Upon C D describe the semi-circle, C P D. Then all such lines as O P represent the stator current per phase in magnitude and phase, and all such lines as C P are proportional to the rotor current. The corresponding power factor of the motor is given by $\cos\phi$.



3. In order to get the actual values of full-load stator and rotor currents, we make the allowable assumption that the maximum power factor of the motor occurs in the neighbourhood of full load. From the diagram it is evident that the angle ϕ is a minimum when the line O P is a tangent to the semi-circle. Hence describe the dotted semi-circle O P Q (point Q is the centre of semi-circle C P D), and join O P and C P. The magnitude of the stator current per phase is scaled off the diagram as the length of line O P. The motor current per phase is given by

$$\text{Length of line C P} \times v_2 \times \frac{Z_1}{Z_2},$$

where Z_1 represents the total number of stator wires in series, and Z_2 the total number of rotor bars in series, counted all round.

4. Having obtained the full-load rotor current per phase, C_R, we have

$$\text{Rotor loss at full load} = 3 \times C_R^2 \times R,$$

and the full-load slip as

$$\frac{3 \times C_R^2 \times R}{(W + 3 \times C_R^2 \times R)},$$

where R is the resistance per rotor phase, and W = 746 × horse-power on pulley at full load.

Knowing then the motor constant, M—in other words,

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the leakage factors of stator and rotor—the calculation of a polyphase motor becomes a matter of great simplicity. The value of the actual E M.F. induced in the rotor conductors does not come in at all, the motor being simply regarded as a transformer with an air-gap in its magnetic circuits, and the relations of the three currents alone coming in. Thus the tedious and inaccurate business of calculating torque and slip from the rotor E.M.F.'s (involving all sorts of complicated quantities and formulæ) is done away with.

If the magnetic circuits of stator and rotor are of the same character, and the style of winding the same in each case—for instance, drum windings in holes or slots upon each—then v_1 may be put equal to v_2. These leakage factors are capable of easy measurement from the finished motor, and do not alter much with the load or for different sizes. Their value lies between 1·02 and 1·07 in good and modern constructions.

The diagram given above does not take into account the motor (iron and copper) losses, which, however, modify it but little. All the errors of the construction are upon the right side—that is, the motor will come out somewhat better than the diagram indicates.—Yours, etc.,

49, Cannon-street, E.C., May 1. A. C. EBORALL.

THE ROYAL SOCIETY'S CONVERSAZIONE.

The conversazione of the Royal Society was held at Burlington House on Wednesday evening last, when a most interesting display of scientific phenomena had been arranged. Naturally many of the electrical exhibits had been shown before, but there were several new details to be seen. We were much pleased with a new influence machine designed and exhibited by Mr. W. R. Pidgeon, M.A. The sectors of this machine are embedded in an insulator, and the earthing brushes carry insulated inductors, kept charged by exploring points projecting through the insulation, and so arranged that at the moment of being earthed each sector stands between two similarly charged bodies; its capacity is then at a maximum and it receives a proportionately large charge. As the sectors move away from the inductors their capacity decreases and the potential rises, thereby producing an increased reaction on the opposite disc. The induction of the machine starts up almost instantly, its output is large, and it is not greatly affected by dampness or dust. Two of these machines were on view, and it was found that very small movements were required to give discharges. The improvement can be gathered from the fact that a movement of 17ft. of the plates was sufficient to charge a given Leyden jar, while a movement of 90ft. with the Wimshurst machine was required to give the same charge. Mr. A. A. Campbell Swinton showed some experiments with the Wehnelt electrolytic contact breaker, amongst which was one demonstrating that the glass when heated became a conductor for the discharge, somewhat in the same way that the filament of the Nernst lamp does from low-voltage currents. Some of the lamps were exhibited by Mr. J. Swinburne. Mr. W. Duddell showed his oscillograph for tracing alternate-current wave forms, and during the evening displayed on a screen the actual waves of potential difference and current in the following experiments: (*a*) non-inductive and inductive circuits supplied with alternating current; (*b*) the alternate-current arc; (*c*) an induction coil with the Wehnelt interruptor in use. Prof. W. F. Barrett, F.R.S.E., had on view a new thermo-electric combination giving a nearly constant E.M.F. through a wide range of changing temperature. This thermo-electric couple consists of a new nickel-manganese-iron alloy combined with the purest commercial iron as the second metal. It is found to have the remarkable property of giving a practically constant E.M.F. (3,700 microvolts) through a temperature rising from 450deg. C. to 950deg. C.—*i.e.*, a black to a bright red heat—the opposite junctions being kept at the temperature of the air. The alloy here used is found to have the enormous specific electrical resistance of 97 microhms per cubic centimetre at 15deg. C., and also a low variation of resistance with change of temperature. Prof. H. L. Callendar, F.R.S., exhibited some recording pyrometers of the platinum and thermo-electric type. The platinum pyrometer, in addition to recording the temperature, is also arranged to regulate the furnace to within 1deg. at 1,000deg. C.

THE RELATIVE IMPORTANCE OF TRAIN SIGNALLING INDICATIONS.

BY J. PIGG.

The signalling of trains, the methods employed, and their capabilities and limits are subjects of considerable importance to the public, but it is questionable whether they are at all understood by the average layman. Indeed, there is some evidence that further consideration of the relative importance of the different classes of signals and indications is desirable, even on the part of railwaymen themselves.

Broadly, the electrical apparatus employed is capable of transmitting, between the two points connected therewith, both *signals* and *indications* for the guidance of the signalmen engaged in controlling the traffic. By *signals* is meant all *exchanges* of code of a preparatory nature, whether given on the bells or on the dials; and by *indications* is meant the more or less permanent significant positions of the indicating apparatus, by which the condition of the line for the time being is shown. Such a distinction between "signals" and indications is perfectly natural, since their functions are entirely different.

Considering more particularly the single-needle form of indicator, we find that the number of indications provided for by it is three. These are "Line blocked," "Line clear," and "Train on line." The first indication is given by the normal position of the indicator, when not under the influence of a current. The "Line clear" and "Train on line" indications are exhibited by deflections of the indicator to the right and left of the normal position respectively, and are only maintained by the continued operation of a current. It is with the relative importance of these indications that it is intended to deal in this article.

Consider the following extracts from the regulations for signalling: "(1) When the block instruments are not in use the handles must be kept vertical; the indicators will then hang vertically, and when in that position will indicate 'Line blocked.' (2) Prior to the dispatch of a train conveying passengers from A, the signalman there, provided he has received the 'Train out of section' signal for the previous train, and the block indicator be in its normal position, must call the attention of B, and, having obtained it, must give the proper 'Is line clear' signal; if the line be clear at B, the signalman there must acknowledge the signal and peg the block indicator to the 'Line clear' position. The signalman at A may then, if the line is clear, take off his signals for the train to leave A. On the train leaving A the signalman there must send the 'Train entering section' signal to B, and the signalman at B must acknowledge the signal and peg the block indicator to 'Train on line.'"

Consideration of these extracts makes the meanings of the different indications very apparent. From the first it may be easily inferred that "Line blocked" represents the condition of the line when the section is unoccupied, and before permission has been given by the actual controller for a train to enter the section. Further, from the remaining extract we find that "Line blocked" is not only indicative, but also prohibitive, since, before a train may enter the section, specific permission must be given by altering the indication exhibited.

Considering the extracts further, we find that the actual controller is the signalman at the receiving end of the section, since it is he from whom the signalman at the entrance to the section receives permission to allow the train to proceed into the section. Such permission we see is given by the acceptance of the "Is line clear" signal, and the acceptance is confirmed by the exhibition of the "Line clear" indication, and its maintenance as long as may be necessary. Further, again, we see that limits are placed upon the offer of the "Is line clear" signal by the sending

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signalman, by the inclusion of the words, "provided he has received the 'Train out of section' signal for the previous train, and the block indicator be in its normal position."

A further extract makes the importance of the "Line clear" indication more apparent: "(3) After permission has been given for a train to approach in accordance with (extract relating to 'Is line clear' signal, etc., as given above), no obstruction of the line on which such train requires to run must be allowed until the train has been brought to a stand at the home signal, or has passed into the section in advance, or the cancelling signal has been received from the signal cabin in the rear. If the line be not clear, or if from any other cause the signalman be not in a position to give permission for the train to approach when the signalman in the rear forwards the 'Is line clear' signal, that signal must not be acknowledged until the signalman to whom the signal has been sent is prepared to receive the train, when he must give permission for it to approach in accordance with the prescribed regulations."

From this extract we see that the signalman who gives permission for the train to be allowed to enter the section, is prohibited from doing so unless the line under his control is clear, and, further, that, having giving permission, he is prohibited from permitting any obstruction on the line to the free passage of the train. Hence we see that the acceptance of the "Is line clear" signal, and the consequent exhibition of the "Line clear" indication, constitutes a change in the condition of the line of the most important character, since it removes the prohibition imposed by the exhibition of the "Line blocked" indication. It is, moreover, noticeable that no provision is made for cancelling the permission given by the signalman at the receiving end.

From the last sentence of the second extract we obtain an idea of the purpose of the "Train on line" indication. Careful consideration shows that it is the permanent acknowledgment of the "Train entering section" signal; that there is no asking or giving of permission for the passage of the train forward in connection with this signal; that it in no way changes the condition of the section relatively to the method of working; and that the only information afforded by it is that since, according to rule, it is to be exhibited "on the train leaving A," the train is passing or has passed out of the control of the signalman by whom the "Train entering section" signal is sent.

Consideration of the conditions under which the three indications are exhibited shows that the necessary permission to allow a train to enter a section is obtained, initially, by the acceptance of the "Is line clear" signal, and the exhibition of its permanent acknowledgment, the "Line clear" indication. We see also that the "Train on line" indication is, to all intents and purposes, of such a character as to indicate a change *in position* of the train for which permission has been given, and is not indicative of a change of condition of the line *from that of the previous indication*. Hence such an indication, whilst of considerable importance in itself, and with relation to subsequent movements is, relatively, subsidiary to the two other indications by which the occupation of the line being controlled is allowed or otherwise.

It may be observed that there are exceptions to certain of the rules for special circumstances, but as it is only intended to deal with the subject generally on this occasion, the exceptions have not been dealt with. It is only with the *relative* importance of the *indications* that the writer is concerned at present.

THE TELEPHONE QUESTION.

Mr. R. W. Hanbury, M.P., received on Wednesday afternoon, at his private residence, a deputation from chambers of commerce and other bodies, who asked the Government to purchase the National Telephone Company and work it as a department of the Post Office. The members of Parliament accompanying the deputation were Sir John Willox, Mr. Charles McArthur, Mr. Bond, Mr. W. F. Lawrence, and Mr. Spicer. The following report of the speeches is taken from the *Times*:

Mr. CHARLES MCARTHUR, in introducing the deputation, said it consisted of representatives of chambers of commerce and other mercantile bodies who wished to protest against the proposals embodied in the Government Telegraphs Bill, upon the ground that they failed to meet the requirements of commerce, and that they authorised the creation of a multiplicity of systems the working of which would be vexatious and unsatisfactory.

Mr. ALFRED JONES (of the Liverpool Chamber of Commerce) said the first action towards the nationalisation of the telephones was taken by the Liverpool Chamber, who passed a resolution declaring the expediency of the Government immediately acquiring the undertaking of the National Telephone Company "upon terms just and reasonable between the nation and the company's shareholders." This resolution was sent to all the chambers of commerce of the United Kingdom, and was very widely and generally approved.

Mr. HANBURY: But at the meeting of the Associated Chambers of Commerce the resolution in favour of nationalisation of the telephones was put forward and withdrawn. This deputation, I understand, only represents a very limited number of chambers of commerce.

Mr. CHARLES MCARTHUR explained that when the Associated Chambers met the delegates were not in a position to discuss the Bill just brought in by the Government, and that was the reason why it was not taken.

Mr. JONES said that the deputation represented 22 of the most important chambers as well as other bodies. If the municipalities were allowed to establish telephone systems along with the National Telephone Company and the Government it would lead to endless confusion.

The other speakers were Mr. WILLANS (Leeds), Mr. J. HARRISON (Edinburgh), Mr. J. ANDREWS (Cardiff), Mr. H. W. SPEAKMAN (Manchester Stock Exchange), Mr. JOHNSON (Middlesbrough), Mr. SPICER, M.P., Mr. BOND, M.P., Mr. W. F. LAWRENCE, M.P., and Mr. FIRTH (Halifax).

Mr. HANBURY, in reply, said he understood from the circular of the Liverpool Chamber of Commerce that they were strongly in favour of—first, nationalisation, and next the retention of the present subscription system. There was no doubt that a single system, whether in the hands of the National Telephone Company or the Government, or any other body, was theoretically and ideally the best. But when they talked of nationalisation, let them see what had been done already. There were, in the first place, the trunk wires, and in the next the local exchanges. The really national part of the service had been nationalised already—that was to say, everything which was not essentially local was already in the hands of the Government. In 1892 the policy was very carefully considered, and it was decided finally as a settled policy of the Government of the day, and adopted by its successor, that the national part of the work which was represented by the trunk wires ought to be in the hands of the Government. But there was really no strong and overwhelming reason why the local exchanges should be in the hands of the Government also. He did not know whether they had realised how essential the telephone service was as a local service at the present moment. Out of every 100 messages sent from any part of the country, 98 per cent. were purely local messages within the exchange. So that, after all, it looked as if that was a purely local service, which, unless there were very strong reasons to the contrary, might very well be left in local hands. Hitherto that service had been left, not exactly in local hands, but in private hands, and he was perfectly willing to admit that that system in those hands had not worked satisfactorily. That was why they proposed to put it into the hands of the local authorities. If he might describe the defects of the present system, they were these: In the first place, it certainly was anti-national, and not in the public interest of the country as a whole, that the company should in any district be able to give undue preferences, that it should be able when two tradesmen were in competition to say to one, "I will give you a service," and to the other, "I shall refuse you a service." That was an evil which the Government clearly thought ought to be done away with. Of course, it would be done away with by the deputation's suggested remedy, but it was also done away with by the

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Government's suggested remedy, because a public body like a corporation would never be allowed to give preference, and it would be one of the conditions of the license that it should be obliged to serve all alike and upon equal terms and conditions. The Government complaint was that the present system in the various localities was insufficient. Their object in handing over the work to a local authority was to give it to a representative body, representing all classes, which would be forced to serve all classes alike, and in their licenses they would lay down stipulations which would require a local authority to give a service also to those who occasionally wanted to use it, and who would find the toll system very convenient. With regard to intercommunication, one of the conditions that they should impose upon corporations would be that they should charge no terminals as against one another. The question of way-leaves was fatal to the present system. Of course, that could be met by a Government system, but it was also equally met by the system the Government recommended, because the local authority would take up its own streets for its own municipal telephone purposes, and so far as the municipalities were concerned, he was bound to say that it was more favourable than the other system. That was the principal reason why they had dealt with London somewhat differently from the other local authorities. It was not the Government's intention to sacrifice the rest of the country in order to give a good telephone service in London. The Government would establish such a rate in London as would fully cover the 10 per cent. royalty as in other cases, and pay them a fair return for the money. London formed an enormous area, which, he was bound to say, had been unduly extended in the interests of the National Telephone Company. The London County Council did not extend over the whole of the area, and it had not the control of the streets. Though he admitted that, ideally, the single system might be the best, the deputation had not pointed out any great advantages which would accrue from it at the present moment. By 1911 the Government would be in a totally different position, and if they then found that a national system was better, they were doing nothing at the present moment which would prevent their nationalising the system in that year. But he hardly thought the deputation had given full weight to the serious difficulties in the way of nationalisation. He doubted whether it was expedient, unless it were essentially a national service, to increase the amount of work done by the State generally. The Post Office was being overburdened with work in every direction, and he did not think that it was capable of taking this enormous additional burden. If the telephone service was cast upon the Post Office it would be to the detriment of both the postal and telegraph services. Then, again, it would increase enormously the Government staff. He need only appeal to the members of Parliament present to say whether they would like to have the weekly appeals for increase of wages from those State servants still further extended. He next came to the question of purchase. In 1911 no difficulties of purchase arose at all. The whole goodwill and everything except the bare plant fell into the hands of the Government. Was it wise, when the taxpayer was in that advantageous position in 1911, to anticipate events unnecessarily and buy up the company now upon terms which would not only involve buying up all its plant, a good deal of which was a single-wire system, and not a plant which the Government or any municipality would be allowed to use, and, in addition to that, to have to pay for the goodwill and those other little items which added so enormously to the cost? What were called "private wires" represented a large portion of the assets of the National Telephone Company which were entirely outside the Government monopoly. Supposing the Government were to buy up the whole of these wires, there was nothing to prevent the company from starting a fresh competition with regard to those private wires. Supposing they were to buy up the National Telephone Company at once, the Government would have to take over all their subscribers, who would object to the introduction of the toll system to bring in the poorer class. If this cry of nationalisation was made too loudly it might hamper proposals for bettering the present system, because the cry was very much in the interest of the company and of nobody else. If the Government bought now they would be buying the telephones as a monopoly before that fair and legitimate competition had come into play. There was an idea in the minds of the Telephone Company that if they were only safe over this year, and that licenses would not be granted beyond 1911, every year's postponement would be so much gain to them. The Telephone Company must not be deceived. This was no party proposal; and he was not so sure that any Government would again offer the exceptionally good terms which the present Government had offered them. Then, again, it would be perfectly fair—and the Government had the power—to extend the time of the municipalities considerably beyond 1911, and, therefore, the postponement need not necessarily benefit the Telephone Company. What the Government were doing was a gradual step in the direction of nationalisation, if practice and experiment should prove that it was necessary. In the meantime the Government would do their best to see that the present subscribers did not suffer, and they would endeavour to cheapen the telephone service. The Treasury minute would be out on Monday or Tuesday next, and he would be able to give further explanations when the second reading of the Telegraphs Bill came before the House of Commons.

The deputation then withdrew.

HIGHLAND WATER POWER BILL.

A committee of the House of Commons consisting of Sir J. Kitson (chairman), Captain Bethell, Mr. Warr, and Mr. Maddison, with Mr. Bonham Carter as referee, commenced the consideration of the Highland Water Power Bill on Monday last week.

Mr. POPE, Q.C., in opening the case for the promoters, remarked that the measure involved questions of more interest and importance than were usually met with in a private Bill discussion. To a certain extent its proposals were novel, and they were of what he might almost call national importance. It was a matter of common knowledge that the supremacy which Great Britain formerly held in the markets of the world with regard to certain industries had now been taken from her by some of her trade rivals. This was to be said of the chemical trade, which had gradually become a German industry. Within the last few years electricity has been made use of as a reagent in disintegrating masses to be dealt with in chemical manufacture. In the alkali trade, for instance, it was found that an electric current was a more powerful reagent that any which had hitherto been employed, with the result that, inasmuch as the employment of electric power depended on the cheapness with which it could be produced, the alkali trade was passing rather out of the hands of the British manufacturer and going into those of foreign manufacturers, who were able to avail themselves of the cheapest possible form of water power. The Bill was promoted by a number of gentlemen who believed it to be the essential duty of those who were interested in the industrial pursuits of the country to render available as far as possible the natural agencies existing at our own doors. These gentlemen included the Earl of Crawford, Lord Tweedmouth, Lord Kelvin, and Lord Farquhar. It was obvious, therefore, that this was no gingerbread scheme. The proposal was to raise the waters of Loch Ericht some 14ft. higher than at present by constructing a dam at the lower end of the loch. Water from the loch would then be conveyed through tunnels and aqueducts to the head of Loch Leven, where it would be used for generating power. It was believed that the utilisation of this power would bring together a manufacturing community on the shores of Loch Leven, which would be the embryo of a large manufacturing industry. The promoters did not propose themselves to engage in specific industries, but they had no doubt that if they could provide cheap power there would be plenty of applicants for it. There was a second and subsidiary scheme by which a large reservoir would be formed out of a series of small lochs extending westward to Loch Inbhir, and additional water power would thus be obtained. The plans of the promoters had created much enthusiasm in the Highlands, because it was believed that they would afford means of employment to the crofter population. One of the effects of the scheme would be to divert the surplus waters of Loch Ericht from Loch Rannoch and eventually from the River Tay; in fact, from the east to the west coast of Scotland. In order, however, to provide compensation water, the promoters proposed to dam up Loch Laidon and to periodically discharge

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from it into Loch Rannoch, and so into the Tay, sufficient water to compensate for the loss of the Loch Ericht water. The scheme was opposed by Sir J. Ramsden, Sir R. Menzies, and Sir J. Stirling-Maxwell, whose interests as landowners would be affected, as also by the County Council and the Town Council of Perth and the Tay District Board of Salmon Fishing, who objected to the diversion of the Loch Ericht water from the Tay.

The only witness called on Monday was Mr. C. MACRAE, chairman of the syndicate which is promoting the Bill. He stated that he was interested in a similar undertaking on the St. Lawrence River, and was an original subscriber to the Niagara scheme. He explained the details of the promoters' plans, and was still under examination when the committee adjourned.

At a subsequent sitting, Mr. MACRAE was cross-examined by Mr. Worsley Taylor, Q.C., on behalf of Sir Robert Menzies. He said that the time taken for the completion of the works was 10 years, but he hoped they would be completed in half that time. The promoters were willing to give reasonable compensation to Sir Robert Menzies for the disturbance to the deer, but if anything exorbitant were claimed it must have the result of killing altogether a scheme the first of its kind ever brought before Parliament. The district interfered with was almost as much a desert as the Soudan, and there was no demand there for water either for domestic or for manufacturing purposes. When Sir Robert Menzies realised the purposes for which this vast water force could be utilised, he desired to appropriate the idea by using the waters of the River Ericht for the establishment of a power station on his own property at the foot of Loch Rannoch. In this way he could only develop 600 h.p. to 800 h.p. per annum, and the cost of obtaining that small amount of power would far exceed any profit to be earned by selling that power for commercial undertakings. Sir Robert Menzies would have to come to Parliament for compulsory power to utilise the whole of the water of Loch Ericht in order to develop a power of something like 7,000 h.p. or 8,000 h.p. In these circumstances he was not entitled to much compensation in the shape either of water or of money.

Other witnesses were called and examined at length as regards the inteference with the salmon-fishing, water rights, etc., and as to the benefits the crofters would receive from the scheme.

After hearing evidence in support of the opposition of Sir Robert Menzies, the committee on Wednesday last decided that the preamble had not been proved.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

163. Detail the different tests you would make on electricity meters before putting them on circuit, giving the points to be ascertained, but not the methods of testing.—R. D.

164. In a Thomson-Houston meter the shunt coil is of platinoid and the rotating disc is of copper. How will the rate be affected if the temperature rises 30deg. C.? Temperature coefficient for platinoid = 0·00022; temperature coefficient for copper = 0·00388.—J. C. R.

ANSWERS.

Question No. 157.—What are the points to be attended to in switchboard design?

Best Answer to No. 157 *(awarded* 10*s.)*.—In designing central-station switchboards, utility and convenience should be the main considerations; appearance being a point of secondary importance, and consequently it need scarcely be studied.

Arrangement.—It will be found a most excellent plan to make the whole board up in a series of small panels of a size that is not too large for convenience in handling, and not necessarily uniform in size, but eventually arranged as symmetrically as circumstances will permit. Each panel should as far as possible be complete in itself—that is, as a feeder, dynamo, booster, battery, or balancer panel; and as such contain its ammeter, voltmeter and switch, main switch and fuse, automatic cut-out, etc., for each particular panel. The whole must then be arranged with due regard to the connections that require to be made at the back of the board, so as to get them as short as possible, and to prevent connections crossing. Overcrowding must not be allowed on the plea of wishing to economise space. It is false economy from beginning to end.

Framework.—The whole should then be mounted on an iron framework in preference to wood, of such a size that the highest meter on the board will come at a fairly convenient height from the platform, say about 8ft. or 9ft. high at most. American practice suggests cast-iron standards, connected together by channel or T irons, but owing to the fact that patterns would require to be made, it would be as well to make it up entirely of wrought iron. This can be done as follows: A suitable number of vertical T or L irons are used. These are bolted together by L irons at the top and base, the latter acting also as a sort of baseplate. A small channel iron is placed back-to-back across the vertical tees and bolted, being fixed rather lower than half-way down the vertical height, and on to this is rested the lower edge of the bottom row of slates, thus taking the strain of the corner bolts. The slates are then bolted to the vertical T irons, each iron taking the outer or adjacent edges of the slates, four holes being required for each slate for, say, $\frac{3}{8}$in. to $\frac{1}{2}$in. diameter bolts, according to size of panel or weight of switches, etc., on same. Owing to the fact that the corner holes in the slate have to be drilled rather far from the edge so as not to split it, say about $1\frac{1}{2}$in. or $1\frac{3}{4}$in., it will be found that a larger T iron than is really necessary to carry the weight will be required in order to get the two corner holes in adjacent slates through the support. This may be obviated by using a smaller vertical T iron, and at the corner of the slates a square wrought-iron plate may be fixed to it large enough to take the holes. A reference to

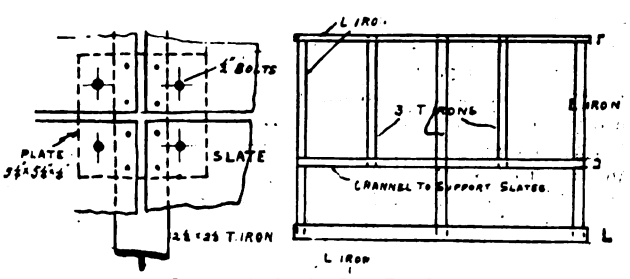

Diagram A, showing Iron Framing.

the sketch, A, will make this clear. Ebonite washers slipped on the bolts between slate and framework will serve to insulate the one from the other.

Base.—Various bases are used—marble, slate, and a composition. Slate is cheap and good, is easily worked, and for the better insulation should be enamelled after the holes are drilled, and not before. Marble is rather dearer, but has an excellent appearance. It is not so easily worked, and sometimes breaks when drilling if near the veins. The composition is very like marble in appearance, is very easily worked and is fairly cheap. The bases should be at least $1\frac{1}{2}$in. in thickness.

Extension.—By using L instead of T iron on the end supports, provision is thereby made for bolting any extension to, at any time. Blank slates or panels should not be resorted to ready for extensions, as they are likely to give the idea that the board was made larger than was necessary when originally built.

Insulation must be carefully attended to, as it otherwise gives rise to leakage. For voltages above 900, every bolt or pin or terminal that passes through the slate should be fitted into ebonite bushes, the latter should be fixed on the slate; for lower voltages this is not necessary.

Connections should be carefully arranged so as to get them as short as possible, and should be made by copper strip in preference to cable with sweating sockets on the end.

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The actual position really dictates the kind of connection most convenient, whether cable or copper strip.

Switches and Instruments.—The edgewise type of ammeters will be found exceedingly convenient on account of the small amount of space they require on the board. The chopper type of switch will form a useful companion to the edgewise instruments, as it does not take up so much room as the circular type, and also lends itself more readily to the attainment of a good break, which is of great importance in high voltages. Ampere-hour meters and recording volt and ammeters should not be placed on the board, but at the side or in any convenient place. Battery regulators should be placed on the board in a position nearest to the battery-room so as to shorten length of cable, which is usually a big item in this direction. The circular type is recommended both in the case of single and double (charge and discharge) regulators, the latter being of the concentric type. To give all the points to be attended to in switch design would take up too much space; the chief points, however, are: ample surface contact, liberality (but not too much) in metal carrying current, and a good long and quick break.

When these points have been fully attended to we may then give a little thought to appearance. For instance, a teak moulding, nicely polished, and a pediment on the top in the centre of the board, will greatly enhance its appearance. The clock, too, will be useful in any central station. C. D.

Answer to No. 157 (*awarded* 5*s.*).—To answer a question like this in the space allotted is almost like trying to discuss dynamo design fully in the same space. The subject of switchboard design is a very large one, and it is absolutely impossible to enter into any detail here, because the conditions of each particular installation determine largely the relative importance of the various matters connected therewith; and, as a matter of fact, the important points are not at all definite, because every consulting engineer has his own "fad," if one might use the word, and emphasises some particular point in connection with fittings, or frame, or insulation, as he thinks best, in the conditions he lays down. One very important point is that of insulation, and it is generally the custom to have the fittings belonging to one particular potential, say, arranged together on separate panels of the material used as the base for mounting. Thus all the positive switches and their accessories would be together, and all the negative similarly would be in one place. This constitutes a first sub-division of fittings. A further sub-division may be, according to the necessities of the case, to have the main switches on separate panels from the corresponding "distributing" or "feeder" switches and accessories. But this is much modified by taste, and, further, the strictness or laxity of insurance rules will determine the amount of sub-division necessary. In fact, a very good answer to the question might be obtained from a perusal of the various fire insurance office regulations. In some cases these are extremely and narrowly rigid, but usually they are fairly rational and sane. As to the material to be used for supporting the fittings, those most often used are slate and marble. Each has its advantages. Slate is easier to drill, but it is often very much broken up in drilling by reason of the layers composing it breaking away. Slate, too, rapidly weakens when many holes are drilled in it, and care should be taken to avoid crowding the fittings in any part. Marble is stronger in this way, but takes a good deal longer to drill, and is generally harder to work. Good marble will cost more than slate, especially if polished. In appearance, a well-enamelled slate is quite equal to polished white marble. The chief defect of both slate and marble is the metallic veins which occur here and there in the slabs. But with care these may be avoided, and good insulation will then be obtained from either. Another reason for avoiding overcrowding is that widely-spaced fittings, especially if they be at different potentials, will tend to neutralise the effects of bad insulation if such should be present. Means of securing good insulation are, therefore, to have sufficient sub-division of panels and to group the fittings suitably on the different panels, to select suitable slate or marble and to avoid overcrowding of instruments, switches, etc. With regard to the framework for supporting the slate or marble panels, this is, in small switchboards, usually made in wood, but in large boards iron is preferable. The writer has designed several lately with frames composed of channel-iron uprights about 3in. by 1½in. by ⅜in., with cross pieces to which the slates were fixed at top and bottom only. A light and strong framework is thus obtained, and the back connections are arranged more easily than in cases where there are large wood battens to avoid. The iron, of course, is also advantageous because it is fireproof. Such frames are finished with a light wood moulding, preferably of teak, merely for appearance's sake. The particular type of frame is largely determined by the number of panels to be fixed and their size.

The back connections should be as simple as possible, and should be run at a fairly low current density, certainly not more than 700 to 800 amperes per square inch. This is often specified as low as 500 amperes. They should be easily distinguishable from one another. In some cases they are painted different colours to denote different potentials, and this is a good idea, especially where there is any tendency to complication. These connections should always be of copper bar—not rod or insulated cable—as it keeps cooler at the same current density, owing to its greater surface for the same section. In some cases the connections are built up of thin strips to the requisite thickness and clamped together at intervals. This is sometimes advantageous where a variation in thickness is wanted, as it is easily obtained by stopping off as many of the strips as may be necessary. The connections from front to back of the board should be substantial, as the conditions for cooling are very bad when the conductor is entirely enclosed in the slate or marble. A word may be said, in conclusion, as to the appearance of switchboards. It is quite unnecessary to go to extremes in order to produce æsthetic effects. The writer knows of one case where it was specified that the switchboard should be of white marble with gold lines! This, of course, is absurd. But, on the other hand, a board may easily be spoilt by haphazard arrangement of fittings. Instruments, naturally, should be as near the level of the eye as possible—*i.e.*, not more than 6ft. from the ground—and the switches and other fittings which are likely to be oftenest used should be placed so as to be got at without stooping unduly. The board should be made as symmetrical as possible. In a word, the details of the switchboard, with the exception, perhaps, of the few matters mentioned above, cannot be set down according to any fixed rule, but must be arranged according to the dictates of experience and the conditions and specifications laid down in connection with the particular work for which the switchboard is designed.—T. C.

Question No. 158.—Supposing a dynamo (shunt, series, or compound) fails to excite, make a list of the faults or defects that should be sought or tested for, putting them in their proper order.

Best Answer to No. 158 (*awarded* 10*s.*).—The question does not state whether it is intended to apply to a machine which has been running for some time and suddenly breaks down, or to a machine just newly erected for testing for the first time. But in any case the following are the chief faults to look for, and they should be sought approximately in the following order, according to circumstances.

In the first place, make quite sure that the brushes are on in the right place on the commutator. In several instances in the writer's experience complaints have been made concerning dynamos which would not excite, and on examination it was found that the brushes had never been on at all! But even if they are on they may be in the wrong place—*i.e.*, the diameter of commutation may be either horizontal or vertical, according to the connections of the commutator—and if the lead be large, it is further important to see that the brushes start at the "no load" position. See also that the brushes are set properly relatively to one another—*i.e.*, that the various sets of brushes rest on strips separated from one another by the requisite angular distance. It may be that the armature is wound in more than one circuit, and in this case the brushes must cover more than one commutator strip at a time. It is important, therefore, to see that the brushes are of the proper thickness. One

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brush might be on a strip corresponding to one circuit, while the opposite was connected to an entirely different circuit. The machine would never excite in this case, of course.

Having ascertained that these particulars with reference to the brushes have been properly attended to, the machine may be started and run up to its proper speed. This, of course, is important, as the machine is not likely to build up its field very quickly if the speed is much too low. If under these circumstances the machine will not excite, it will be well to ascertain if the shunt winding is actually connected to the brush terminals. This, of course, applies only to shunt or compound machines. It often happens that the shunt wire is overlooked in connecting up. This is not so likely to occur in a series machine, where the defect would be noticed at a glance. If the connection is found to be all right, the next thing is to try for earth leakage. This is especially important in the case of a shunt machine, for if such a dynamo is short-circuited, it is evident from the characteristic curve that it will never excite up at all. A short-circuit may occur in the brush-rocker in a badly-constructed machine, or it may happen through a connection between the winding of the magnets or armature and their respective cores. This applies also to a compound-wound machine in which there are few series turns.

If the insulation is good, it may be that there is a break in the field winding. This is most likely to occur (if at all) in a shunt machine. If the winding is severed, somewhat extensive repairs will be necessary before the fault is remedied; but if no defect is found here, some other cause of trouble must be searched for. It is clear, by the way, in all these tests that the main leads from the machine, and the whole installation generally should be carefully tested for earths and short-circuits, as a fault there would, of course, prevent a machine from exciting; and it is preferable to make the search for faults with the machine disconnected if possible.

If the machine now refuses to excite, it will be advisable to change the shunts over by crossing the brush flexibles. For it may be that the direction of winding of either the magnets or the armature is wrong, and that the exciting current actually neutralises the field which has produced, or tends to produce, it. It must also be carefully seen to that the field winding is connected up so as to give the proper sequence of poles—*e.g.*, in a two-pole machine there might be two north poles instead of a north and a south. This naturally would prevent excitation.

If there be slight signs of a field, it is sometimes good to couple up the shunt windings in parallel (if there be two limbs), and this, giving an increased number of ampere-turns, may cause the machine to excite up and give some clear indication of the point of weakness. It is no use coupling up series windings in parallel, because this diminishes the number of ampere-turns, seeing that the current is not increased, as it is in a shunt machine, with the shunts in parallel, when the resistance is quartered, while the effective turns are only halved. In the case of a compound machine it is well to see that the shunt and series windings are not opposing one another, for in this case the machine might excite up light, but would quickly lose its field when load was put on.

The above are the chief sources of trouble in connection with the field windings. Provided that none of these defects are found to be the cause of non-excitation, attention must be directed to the armature. It may be that some of the coils are short-circuited, and the best way to discover this is to separately excite the machine from some other source where such is available, and then find which sections become overheated in the armature. These may be connected through a breakdown of internal insulation or through metallic dust between the commutator arms, and must be at once removed. Probably this will put matters right. If not, and if there are no short-circuits, continue to run the machine separately excited with the normal volts at the field terminals, and see if the armature gives out its normal output. If it does not, then, provided the machine is a new one, the armature is wrong in some way. It may be coupled up wrong internally; it may have a wrong number of circuits; it may, in extreme cases, be coupled up so that no circuit exists at all, or so that all the coils are short-circuited on themselves. The fault must be discovered and remedied. If after this no effect is obtained, the case seems fairly hopeless, and to be remedied would need an expert on the spot. In ordinary cases, the main trouble arises through breakdown of insulation or loose contacts somewhere; it is obvious, too, that many of the above tests will not apply to old machines, especially as regard armatures. But they have been all included to make the case as general as possible.—T. C.

Answer to No. 158 (*awarded* 5*s.*).—The failure of a dynamo to excite may be complete or partial, and the cause may vary according to the winding used, whether shunt, series, or compound. In setting forth the various defects which usually give rise to this failure, the writer has dealt, firstly, with those defects which apply to any dynamo, regardless of the winding, afterwards specifying those which are inherent to machines of each respective class.

1. One of the first points to observe, should a dynamo fail to excite, is the speed. This should equal, or even exceed, the number of revolutions for which the machine is designed.

2 The position of the brushes should be correct, and correspond with the diameter of commutation at no load, unless, of course, the machine is being started up on its load. A slight movement of the brush-rocker, backwards and forwards, generally assists a machine to excite.

3. Bad brush contact, or slight defects of the brush gear generally, is a common cause of a machines refusal to excite. It is, of course, liable to arise in any type of machine, and is of frequent occurrence with series machines, such as Brush or Thomson-Houston, in which oil is used to lubricate the commutator. In event then of a machine which has previously been running all right refusing to excite, examine the brushes carefully and see that they are clean, bearing well on the commutator and with reasonable pressure.

4. A broken contact in field coils is very liable to happen in smaller machines, where we sometimes find the coils connected by twisted joints or thumb-screw connectors. Such a defect might easily arise from an *overlook* should the fields have been disconnected for testing or repairs, and would be made apparent by a simple continuity test.

5. It is obvious that a dynamo which is self-exciting must possess a certain residual field. If from any cause this field does not exist, separate excitation must be temporarily resorted to. This defect is very common in new machines, whose fields, in the process of transhipment, have become magnetically neutral. It is also to be found in series machines in consequence of the relatively small proportion of iron to copper. The writer has found this to occur frequently, and a handy method of rectifying such a defect is to momentarily short-circuit the dynamo terminals with a convenient length of No. 16 or No. 18 copper wire.

6. A similar defect is that of reversed poles, which is generally due to lightning discharge, the earth's field, or the fields of neighbouring dynamos. Reversal is also liable to happen if accumulators are charged from a series or compound machine. On the other hand, the connections may be entirely wrong, with the result that the poles are reversed or opposed. A compass needle would prove of service in this case, and here again we must resort to external or separate excitation, for a time, in the proper direction.

7. Faults in brush-rocker, armature, or field magnets should now be tested for if above defects are absent. Should a fault exist it would be necessary to disconnect and test each separately, thus locating the fault. A fault in the brush gear is sometimes due to an accumulation of copper dust, which may also bring about short-circuiting of a number of the armature coils. Should such a state of affairs exist, the brush gear must be carefully cleaned and the armature well "blown out." Any further defect must be located by dismantling in the case of the former, and in the case of the latter by testing in order to discover and, if possible, locate a leak to frame or short-circuited coils. A fault in the field coils would also require to be tested

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for and located as nearly as possible. Inspection might suffice in some cases, and it is always well to examine metal bobbin flanges and the wires contiguous to them, as in many cases the insulation is inadequate and a leak to frame is the result.

8. Should the shunt-regulating resistance be left *full in*, a shunt (or compound) machine if able to excite at all would do so very sluggishly. This defect is very liable to happen, and is no doubt one of the first points to be looked into; but, as already stated, the writer has preferred to deal first with those defects which are liable to appear in any machine, whether series, shunt, or compound.

9. A "short-circuit" in the external circuit of a shunt machine will prevent excitation in much the same way as a "short" in the machine itself, and the reason is obvious. It should be located and removed, or burnt out. Under similar circumstances a series or compound-wound machine would *over-excite*, with the result that either the "short" would be burned out or its protecting fuses blown.

10. An open circuit will effectually prevent a series machine from exciting, and it is a good practice to test the circuit for continuity *before* starting up. An earth test could be carried out at the same time, as the effect of a leak would be similar to that referred to in No. 9, at least to the extent of overheating of the machine. In this case again the "break" or "earth" must be tested for, located, and rectified.

A M. O.

PHYSICAL SOCIETY.

At the ordinary meeting on April 21, 1899, Mr. T. H. Blakesley, vice-president, in the chair, a mathematical paper on "**The Effect of a Solid Conducting Sphere in a Variable Magnetic Field on the Magnetic Induction at a Point Outside**" was read by **Mr. C. S. Whitehead**. It is an investigation of the magnetic induction at a point outside a solid conducting sphere when magnetic disturbances are taking place in the dielectric envelope. An expression is given for the maximum value of the magnetic induction when the sphere becomes an infinite plate and the inducing system consists of an alternating current in a circular circuit whose plane is parallel to the plate—*i.e.*, when the maximum value of the induction tangential to the surface is zero. A second expression gives the maximum value of the magnetic induction normal to the surface for a point at considerable distance from the axis and just outside the plate. In this latter case, the maximum value of the induction tangential to the surface appears as a function of the maximum current of known frequency in the inducing circuit, the various dimensions in space of the system, and the permeability and specific resistance of the plate. From these equations, taking the most authentic values of the involved constants, the maximum magnetic induction normal to the surface for a sea-water plate is 44 times as great as it would be for an iron plate, and more than 3,000 times as great as it would be for a copper plate. The paper also shows that, for the purpose of induction telegraphy, to get the best effect the receiving coil should have its plane vertical—not horizontal: firstly, because the distance of the inducing circuit from the surface of the plate must in practice be small compared with the distance of the point from the axis, so that the maximum normal induction is small compared with the maximum tangential induction; and secondly, because the maximum *normal* induction varies inversely as the *fifth* power of the distance of the point from the axis, whereas the maximum tangential induction varies inversely as the fourth power of that distance. In conclusion, Mr. Whitehead applies his formulæ to the practical case mentioned by Prof. Lodge in the *Journal* of the Institution of Electrical Engineers, February, 1899, p. 805. Prof. Lodge there describes a horizontal receiving circuit, and states that with no condensers in the circuit he "was not usually able to hear anything" in the telephone. Mr. Whitehead calculates that under such conditions the theoretical value of the current in Prof. Lodge's horizontal secondary is 0·066 *micro*-ampere, but that with a vertical circuit the received current would have been 33 *milli*-amperes.

Mr. Blakesley observed that as a rule experiment proceeded theory. He congratulated Mr. Whitehead upon having settled from theoretical considerations that the vertical position of the receiving coil is best.

Prof. Everett said that the very elaborate method of analysis adopted in the paper appeared to be very clearly stated. He would like to know whether the inducing coil ought to be vertical as well as the receiving coil.

Mr. Appleyard thought that experiment had left no doubt as to the best position of both coils. The early investigations of Mr. Willoughby Smith and the later work of Mr. H. R. Kempe and Mr. Preece had proved that for the best effect both coils should be vertical. But large vertical coils were difficult to fix and expensive to maintain. It was this reason probably that led Prof. Lodge to try what could be done with coils placed horizontally.

Mr. Whitehead, in reply, said that his formulæ only applied to a horizontal inducing coil. He had not worked out the case of what would happen if the inducing coil itself was vertical. In the Flat Holm experiments both circuits were straight wires with their ends to earth, so that they really amounted to vertical coils.

LEGAL INTELLIGENCE.

NATIONAL SOCIETY FOR THE DISTRIBUTION OF ELECTRICITY BY SECONDARY GENERATORS, LIMITED, v. GIBBS.

Judgment was given in this case last week by Mr. Justice Cozens-Hardy. The company in the action entered into an agreement in 1883 to acquire the Gaulard and Gibbs alternate-current distribution patents, and now claimed (1) that the defendants might be ordered to assign the patents; (2) damages for breaches of agreement and warrants; and (3) repayment of a portion of the purchase money. A compromise was effected with Gibbs, and the action came on for trial against the other defendant on April 17, on which day and on April 18 the preliminary points referred to in his Lordship's judgment were argued.

Mr. Justice Cozens-Hardy, in his judgment, said that the form of the covenant was joint, and he did not feel justified in making it several. For these reasons the plaintiffs were not entitled to any relief against Gaulard's representative. The action was therefore dismissed with costs, and the counter-claim was also likewise dismissed with costs

PROPOSED MOTORCAR COMPANY.

Before Mr. Justice Day and a special jury the case was heard of Cock *v* Elieson. This was an action brought by Mr. John Cock against Mr. C. Prosper Elieson, an electrical engineer of West Kensington, for specific performance of a contract dated July 30, 1897. In the alternative plaintiff claimed damages for breach of contract. Mr. Jelf, Q.C., and Mr. D. Stewart Smith were counsel for the plaintiff, while Mr. Carrington represented the defendant.

It appeared that the defendant had patented certain improvements in relation to the driving gear and accumulators of motor-cars, and in July, 1897, he entered into an agreement with the plaintiff, who was the nominee of Mr. Martin Fradd, a financial agent, to transfer his patents to a company to be called the Elieson Lamina Accumulator Company, Limited, in consideration of his receiving £100 down, £900 out of the sale of shares, and 10,850 fully paid-up £1 shares in the company, and being appointed managing director of the company for five years at a salary of £600 a year. Plaintiff's case was that after the defendant had received the £100 and his salary at the rate of £600 per annum for something like 15 months he refused to transfer the patents. Defendant said he had always been ready and willing to carry out his part of the agreement if the plaintiff had performed his by paying him £900 and getting the company to transfer to him 10,850 fully paid-up shares and to appoint him as managing director at a salary of £600. The defendant further said that the company had offered 12,000 shares to the public, but only £10 was subscribed.

The jury found a verdict for the plaintiff for specific performance, and also awarded him £50 damages. Judgment accordingly, with costs.—*Financial News.*

THE ELECTRIC ORGAN COMPANY, LIMITED.

In the Chancery Division, on Saturday, before Mr. Justice North, Mr. Kerley moved for the appointment of a receiver in the matter of the Electric Organ Company, Limited, of Norwich, on the ground that the debentures were in jeopardy. Counsel stated that the company were unable to pay their debts, the company having lost £27,000, and some of the creditors were now in a position to issue execution, thus placing the securities in danger. The matter was an urgent one, and he asked that the Official Receiver of the Norwich Court should be appointed receiver. There was no opposition on behalf of the company, and his Lordship made the order asked for, with leave to act at once, subject to affidavits of fitness, and a completion of the security forthwith.—*East Anglian Daily Times.*

ACTION AGAINST ELECTRICAL ENGINEERS.

In the Westminster County Court on Monday, his Honour Judge Lumley Smith, Q.C., had before him the case of Gillings *v.* the Strand and Charing Cross Electric Light Company, in which plaintiff sought to recover compensation for personal injuries sustained owing, as he alleged, to the bursting of a fuse.

The **Plaintiff** was called, and said that on Jan. 3 he was employed at the defendants' works as a boiler setter, and whilst engaged in his work he was severely injured by the bursting of a fuse. His injuries were such that he was an in-patient at St. Thomas's Hospital for several weeks, and had been an out-patient ever since. He had almost totally lost the use of his left hand, and, according so the opinion of his doctor, he would never again recover the proper use of it. At the time of the accident he was earning an average wage of £2. 1s. 8d., and that sum was paid to him for six weeks, but after that time the defendants refused to pay anything.

In the course of cross-examination, the **Plaintiff** denied that accident was caused by his touching a naked wire. His contention was that the fuse burst, and so caused the accident.

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The defence was that although the plaintiff had been shown a considerable amount of kindness at the hands of the firm, they did not recognise any liability, as their case was that the plaintiff brought on the accident by his own negligence in touching a naked wire in which the current was running.

After hearing a considerable amount of evidence, his **Honour** gave judgment for the plaintiff, and assessed the damages at £1 a week from the date when the payment of the plaintiff's wages ceased.

TESTING AN ELECTRICAL BATTERY.

In the Westminster County Court on Friday the case of Hodges and Todd *v.* the Woodward Electrical Storage Company came on for trial before his Honour Judge Lumley Smith, Q.C. It was an action by the plaintiffs to recover the sum of £21. 11s. 7d. in respect of experiments carried out to the instructions of the defendant company in connection with an electric battery.

The plaintiffs' case was that in June of last year a Mr. Shippey, who was the consulting engineer to the defendant company, called upon Mr. Hodges and informed him that the company were desirous of making certain tests in connection with an electric battery, and that they desired to have one exhibited in the plaintiffs' showroom. After some discussion it was agreed on behalf of the plaintiffs that the work should be done for a sum of from 20 to 25 guineas, and on those terms the order was given.

The defendants, however, now refused payment on the ground that Shippey had no authority to give the order, and that therefore the defendants were not liable for payment.

After hearing the evidence for the defence, his **Honour** said he had come to the conclusion that the engineer Shippey acted as agent for the defendants, and therefore judgment would be for the plaintiffs for the amount claimed with costs.

COMPANIES' MEETINGS AND REPORTS.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY, LIMITED.

The report for the half-year ended Dec. 31 last to be presented at the meeting on 10th inst. states that the total revenue amounts to £79 104 (£72,332), showing an increase of £6,771. The working expenses amount to £43,179 (£37,774), an increase of £5,405. Including the amount brought forward, and the dividend receivable upon the shares held in the "Platino" Company, and after providing for income tax, interest on debentures and debenture stock, debenture stock redemption fund, and £9,000 to reserve fund, a balance remains of £21,087. The directors recommend the payment of 4s. per share, free of income tax, for the half-year on the ordinary shares, making, with the dividend paid in November last, 3 per cent. for the year, leaving balance of £1,608 to be carried forward. In the case of shares which have been divided into preferred and deferred, the 4s. per share now recommended will be payable—namely, 3s. 9d. to the preferred shareholders (making up the full dividend of £5 per cent. on these shares up to Dec. 31 last) and 3d. per share to the deferred shareholders.

INDO-EUROPEAN TELEGRAPH COMPANY.

The ordinary general meeting of the Company was held on the 27th ult. at Winchester House.

Mr. J. H. Tritton, who presided, said that the increased employment of the Wheatstone apparatus had satisfactorily increased the speed of their messages. When they had the new wire in use they would be able to deal with considerably more traffic if they could secure it. They had several measures, which would probably be commenced during the current year, in contemplation. Wireless telegraphy might be found useful for limited purposes and for limited distances, but the Board did not look on it as a formidable rival. The Company's revenue from all sources for 1898 amounted to £134,642, as compared with £130,347 for 1897, showing an increase of £4,295. The expenses were £74,346 (£69,378), an increase of £4,967; £15,000 had been placed to reserve, and this sum, together with £10,625 (amount of interim dividend), left a balance of £41,577. The directors proposed a dividend for the six months ending Dec. 31 of 17s. 6d. per share, making, with the dividend already paid, 6 per cent., and a bonus of 20s. per share, both free of income tax, making in all 10 per cent. for the year, carrying forward £9,702 to the credit of 1899.

The report was adopted, and the dividend approved.

CALCUTTA ELECTRIC SUPPLY CORPORATION, LIMITED.

Directors: Colonel A. J. Filgate, R.E. (chairman); E Boulnois, Esq., M.P.; P. V. Luke, Esq., C.I.E.; Sir Guildford L. Molesworth, K.C.I.E.

Second report of directors to be presented at the annual general meeting of the shareholders of the Company, at the City Terminus Hotel, Cannon-street, in the City of London, on Friday, 12th inst., at p.m.:

The contractors have made good progress with the erection and equipment of the generating station and with the laying of the mains. Possession of the site was not obtained until March 10, 1898, and the work of erection was not actually started until May 19. The buildings were, however, practically finished at the end of last year, and are reported to be a good example of a central station, comparing favourably with any station in this country, the chimney being mentioned as exceptionally well built. Owing to the difficulty in settling the question of the overhead wires with the Government, to labour troubles, and to delay in delivery of some of the materials for the mains, the supply of electrical energy to the public was not commenced as early as was originally contemplated, but the works were opened and current started on the 17th ult. At that time there were applications registered for 2,000 lights and for power for a considerable number of electric fans. As was reported at the meeting last year, the Government of Bengal have confirmed their promise to renew the Company's license at the expiration of the period of 21 years if the undertaking be not then purchased by the municipality or the Government, but this confirmation is now coupled with conditions which the directors do not consider satisfactory, and the question is still under discussion. The Government of Bengal, in consideration of the delay in settling the question of the mains, have altered the date for the commencement of the Company's license from Jan. 13, 1897, to Oct. 20, 1897. Application has been made for a large extension of the Company's area of supply embracing the south and south-west districts of Calcutta, including the Ballygunge and Alipore suburbs in which many Europeans reside, and which are still being built on for European residences. This application has received the formal approval of the municipality and only awaits the confirmation of the Government. The Board very much regret to report the death of Mr. Harrison Hayter, one of the directors of the Company. In accordance with the articles of association of the Company, Colonel A. J. Filgate retires by rotation from the board of directors, and, being eligible, offers himself for re-election. The auditors in London, Messrs. J H. Duncan and Co., chartered accountants, also offer themselves for re-election, and it is suggested by the Board that Messrs. Lovelock and Lewis, accountants, of Calcutta, should be appointed auditors of the Company's local accounts.

CITY AND SOUTH LONDON RAILWAY COMPANY.

A special meeting of the shareholders took place at the offices of the Company on May 2, when the provisions of the Bill "to confer further powers on the City and Brixton Railway Company for the construction of an extension railway and works in the county of London and for other purposes" were approved. The **Chairman** (Mr. C. G. Mott) stated that they had completed an arrangement last year with the City and Brixton Company by which they undertook to complete a portion of the line between its junction with their old line near the Borough Station, and after completion to lease it for a term of 999 years at £20,000 per annum, increasing by £1,000 up to £25,000. The City and Brixton Company were now asking Parliament to confer further powers upon them for the construction of certain works not included in the Bill already passed. They would not work the new line until it was handed over to them certified by the Board of Trade.

ANGLO-ARGENTINE TRAMWAYS COMPANY, LIMITED.

After the fifteenth ordinary general meeting of shareholders, held on Friday at Cannon-street Hotel, Mr. H. Doughty Browne in the chair, a special meeting was held, at which an agreement was ratified between the Company and the Argentina Electric Traction Company.

The **Chairman** explained that the Argentina Electric Traction Company had offered to supply electricity to the tramway and guarantee a minimum of 4 per cent. upon the Company's capital for five years, and also that this Company would be entitled to any additional profits proved to be earned during that time. After that period stock would be issued in payment for the outlay incurred, when the shareholders of the Anglo-Argentine would enjoy a 5 per cent. cumulative dividend, which would be a prior charge on the undertaking. The Traction Company were to pay all expenses of acquiring the concession for the conversion of the tramway, no liability being incurred on the part of the Anglo-Argentine Company.

NEW GENERAL TRACTION COMPANY, LIMITED.

Directors: Francis Pavy, Esq. (chairman); the Hon. Arthur G. Brand; Baron Emile B. D'Erlanger; E. A. Hopkins, Esq. (managing director).

Report of the directors to be presented at the third annual general meeting of the shareholders, to be held at the Cannon-street Hotel, E.C., on May 8, 1899, at 2.30 precisely:

The subjoined accounts show that the gross profits for the year were £17,517. 2s. 7d., to which has to be added £4,312. 15s. brought forward from last year, making a total of £21,829. 17s. 7d. Deducting from this £4,495. 12s. 9d., the amount of general expenses, salaries, etc., chargeable against revenue, there remains the sum of £17,334. 4s. 10d. as the net profit to be dealt with. From this the directors propose to write off £2,122, the remaining half of the cost of the issue of the new capital, which leaves a balance of £15,212. 4s. 10d. A dividend at the rate of 6 per cent. on the preference capital for the past year amounts to £9,000, and the directors recommend that this be paid, and the balance of £6,212. 4s. 10d. carried forward to next year. The work on the lines of tramways being constructed under this Company's direction has made good and satisfactory progress during the year. The new Coventry lines are near completion, and will, it is confidently anticipated, be opened in the course of the next two months; meantime, the section already open for traffic

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shows continually increasing earnings. The work at Norwich is proceeding satisfactorily. An issue of £100 000 of preference capital was successfully made in 1897; and in view of the already considerable expenditure of capital on the works in progress, and of further business lately undertaken, the directors propose to ask the sanction of the shareholders to a further issue of a like amount of preference capital. For this purpose meetings of the shareholders are called to approve of the creation of 20,000 new preference shares of £5 each, bearing 6 per cent. dividend and ranking *pari passu* with the existing preference shares. A considerable amount of new business has during the past three years been offered to the Company, but, after careful examination, only one proposal was accepted, the Board being anxious to confine operations to what appears to be not only profitable but also intrinsically sound business. The Hon. Arthur G. Brand is the director who retires, and offers himself for re-election. The auditors of the Company, Messrs. Deloitte, Dever, Griffiths, and Co., are eligible, and offer themselves for re election.

Dr. BALANCE-SHEET, MARCH 23, 1899.	£	s.	d.
Capital authorised and issued– 30,000 6 per cent. cumulative preference shares of £5 each, fully paid	150,000	0	0
24,000 ordinary shares of £5 each, fully paid	120,000	0	0
	270,000	0	0
Reserve	2,230	14	4
Creditors (including loans secured)	90,698	19	10
Receipts on account of uncompleted contracts including shares taken at par)	183,000	0	0
Profit and loss account—			
Undivided balance at March 23, 1898 £4,312 15 0			
Profit for the year to date 10,899 9 10			
	15,212	4	10
	£561,141	19	0

Cr.	£	s.	d.
Cash—in bank, £4,686. 16s. 10d.; in hand, £28. 5s. 5d.	4,715	2	3
Shares taken in part payment of work done (at par), and shares acquired (at cost)	281,400	0	0
Parliamentary and other deposits	21,736	12	8
Debtors	126	15	11
Furniture, etc.	450	0	0
Expenditure on uncompleted contracts	132,713	8	2
Goodwill, at cost	120,000	0	0
	£561,141	19	0

PROFIT AND LOSS ACCOUNT, YEAR TO MARCH 23, 1899.

Dr.	£	s.	d.
General expenses, salaries, directors' fees, interest, rent, travelling, legal charges, etc.	4,243	12	9
Balance down	13,273	9	10
	17,517	2	7
Remaining moiety of expenses of issuing 20,000 preference shares, less premium of 2s. per share	2,122	0	0
Liquidation expenses *re* Coventry Tramways Company, Limited	252	0	0
Balance carried to balance sheet	10,899	9	10
	£13,273	9	10

Cr.	£	s.	d.
Dividends received on shares in the Coventry Electric Tramways Company and the Douglas Electric Tramways, Limited	2,554	11	0
Profit on construction of tramways (subject to shares received in payment realising par value), and profit on engineering work	14,954	19	1
Transfer fees	7	12	6
	17,517	2	7
Balance down	13,273	9	10
	£13,273	9	10

BROCKIE-PELL ARC LAMP, LIMITED.

Directors: Right Hon. Lord Suffield, K.C.B. (chairman); Sir F. D. Dixon-Hartland, Bart., M.P. (vice-chairman); Hon. R. Brougham; H. W. Maynard, Esq.; W. Shrimpton, Esq. (managing director).

Second annual report of the directors, to be presented at the ordinary general meeting of the Company, to be held at Winchester House, in the City of London, on Monday, May 8, at 3 p.m.:

The directors have pleasure in submitting the accompanying profit and loss account and balance-sheet for the 12 months ending Dec. 31, 1898, being much more satisfactory than those of the previous 17 months, and showing a decided progress in the Company's business, and a general improvement in its profits and management. The profit and loss account shows a debit balance of £1,496. 15s. 5d. (as against £4,590. 0s. 5d. for the preceding 17 months), but this includes £301. 11s. 7d. written off the tools and patterns (as against £59. 12s. 3d. only in the previous account), legal expenses, £386. 6s. 9d., also £472. 12s. special payments made to close expert and former management expenses (amounting to £1,160. 8s. 4d.), the greater part of which are not likely to occur again. The sales of the Company's lamps during the last year show an increase of over 70 per cent. compared with the preceding 17 months. The Company have during the last year supplied their patent lamps to Ashton-under-Lyne, Morecambe, and Paisley, and their continued approval has been shown from their having received important repeat orders from the Corporation of Bristol, and from the Hammersmith, St. Pancras, and Shoreditch Vestries. They are now occupied on an important contract for some hundreds of lamps for the Great Central Railway. On the introduction of the chairman, the Company's lamps have been erected for H.R.H. the Prince of Wales at Marlborough House. Shortly after the last yearly meeting the directors, to get into closer touch with their shareholders, convened a meeting of those holding the largest number of shares, and in the result a committee was appointed, who went thoroughly into the affairs of the Company. That committee, which was presided over by Mr. Shrimpton, did most valuable work, and as Mr. Pell at this juncture resigned, the directors felt they could not do better than urge Mr. Shrimpton to accept the position thus vacated of managing director, which he eventually accepted on terms very favourable to the Company. The directors feel they cannot speak too highly of their satisfaction in the results of this appointment, as Mr. Shrimpton has shown himself most capable, energetic, and successful in the conduct of the business. The directors also, with a view to further economies, have reduced their fees to one-half, closed the head office, and moved the staff to the Company's works. The contract for the sale of the Belgian and French patents has not been completed, and the £500 paid as deposit has, therefore, been forfeited to the Company. Other negotiations are in hand, and the directors will continue to use their best endeavours to realise these patents. As intimated at the last general meeting, the directors had taken proceedings against Messrs. Johnson and Phillips (the late makers of the lamp) for continuing to make lamps which they were advised infringed the Company's patents. The directors, however, are glad to say such proceedings have been settled, that firm consenting to an order of the Court restraining them from manufacturing or selling Victoria lamps, and from in any other way infringing the said patents. Messrs. Johnson and Phillips have also undertaken not to issue any advertisements which may lead to the belief that they are entitled to manufacture or sell Brockie-Pell lamps or any lamps under license from the Company. In addition, the firm have paid to the Company the amount named in the profit and loss account for compensation. Nothing has on this occasion been written off plant and machinery, as this has been maintained in thorough efficiency. The inadequacy of the Company's works to cope with the Company's growing business is proving a serious difficulty, and the directors are carefully considering the question of larger and more suitable premises. Under the articles of association Lord Suffield is the retiring director, but, being eligible, offers himself for re-election. The auditors, Messrs. Mellors, Basden, and Co., also offer themselves for re-election.

TRADING AND PROFIT AND LOSS ACCOUNT, YEAR ENDING DEC. 31, 1898.

Dr.	£	s.	d.
Rent, rates, and taxes, electric light, coal, gas, and insurance	779	17	7
Salaries	2,514	14	7
Agency and travelling expenses	385	9	9
Advertising	241	1	11
Printing, stationery, and postages	207	2	10
Trade, office, and other expenses (including carriage)	324	5	3
Patent fees, etc.	189	18	0
Discounts and reserve doubtful debts	168	19	4
Moving plant	25	3	9
Loss on sale of plant	121	10	5
Directors' fees	766	13	4
Legal expenses	386	6	9
Repairs and additions to tools and patterns	301	11	7
Consulting engineer's fee	210	0	0
Compensation to officials in lieu of notice	262	10	0
	£6,885	5	1

Cr.	£	s.	d.
Manufacturing—gross profit	4,192	10	4
Transfer fees	14	8	6
Interest received on overdue calls	6	10	10
Option for sale of French and Belgian patents, etc.	500	0	0
Compensation for infringement of patents, etc.	675	0	0
Balance carried to balance sheet	1,496	15	5
	£6,885	5	1

BRAZILIAN SUBMARINE TELEGRAPH COMPANY, LIMITED.

The report for the half-year ended Dec. 31 last, to be presented at the meeting on 10th inst., shows a revenue of £115,159 and working expenses of £22.253. After providing £3,200 for debenture interest and sinking fund, and £1,943 for income tax, a balance of £87,762 remains. To this is added £18,212, dividends receivable from the Western and Brazilian Telegraph Company, Limited, and the London Platino-Brazilian Telegraph Company, Limited, and £8,964 brought forward from June 30 last, making a total of £114,939. First and second interim dividends amounting to £61,568 have been paid, and £30,000 transferred to the reserve fund, leaving £15,801 to be carried to the next account.

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WEST COAST OF AMERICA TELEGRAPH COMPANY.

The report of the directors states that the gross income for the year 1898 was £25,080. After providing for the working expenses (£18,840) and the interest on the 4 per cent. debentures, the net balance of profit was £239, and adding £34, brought forward from the previous year, leaves a balance of £273 to be carried forward.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Birkenhead.—The Corporation invite tenders for 100 electricity meters by 26th inst.

Edinburgh.—The Corporation invite tenders for two steam-driven fans for induced draught by May 22.

Edinburgh.—The Council are prepared to receive tenders for the supply of copper strip for electric conductors. Tenders by May 15.

King's Lynn.—The Corporation are prepared to receive tenders for the electric wiring and fittings of the Lynn Technical Schools by May 16.

Derby.—The Corporation invite tenders for the works in the superstructure in connection with the extensions to the electric lighting station by May 8.

London, W.—The Hammersmith Vestry invite tenders for erection of the buildings upon land adjoining the present electric lighting station by May 10.

Almaden (Ciudad Real), Spain.—The Municipality invite tenders for the installation of electric light and the working of the same for 20 years. Tenders by May 19.

Epsom.—The Urban District Council are prepared to receive tenders for the supply and erection of various electric plant. Tenders by 12 o'clock noon on May 8.

Hackney.—The Electric Lighting Committee of the Vestry invite tenders for trenching, troughing, cables, joint-boxes and jointing, and house services, by June 13.

London, E C.—The Directors of the Great Eastern Railway Company are prepared to receive tenders for the supply of various stores and materials. Tenders by May 11.

Talavera de la Reina (Toledo, Spain).—The Municipality invite tenders for an electric lighting installation and the working of the same for five years. Tenders by May 20.

Darlington.—The Corporation invite tenders for the supply and delivery of various plant, together with the fixing of the same, at their electric generating station. Tenders by May 30.

St. Marylebone.—The Guardians invite tenders for electric light wiring and fittings for the new front blocks of their workhouse, Northumberland-street, W. Tenders by 10 a.m. on May 8.

Salford.—Tenders are invited for supply of 5,000 tons of steel tramway rails, 7in. deep, 105lb. per lineal yard. Particulars may be obtained at the Borough Engineer's Office, Town Hall, Salford. Tenders by May 9.

St. Pancras.—The Vestry are prepared to receive tenders for supplying and fixing additional plant at the Regent's Park electricity works, comprising dynamos, engines, etc. Tenders by 12 o'clock noon on May 16.

London.—The Asylums Committee of the London County Council invite tenders for the installation of telephones, fire-alarms, tell-tale clocks, and call bells at the Heath Asylum, Bexley, Kent, by May 31.

Almaden del Azogue (Spain).—Tenders are invited for an electric lighting installation, and the preliminary deposit required is £60 to £100. Specifications, etc., are to be obtained from, and tenders addressed to, the Syndaco of the above town by noon on May 19.

Tarifa (Spain).—Tenders are invited for public electric light installation, and working of the same for 20 years. The deposit required is 5 per cent. of the tender. Specifications, etc., are to be obtained from, and tenders addressed to, the Syndaco, Tarifa, Spain.

Bangor.—The Lighting Committee of the Corporation invite tenders from parties willing to undertake the wiring of their district, on what is understood as the free-wiring system. Tenders to be sent to Mr. John Smith, clerk to committee, Bangor, by 6th inst.

Bexhill.—The Urban District Council invite tenders for the erection of an electric lighting station and chimney shaft in Bexhill. Specifications, etc., may be inspected at the Town Hall or at the offices of Mr. A. H. Preece, 13, Queen Anne's-gate, Westminster, S.W. Tenders by 12 noon on May 15.

Teneriffe.—Tenders are invited for the erection and working of an electric tramway between Santa Cruz and San Cristobal. The deposit required is about 776 214 pesetas (about £350). Specifications, etc., are to be obtained from, and tenders addressed to, Public Works Department, Madrid, by 1 p.m. on June 14.

Belfast.—The Electric Committee are prepared to receive tenders for the supply of coal required at the East Bridge-street electric light station for a period of 12 months from June 1, 1899. Specification, etc., may be obtained on application to Mr. Victor A. H. M'Cowen, city electrical engineer. Tenders by May 11.

Islington.—The Guardians invite tenders for the installation of the electric light at the new infirmary for the parish at Highgate-hill, Upper Holloway. Particulars may be obtained from Mr. William Smith, architect, 65, Chancery-lane, W.C., up to May 20 upon depositing £5, which will be returned on receipt of a bona fide tender. Tenders by June 1.

Darlington.—The Corporation invite tenders for the various works required to be executed in the erection of buildings to be used as an electric lighting station in the borough. Specifications, etc., may be obtained on payment of £2 2s. (which sum will be returned on receipt of a bona fide tender), from the Borough Surveyor, Town Hall, Darlington, on and after 15th inst. Tenders by 30th inst.

Hampstead.—The Vestry invite tenders for the supply, delivery, and erection of electrical plant, including steam alternators and engines, switchboard panels, boilers, feed-water heaters, vertical steam feed pumps, exciter, water-softening plant, air pump and condenser, Green's economiser, and overhead travelling crane. Particulars may be had of Mr. A. P. Johnson, vestry clerk, to whom tenders must be sent by 12 noon on May 18.

Fleetwood.—The Urban District Council invite tenders for the following: (Section 1) cast-iron lamp pillars and brackets; (2) street lamps for electric incandescent street lighting; (3) arc lamps and posts; (4) installation of wiring, switchboards, lamps, etc., for the electric lighting of the town hall, Fielden free library, public market, and slaughter-houses. Specifications, etc., can be obtained from Mr. Thomas Barton, Ainsworth-street, Blackburn, on payment of £2. 2s., which sum will be returned after a bona fide tender has been received. Tenders by May 16.

Prestwich.—The Committee of Visitors of the Prestwich County Lunatic Asylum invite tenders for steam-pipes, condensers and cooling tower, steam dynamos for 274 kw., mains, switchboards, storage batteries, and wiring for an electric light installation. Firms desiring to tender are directed to send their names, with a statement of the parts of the work they desire to quote for, to Mr. Charles Hopkinson, M.I.C.E., 29, Princess-street, Manchester: or to Messrs. Hopkinsons and Talbot, 26, Victoria-street, London, S.W. They will then be informed when the specifications are ready for issue.

Blackpool.—The Tramway Committee invite tenders for the taking up of the tramway line and conduit and the relaying of new tramway lines on the carriage drive between Church-street, and Adelaide-street. The contract will include the laying of rails, etc., excavating, concreting, paving, and making good the roadway. The Corporation will provide all ironwork and wood setts. The contractor to allow for running with pitch and tar (labour and materials. Specification, etc., may be obtained from Mr. J. Wolstenholme, borough engineer, St. John's Market Buildings, on deposit of £1, which will be returned on receipt of a bona fide tender. Tenders by 10th inst.

London, S.W.—The Vestry of St. Mary, Battersea, invite tenders for the supply and erection and the carrying out of work in connection with the electric lighting of the parish to specifications as follows: (Specification No. 1) feeders, distributing mains, and arc light leads, including laying and jointing; (2) water-tube boilers; (3) steam dynamos and engines. Specifications, etc., may be obtained from the Vestry Clerk, at the Municipal Buildings, Lavender-hill, S.W., on payment of £3. 3s. for each specification, etc., which sum will be returned after the receipt of the specification, etc., accompanied by a bona fide tender. Specifications and drawings can also be seen at (but not obtained from) the office of Prof. Alex. B. W. Kennedy, 17, Victoria-street, Westminster. Tenders by 12 noon on June 7.

RESULTS OF TENDERS.

Liverpool.—The Tramways Committee have accepted the tender of Messrs. Dick, Kerr, and Co., Limited, London, for 80 cars at £490 each.

Glasgow.—The Corporation have ordered from Messrs. D. Bruce Peebles and Co., Edinburgh, four 150-kw. sets for motor-generators.

Aberdeen.—The contract for a 200-kw. traction set for the Corporation tramways has now been given to Messrs. D. Bruce Peebles and Co., Edinburgh.

Batley Carr.—The tender of Messrs. C. Whitehead and Sons, Ravensthorpe, for the erection of the electric light station for about £2,000, and the tender of Messrs. Bruce Peebles and Co., Edinburgh, for the supply, delivery, and fixing at the station of one 110 kw. steam dynamo and Willans engine, have been accepted.

Doncaster.—The Electricity Committee have accepted the following tenders: The Electrical Power Storage Company, storage batteries, £1,323; Messrs. Edison and Swan, electrical instruments, £1,321. 10s.; Messrs. Callender and Co., cables, £8 689.

Hull.—The Electric Lighting Committee have accepted the following tenders for supply of South Yorkshire steam coal, from 1st inst. to Oct. 31, 1899: A. Bannister and Co., Minerva-chambers, Hull, Hickleton main coal, 14s. 8d. per ton; M. Strachan and Son, Collier-street, Hull, South Kirby coal 13s. 10d., Wath main coal 14s. 10½d.

Hull.—The Corporation Tramways Sub-Committee have received the following tenders for the construction of the new electric tramways upon the Holderness-road: Messrs. Turner, Heason, and Mitchell, Manchester, £19,933. 5s. (accepted); Mr. P. Smith, Manchester, £24,272. 4s. 4d.; and Messrs. Burton and Son, Hull, £26 391. 5s 10d.

Hull.—With regard to the tenders which were invited for estimates for an adequate installation of the electric light at the

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central higher-grade school and school of science in Brunswick-avenue, Beverley-road, we learn that one or two tenders have been returned unopened, as it is the Board's intention to prepare a special specification and readvertise.

Chatham.—The following tenders have been received for the electric lighting of the town hall and municipal buildings. The specifications were prepared by Mr. John Hewett, B.A., of Messrs. Harrap, Hewett, and Duffield, 34, Queen-street, London, E.C., consulting engineers to the Corporation:

	Wiring.	Plain Fittings.
Vaughan and Brown, Limited	£902 0 0	... £239 0 0
E. L. Berry, Harrison and Co.	924 14 0	... 156 1 3
Donnison, Berlyn, Sillem, and Co. ...	799 0 0	... 227 0 0
P. C. Middleton and Co., Limited, Edinburgh	867 0 0	... 126 8 0
Stevens and Barker, Maidstone (accepted).....	615 0 0	... 212 0 0

BUSINESS NOTES.

Gorton.—The District Council have received their provisional lighting order.

Limerick.—The tramways company intend to apply for an electric tramways order.

Dublin.—The application for the loan of £24,000 for the lighting extensions has been granted.

Cowes.—The District Council are transferring their lighting order to Edmundsons' Corporation.

Crewe.—The Local Government Board have sanctioned a loan of £26,000 for electric lighting purposes.

Aberdeen.—The Gas and Electric Lighting Committee have authorised various extensions of electric mains.

Newcastle.—Mr. Charles Hopkinson, C.E., M.I.C.E., is to be appointed consultative engineer for the tramways.

Cork.—The Corporation are considering an offer of the electric tramway and power company for public lighting.

Wrexham.—The provisional tramway order, as altered and approved by the Board of Trade, has been issued.

Wigan.—It is proposed to apply to the Local Government Board for sanction to borrow £90,000 for electric lighting purposes.

Grimsby.—The Town Council have decided to apply for a loan of the amount required for carrying out the electric lighting works.

Greenwich.—The District Board of Works have passed a resolution approving of the London County Council's tramway scheme.

British Electric Works Company.—It is reported that the capital of this Company, offered last week, was largely over-subscribed.

Memorial Hall, City.—This hall in Farringdon-street is about to be provided with an installation of the electric light throughout.

Penzance.—The Corporation have been successful in their opposition to the application of Edmundson's Electricity Corporation.

Parliament.—The Manchester Corporation and the Oldham Corporation Tramways Bills have passed the Committee of the House of Lords.

Halifax.—The question of the extension of the tramway from Halifax to Shelf is being discussed favourably by the Shelf District Council.

Weybridge.—The business of the Upper Thames Valley Launch Company has been acquired by Messrs. W. R. Edwards, A.M.I.E.E., and J. F. Beevor, A.I.E.E.

Sunderland.—During the past year the Corporation has made a profit of £300 in connection with the electric light, after providing for sinking fund and interest.

West Bromwich.—The Town Council are considering reports from two consulting engineers on the best methods of supplying and lighting the town with electricity.

Hillfoots.—A firm of Edinburgh electricians propose constructing an electric railway from Alva to Tillicoultry, and of lighting the three Hillfoot burghs with electricity.

Margate.—Operations have been commenced on the Margate portion of the line for the new electric railway. We learn that the work promises to be finished by June.

Ilford.—A committee of the Urban District Council is to visit Glasgow and other large towns to inspect the various systems of electric lighting and electrical traction in operation.

Birmingham.—The Museum and School of Art Committee have under consideration the desirability of lighting the whole of the museum and art gallery by means of electricity.

Derby.—The Light Railway Commissioners have submitted to the Board of Trade for confirmation an order made by them for the construction of the Derby-to-Ashbourn light railway.

Todmorden.—It is proposed that a committee be appointed by the Town Council to take into consideration the desirability or otherwise of erecting works for the generation of electricity.

Deal.—The Town Council have definitely decided not to entertain the electric lighting proposals of the Walmer District Council on the ground that their financial position would not allow them to do so.

Buxton.—The Electric Lighting Committee have offered to supply the Buxton Gardens Company at the rate of 6d. per unit and 4d. for every unit in excess of 4,000 units in one year for lighting purposes.

Teneriffe.—The concession for an electric railway at Teneriffe, referred to in a previous issue, has been granted by the authorities of the island to a Belgian syndicate, and the works are to be commenced shortly.

Coventry.—The City Council propose to purchase a piece of land adjoining the present electric light works at a price of 7s. 6d. per yard, but with a deduction in consideration of certain requirements being conceded.

Camborne.—The Urban District Council have appointed the following as a Lighting and Town Improvement Committee: Messrs. Negus (chairman), Holman, Berryman, Whitworth, A. H. Thomas, Bickford, and J. Vivian.

Dover.—At a special meeting of the Town Council on Tuesday, the resolution passed in the Managing Committee last week authorising the opening of negotiations for the purchase of the electric light works was confirmed.

Preston.—The Corporation have referred to a committee an offer from a company to take over and largely extend the tramways from the Corporation, and substitute a service to be worked by the overhead trolley system of electricity.

Removal.—Mr. A. C. Eborall, electrical engineer, has removed from 11, Queen's-road, Chelsea, to 104, Upper Tulse-hill, S.W. His City address is care of the Helios Electrical Construction Company, 49, Cannon-street, London, E.C.

Lanark.—The County Council and the General Post Office are corresponding about the intention of the latter of erecting telegraph lines along Shettleston-road, which, it is said, would interfere with the electric wires of the tramways.

Eastbourne.—A meeting in opposition to the electric tramways scheme has been held at Torfield. A special meeting will be held on the 25th inst. to determine upon the expediency of applying to the Light Railway Commissioners for a provisional order.

Leeds.—The profits derived from the tramways during the year ended March 25 last amounted to about £20,000. The receipts amounted to £114,000, including £48,000 from the electric section, as against £73,000 in 1897-8. Mr. Wharam's services are to be retained, and a traffic manager is to be advertised for.

Twickenham.—The District Council have settled an agreement with the London United Tramways Company, Limited, and rescinded the motion to oppose. Arrangements for opposing the Drake and Gorham project have been left to the clerk. The Light Railway Commissioners will hold their enquiry this month.

London Gazette.—(1) Adjudication: April 25, 1899, W. A. Charles, Leicester, electrical engineer, one of the partners of the firm of Charles and Co., trading as the Central Electrical and Engineering Company. (2) Winding-up order: April 26, 1899, the Electric Exploitation Company, Limited, Walbrook, E.C.

Leamington.—We understand that the Board of Trade are prepared to grant the Town Council a provisional order for the lighting of the borough under certain conditions referring to the rights of the Midland Electric Lighting Company, which for many years has been supplying light in the borough under an agreement with the Corporation.

Adams-Randall Telephone Patents, Limited.—This Company has been registered with a capital of £60,000 in £1 shares, and the objects are to carry on in all or any branches the businesses of constructors of telephones and telegraphs; to establish and maintain electric light, heat, and power works; to undertake the lighting of streets, etc.

Reading.—With regard to the successful application of the Corporation for powers in respect of the acquisition of the present tramway system in the borough, and its construction and extension, we learn that the Council in committee have practically decided upon the routes included in the extension of the tramways system, which will be worked on the electric overhead trolley system.

British Columbia Electric Railway Company, Limited.—The directors announce a dividend at the rate of 5 per cent. per annum on the preference shares. The profits for the year ended March 31 last, after deducting fixed charges and the preference dividend, amount to £16,283, and the directors recommend, subject to final audit, a dividend on the ordinary shares of 4 per cent. per annum free of income tax, which will absorb £8,275, and to carry £8,008 to special and general reserves.

Monmouth.—The engineer's report states that up to the present 1,685 8-c.p. electric lights have been applied for. The turbines now ready will only produce sufficient electricity for 1,400 lights, and, deducting 20 per cent. for waste, will reduce the power to 1,120. This is considered sufficient for the present, as all the lights will not be burning at one time. The question of providing another turbine, owing to the great number of private applications, will come before the next meeting.

Electric Cars.—The Tramways Committee of the Liverpool Corporation have had an opportunity of judging on their experimental line the efficiency of both German and American cars. They are evidently satisfied with the "home make," as the order for the 80 cars required has been placed with an English company. The successful tenderers are Dick, Kerr, and Co., Limited, of London, who are to supply 80 electric cars at a cost of £490 each. The total amount involved in the contract is thus £39,200.

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Notices.—Notices are published by the Mid-Suffolk Light Railway of intention to make application this month for an order to construct light railways from Haughley to Halesworth, Bedingfield to Debenham, Debenham to Westerfield, and Debenham to Needham Market; and by the Cork Electric Tramways and Lighting Company for the construction of tramways in the county of Cork, to be worked by electrical or other power.

General Electric Company, Limited.—This Company have acquired the business from Messrs. Gullette and Co., manufacturers of electrical apparatus of every description, White Horse Electrical Works, Cowcross-street, E.C., having purchased their tools and plant. We are informed that Mr. J. W. Gullette has permanently joined the staff of the General Electric Company as a technical manager in their Peel Works, Manchester, to superintend the manufacture of telegraph, electric bell, and telephone instruments.

Blackpool—At the quarterly meeting of the Town Council a statement was made to the effect that the income from trams was £18,220, expenditure £11,540, gross profit £6,680, interest £3,180, available balance £3,500. The cars had run 259,754 miles at a cost of 1½d. per car per mile. The receipts from the electric lighting were £15,580, expenses £8,044, gross profits £7,464, interest £5,324, available balance £2,140. In view of the expenditure upon new cables three years ago the charges for electric light cannot be reduced.

Guildford.—On a notice by the electric lighting company of an extension of their mains being discussed at the last meeting of the Town Council, the question was asked whether the Council had not the power to compel the company to lay their mains in the road instead of smashing up the new cement pavement which could never be properly repaired. The matter was referred to the Paving Committee. The Surveyor said the company preferred to place their cables under the footway, as they had not to go so deep as in the road, and they were nearer the houses for connections.

Batley Carr.—Since the mains were continued to the Oxford-road district nearly 1,000 lights have been connected, and there is yet a large number to connect. Instructions have been given to the engineer (Mr. O. M. Jonas) to extend the mains to Springfield-terrace, at an estimated cost of £188, and to the new premises to be erected at the bottom of Birkdale-road by Messrs. Leadbetter, at an estimated cost of £20. The cost of the further extension of the works will probably be about £1,000, and the work will be pushed on shortly, as the new engine and dynamo will be required for next winter.

Hull.—At the last meeting of the Works Committee of the Corporation the Chairman moved a resolution to the effect that, having regard to the possible cessation of work in connection with the building trade, and it being, in the opinion of the committee, absolutely necessary that the power station in Osborne-street, and the car-sheds on the Holderness road and Anlaby-road tramway routes, should be completed without delay, the committee be empowered to take such steps for securing the completion of the work as they may deem necessary. The motion was lost, six voting for and seven against.

Elmore Copper Companies.—A circular has been issued to the shareholders of Elmore's Patent Copper Depositing Company, Limited, Elmore's Wire Manufacturing Company, Limited, Elmore's Foreign and Colonial Patent Copper Depositing Company, Limited, and Elmore's American and Canadian Patent Copper Depositing Company, Limited, stating that the negotiations for the amalgamation of the above-named companies and for the provision of ample working capital are now completed, and that Messrs. L. Hirsch and Co. have subscribed a sum of £200,000 (free working capital) in cash to the new company.

Bath.—At a recent Town Council meeting a report was adopted which entails that the Council are of opinion that a tramway system should be initiated by the authority, and the necessary steps taken to secure this object. That portion which referred to the taking of steps on account of the cost of obtaining an order, however, was deleted. The Electric Lighting Committee have resolved to apply for a further loan in respect of electric lighting of £24,000, in addition to £54,000 already obtained and expended. The amount includes £11,000 for extension of mains, and £8,000 to cover extras incurred over contracts already completed.

Hawick.—The Board of Trade have made and issued a provisional order under the provisions of the Electric Lighting Acts, 1882 to 1890, with a view to the same being included in a confirmation Bill about to be introduced into Parliament, to the Urban Electric Supply Company, Limited, authorising them to supply electrical energy for public and private purposes within the whole of the burgh of Hawick, as constituted at the commencement of the order. It is provided that the company are to lay, within two years after the commencement of the order, distributing mains in North Bridge-street, High-street, Tower Knowe, and Sandbed.

Darwen.—The Corporation having recently purchased their tramways, are now about to convert them from steam to electric traction, and, as a preliminary, formed their Tramways Committee last week. Mr. Alderman Lightbown, B.A., J.P., C.A., was elected chairman, and Mr. Councillor J. W. Gillibrand, J.P., vice-chairman. The committee instructed the borough engineer (Mr. Smith-Saville) and the borough electrical engineer (Mr. Stanley Clegg), who are now carrying out an electricity supply scheme for the borough, to proceed with the details of work necessary for the conversion, with a view to letting the contracts at the earliest possible date.

Exeter.—The Electric Lighting Committee's report submitted to the Town Council last week states that since the last meeting 186 8-c.p. lamps had been connected, and appliances for 950 lamps of similar capacity were in hand. It had been decided that the price per unit for current supplied for power purposes be 3d. per unit, except from 4 p.m. until midnight, from Michalmas until Lady Day in each year, any current supplied during those hours to be charged for at the same rate as current for lighting. It had also been resolved that the sum of £100 be added to the estimated cost of the extension of mains. This amount is included in the proposed loan of £10,100 reported in our issue of last week.

Edinburgh—The estimates submitted by the Electric Lighting Committee show an ordinary expenditure for the current year, including sinking fund and contribution to the reserve fund, of £67,605. The estimated revenue was the same. The estimated contribution to the reserve fund was £6,475. The estimated expenditure for 1898-99 was £50,950, including a contribution to the reserve fund of £7,000, while the estimated revenue was £55,450. The actual expenditure for 1897-98 was £35,025, including a contribution to the reserve fund of £460, and the actual revenue for the same period was £38,049. The number of new lamps applied for between April 14 and 27 is equivalent to 7,778 8-c.p. lamps.

Enniskillen.—The Urban Council on Friday decided to light the new town hall by electricity. Messrs. Scott, the architects of the new building, laid before the Council an estimate of the cost of the plant for lighting with gas and electricity. In the case of gas the report showed that the expenditure on the plant would be £262. 17s. If a meter were required this sum would be increased by £20. Roughly speaking, £300 in all would be required for the gas plant. To put in the electric plant about £756. 3s. 6d. would be required, while the annual outlay in maintaining it would come to about £20 per year. The annual saving by the introduction of the electric system would amount to about £52 compared with gas.

Worcester.—We learn that while the City Council are deliberating as to whether they shall approach the Worcester Tramway Company with a view to purchasing their property, the directors of the company have secured the co-operation of the British Electric Traction Company with a view both to considerable extensions and the adoption of electricity for the motive power. The arrangements have been made with Mr. E. Garcke the managing director, and Mr. J. A. Lycett, superintendent of the Birmingham district. It is in contemplation to reconstruct the existing 3ft. lines on a 3ft. 6in. gauge, and to extend them in various directions, the overhead electric traction system being used. The carrying of agricultural produce, merchandise, etc., will also be catered for.

Appointments Vacant.—An engineer (working) is required for the Wilts County Asylum, Devizes. Salary £105, with unfurnished house, coal, gas, and garden. Applications by 10th inst.—The Corporations of Dewsbury and Eccles are both prepared to receive applications for the appointment of switchboard attendants at their electricity works.—The Electric Committee of Belfast are prepared to appoint an assistant electrical engineer, at a salary of £200 a year, with annual increments of £25 up to £250. Applications by 15th inst.—The Vestry of Fulham invite applications from engineers for the appointment of a clerk of works. Particulars of these and other appointments vacant and wanted, including travellers, draughtsmen, electricians, foremen, and wiremen, will be found elsewhere.

Tunbridge Wells.—The Council have an offer by the Telephone Construction Company for an experimental installation of the new automatic system at the town hall and other buildings under municipal control. The cost is to be £5. 10s. for each instrument, payment for the work of telephone constructors, and a royalty of 10s. per annum to be paid to the company for each telephone used by the Corporation. It is proposed that a four months' preliminary trial of the new system be adopted as an experiment. The borough electric light central station is to be greatly enlarged to meet the needs of the town in view of the growing demand for the electric light. The Tunbridge Wells Gas Company propose an extensive acceptance of the Welsbach system of incandescent lighting by gas in Tunbridge Wells, and are urging the Council to contract for this method of lighting. The electrical engineer has been instructed to report to the Council on the matter.

Earlestown Electric Supply Company.—With regard to the lighting of small districts, the following particulars of an installation successfully carried out by Mr. George H. Bentley, under the style of "The Earlestown Electric Supply Company," may be of interest. The machinery at present comprises a 14 b.h.p. "Premier" gas-engine, running at 200 revolutions per minute, and driving a 12-kw. generator at 980 revolutions per minute. The dynamo is capable of supplying some 200 16-c.p. lamps. The current is transmitted to various parts of the town by aerial conductors at a pressure of 200 volts. The machinery runs with unusual steadiness. Mr. Bentley also charges accumulators which are sent out to various residents in the district. He has on view some powerful arc lamps of about 2,000 c.p. The charge for current is 6d. per Board of Trade unit. The machinery was supplied by the General Electric Company, Limited, London and Manchester.

Whitehaven.—The statement of expenditure for the past year and estimate for the current year of the Town Council show a profit in the electric lighting account of £128 on the year's working. The generating of electricity has cost £777 as against an estimated expenditure of £821. The public lighting has cost considerably more than was estimated, £452 as against £337. The difference in this is attributed entirely to new tops and globes (arc lamps) required in place of ordinary lamps, and the whole cost of this was charged to revenue of last year. With

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regard to the income side a considerable excess in the amount for public lighting is shown. It was estimated at £1,300, and it actually amounted to £1,441. This, of course, was accounted for by the fact that the streets had consumed considerably more current than was estimated, because of the multiplication of arc lamps and the scarcity of moonshine during the period under review.

Southampton.—At the last meeting of the Town Council the Electric Lighting Committee submitted a report from the electrical engineer, which showed that the number of units sold during the month of March amounted to 30,082, being an increase of 56·7 per cent. over the number sold during the corresponding month of last year. An equivalent of 728 8-c.p. lamps had been connected during the month, and about 900 more had already been connected during the first half of the recent month. The report was adopted, as were also the estimates of the committee's receipts and expenditure. There has been an excess of expenditure over receipts, amounting to £1,800, for two years, but now a profit is being made. It has been suggested that the deficit should be spread over five years, so that the ratepayers might get some benefit from the works. The estimated profit is £182, but the Chairman said he had no doubt that it would be very much larger than anticipated.

Dundee and Broughty Ferry Light Railway.—The hearing of objections to the confirmation of the light railway order to establish an electric light railway between Dundee and Broughty Ferry was resumed before Sir Courtenay Boyle, at the Board of Trade, London, on Saturday. At the previous sitting the Caledonian and North British Railway Companies, as the owners of the Dundee and Arbroath line, opposed the confirmation, on the ground that the light railway was of such a nature that it ought to come before Parliament as a railway—that, in fact, having powers to take goods, minerals, and cattle, it was a railway scheme, competing substantially with the existing railway. Several witnesses were examined, and Sir Courtenay Boyle said the points were very important, the matter would be most carefully considered, and a communication would be addressed to the parties as soon as possible; the clauses would be gone into at some future date if the preamble was approved.

Stock Exchange.—The Stock Exchange Committee have appointed May 11 as special settling day for: British Electric Traction Company, Limited, further issue of 20,000 6 per cent. cumulative preference shares of £10 each fully paid up, Nos. 40,001 to 60,000; County of London and Brush Provincial Electric Lighting Company, Limited, provincial certificates for £200,000 4½ per cent. debenture stock; Folkestone Electricity Supply Company, Limited, 10,000 ordinary shares of £5 each fully paid, Nos. 1 to 10,000; Potteries Electric Traction Company, Limited, 13,334 ordinary shares of £10 each fully paid, Nos. 26 667 to 40,000, and 20,000 5 per cent. cumulative preference shares of £10 each fully paid, Nos. 1 to 20,000. The committee have ordered the issues of the British Electric Traction Company, the County of London and Brush Provincial Electric Lighting Company, Limited, and the Potteries Electric Traction Company, above referred to, to be quoted in the official list.

Islington.—A memorial signed by 10 residents in St. James's-road was received at the last meeting of the Vestry asking that that roadway might be lighted by electricity. It was stated that the roadway had been recently viewed with the object of laying down the conduits for the electric lighting of the roadway. At an ordinary meeting of the Vestry to-day the Electric Lighting Committee will report upon the proposed extension of the electric lighting mains to the Hornsey Rise and Newington Green districts and the lighting of the thoroughfares in the Highbury New Park district by means of arc lamps, recommending that upon receipt of the sanction to the borrowing of the necessary funds the several works referred to in the engineer's estimates be executed. The engineer's report states that in the Hornsey district 105 street arc lamps would be sufficient, and in the Newington Green scheme 56 lamps would be required. The estimates are: for Hornsey, £34,000; for Newington Green, £26,000; and for Highbury street-lighting, £7,150.

Fulham.—In our issue of the 21st ult. we published Mr. F. H. Medhurst's report to the Electric Lighting and Dust Destructor Committee of the Fulham Vestry on the tenders for the electric lighting works. The committee recommended the Vestry to accept the lowest tender—namely, that of the General Electric Company, Limited, whose price was £44,968. 7s. 10d., subject to the design of their dynamos being deemed satisfactory. An amendment was, however, carried, referring the matter back to the committee, with powers to advertise for tenders if they saw fit. At a meeting of the Vestry on Wednesday 3rd inst., this committee reported as follows: "We have referred the tenders for the supply of mains, machinery, and plant to our Permanent Sub-Committee, together with the letters received from the General Electric Supply Company, the Electrical Trades Union, the General Electric Construction Company, and the Brush Electrical Supply Company, for their careful consideration, and with instructions to report at an adjourned meeting of this committee, to be convened for Monday next."

Crystal Lamp Company.—We have received from this Company, with which Messrs. Rose and Bird are associated, their list of electrical lamps. In the front of the catalogue there is given two views of the factory in Bedford at which these lamps are manufactured. We take it that the size of the factory in some way indicates the great business which the Company is doing with their incandescent lamps. As regards the lamps themselves, full details are given of various makes, including the standard 3½ watts per candle-power, the high-voltage lamps and those for high-efficiency work, which give a candle-power with an expenditure of from 2½ to 3 watts. At the end of the list a number of fancy and ornamental examples are illustrated, in which the glass bulbs are moulded in various designs to improve the general appearance of the lamp. We take it, however, that all such devices more or less decrease the high efficiency of the lamp as a source of light. The Company also specialise lamps in which one-half of the glass is silvered, and, again, other lamps in which certain portions of the globe are frosted. The catalogue will be found exceedingly handy for reference.

Portrane.—With reference to the electric installation at Portrane, in connection with which the Governors passed a resolution protesting against the action of the Board of Control in accepting the terms of a Belfast firm in preference to that of a Dublin firm, the *Dublin Evening Mail* states, in a report of a recent meeting, that a letter was read from the Board of Control stating that the lowest tender was that of Mr. Drennan, of Belfast, at £9,436. 17s., but he subsequently withdrew it owing to a rise in the price of materials. The next lowest was that of Messrs. Port, Sykes, and Co., Dublin—£9,908. 9s. 6d.—but this tender was not in accordance with the specification, and could not be considered. The next lowest tender was that of Walsall Electric Company at £10,858, but they withdrew it subsequently. The next lowest tender was that of Messrs. W. Coates, Belfast, at £10,892, and it was in strict accordance with the specification. This firm had carried out contracts in various other institutions, and had done the work in a satisfactory manner. The next lowest tender from Dublin, in accordance with the specification, was £942. 3s. 6d. above that of the accepted Belfast firm.

Camberwell.—The Electric Lighting Committee have submitted a report to the Vestry on the accounts of the County of London and Brush Provincial Electric Lighting Company for the year ending Dec. 31, 1898, which were before the Vestry at its last meeting, and also whether it is desirable that the Vestry should purchase such undertaking under the terms of the provisional order granted in 1896. The committee state that in order to enable the Vestry fully to understand on what work the County of London and Brush Provincial Electric Lighting Company has expended the sum of £45,932. 17s. 9d., it will be necessary to have the opinion of an expert in electricity to fully advise the Vestry thereon, and recommend that they be empowered to engage the services of an expert, at a fee not exceeding 50 guineas, to fully advise the Vestry upon the question of the works already carried out by the County of London and Brush Provincial Electric Lighting Company, and also upon the adaptability of the mains laid down in the parish to be used in connection with the generating station to be erected in the parish of Camberwell, and to generally advise upon the whole question of the acquisition of the electric light undertaking.

Personal.—Mr. Alfred Lucas, on retiring from the position of superintendent of mains in the electric light department in Sheffield, was on Saturday last presented by the staff with a handsome testimonial, consisting of marble clock, ornaments, and salver. Mr. Lucas, who has accepted an appointment with the British Thomson-Houston Company, has been associated with electrical developments in Sheffield for the past 14 years.—Mr. A. P. Hudson has been appointed assistant electrical engineer to the Stafford Town Council.—We understand that Mr. C. M. Mayson, who is in charge of the electric lighting works at Whitehaven, has just accepted a remunerative post with the Charing Cross and Strand Electricity Supply Corporation. He will enter upon his new duties on the 1st proximo, and we wish him every success in his career in London.—Mr. C. H. Furness has been appointed, out of 35 applicants, borough electrical engineer of Devonport, at a salary of £300 per annum.—Mr. V. A. H. M'Cowen, the city electrical engineer, Belfast, last week presented Mr. M. C. Olsson, in the presence of the staff, with a handsome travelling bag, as a token of their esteem and goodwill, on the occasion of his departure to take up a responsible post at Dublin.

London County Council.—The Highways Committee have submitted to the various vestries and boards of work of the Metropolis a scheme for the extension of the existing tramway system both north and south side of the Thames. All the new lines are to be worked by electricity. They include the extension of the existing lines over Waterloo and Blackfriars bridges; lines from Streatham to Thornton Heath; from Balham-hill-road to Wimbledon; from High-street, Clapham, to Kingston and to Tooting; from Newington-causeway a line to Duke-street; from High-street, Peckham, to the Crystal Palace and Lordship-lane; from Catford to the Crystal Palace and to Southend village, near Beckenham; from Blackheath-hill to Shooter's-hill-road; from Greenwich through the Blackheath Tunnel to the East India Dock. In North London a large number of extensions are proposed. The Standing Orders Committee of the House of Commons have refused to suspend orders to allow the procedure this session of the Bill to empower the Council to use one or more of the following systems of electrical traction—viz., conduit, trolley, or surface contact—on its tramways, and for that purpose to reconstruct the tramlines, owing to the opposition of the Wandsworth District Board and the Vestry of Lambeth. Notices under Electric Lighting Acts and Orders from the House-to-House Electric Light Supply Company have been agreed to. The Vestry of Hammersmith, under the Hammersmith Order, 1893, are also extending their mains.

Acton.—At last week's meeting of the District Council the Chairman alluded to a circular letter sent by Sir Richard Nicholson respecting certain resolutions adopted by the Council in regard to light railways in the county. Mr. Corrie Grant referred to the opposition last year against the North London Company's applica-

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tion for powers to construct light railways covering the whole of North Middlesex, so as to link them on to the present system of tramways, and to the rejection by the Light Railway Commissioners of the application of the North Metropolitan Tramway Company on the ground that the local authorities had so opposed the scheme. He suggested, as the Middlesex County Council had announced at the end of the enquiry that they had been considering the advisability of applying themselves, that the District Council should strongly support the action of the Middlesex County Council in this matter, as he thought the control of the highways should be in the hands of the local authorities, and not under the control of a private company. The question was referred to a committee. At the same meeting a letter was received from the secretary of the English Industrials, Limited, asking if the Council was open to deal with them with reference to supplying the electric installation for the Acton district. Other letters have been received on the same question, and these were all referred to the Electric Lighting Committee.

Heckmondwike.—Mr. Hawtayne's report in connection with the proposal of the District Council to establish a system of electric lighting, which will probably come before the Council at their next meeting, contemplates an expenditure of over £13,000, and anticipates a gross revenue of £2,350 per annum, which, if realised, would be sufficient to meet all charges and leave an annual profit of £229. The scheme is based on a demand for at least 6,000 8-c p. lamps, apart from the public lighting in those parts of the town where cables might be laid for supplying the private demand. The low-tension continuous current system is recommended, and it is pointed out that the public baths can be heated from the electricity works, with considerable saving both as to capital expenditure and cost of maintenance. Also if the proposed light railway should be constructed from Dewsbury to the Spen Valley, an arrangement might be made with the company for a supply. The estimated cost of the scheme is set out as follows: buildings, £3,000; generating plant, £5,500; underground mains, £2,310; public lighting, £200; public arc lamps and pillars with mains, etc., £280; house connections and meters, £1,000; legal and expert services and contingencies, £1,000—making a total of £13,290. The gross estimated income is made up thus: 6,000 lamps, consuming 96,000 units at 5d., £2,000; rent of meters, £75; public lighting as per present gas account, say £175; add eight arc lamps at £12. 10s., £100—or a total of £2,350; and the net estimated result is as follows: gross revenue, £2,350; works cost, 129,400 units at 2·63d., £1,422. 10s.; gross profit, £927. 10s.; repayment of capital and interest, £698. 5s.; which leaves a profit, available for reduction of rates or other purposes, £229. 5s. Mr. Hawtayne strongly advises the Council neither to sell nor lease their provisional order, and to work it themselves. We learn that the Dewsbury Corporation have offered to supply Heckmondwike at 4d. per unit.

Manchester and Stockport Corporations' Bills.—A petition by the Stockport Corporation against the Manchester Corporation (General Powers) Bill was considered by the Court of Referees of the House of Commons last week. In the Bill there is a clause to enable the Corporation of Manchester to take from districts adjacent or near to the city their electric lighting orders if these districts wished to transfer them to the Corporation. Power was obtained under the Manchester Corporation Act of 1897 to do this in respect of districts adjacent to the city, but the Corporation wished this power extended so as to apply to districts near to the city. The Stockport Corporation having in view the supply to Heaton Norris, a district abutting on Stockport and lying between Levenshulme and Stockport, contended that if any transfer was to be made it should be to them. The Manchester Corporation objected to the *locus standi* of Stockport Corporation, inasmuch as the Heaton Norris lighting order made provision for the transfer to any company or person subject to the approval of the Board of Trade. The promoters therefore contended that their clause did not prevent Stockport appearing before the Board of Trade and trying to induce that body to consent to the transfer being made to them if Heaton Norris so desired. The Stockport Corporation *locus standi* was disallowed. The Stockport Corporation Bill was next considered by the Court of Referees. Under the Bill the promoters seek power to arrange with adjoining local authorities for the working, leasing, etc. of tramways. They also seek running powers, with consent, in neighbouring districts; but if the consent is not given they ask that the Board of Trade should be empowered to appoint an arbitrator to determine whether such consent was reasonable and should be given. The Manchester Corporation petitioned against the Bill, on the ground that if a clause as to running powers were granted it might enable Stockport to run through into the city of Manchester lines, which, Manchester contended, should not be the case, and would be quite contrary to precedent. Here, in turn, it was decided that Manchester had no *locus standi*.

Bradford.—At the meeting of the Gas and Electricity Committee of the Corporation on the 28th ult., it was decided to recommend certain reductions in the charges made by the Corporation for electricity for motive power. The proposal is to charge 1d. per unit net to all firms who are able to satisfy the electrical engineer and the chairman and the deputy-chairman of the committee that they are using electricity for motive power during the whole of the working hours. For cranes, hoists, and certain other descriptions of machinery the charge will be 2d. per unit net. The revised scale will come into force in July, and remain in operation for 12 months. The *Manchester Guardian* says: "The sudden and unexpected withdrawal by the Bradford Corporation a few months ago of their opposition to the scheme of the Power and Traction Company, Limited, to construct a tramway between Bradford and Leeds can now be explained. As far back as Dec 12 of last year the Bradford Corporation had entered into a private agreement with the company that in the event of an order being granted the Bradford Corporation should be permitted 'to take over the powers and undertaking of the company under such order for the purpose of constructing the proposed light railway, and working the same in connection with their tramways in the city of Bradford, subject to the Corporation obtaining parliamentary powers to do so, and the company have agreed that in such event they will, subject to the consent of the Board of Trade, transfer their powers and sell their undertaking to the Corporation in consideration of the payment to them by the Corporation of the sum of £1,500.' The agreement further stipulates that: '(1) The company shall, as soon as practicable after the Board of Trade shall have granted to them an order under the Light Railways Act, 1896, enabling them to construct the said light railway, and the Corporation shall have obtained such parliamentary powers as aforesaid, transfer their powers thereunder and sell their undertaking to the Corporation, subject to the consent of the Board of Trade. (2) The Corporation shall, on such consent as aforesaid being given to the said transfer and sale by the Board of Trade, pay to the company the sum of £1,500 as purchase money in consideration of the said transfer and sale. (3) The company hereby acknowledge the receipt of £100 as a deposit of part of the said purchase money, the sum of £1,500, in the event of the said transfer and sale being completed. In the event of the said order not being sanctioned, the company shall return the whole of the said deposit of £100 to the Corporation. In the event of the said order being sanctioned, but the Board of Trade refusing their consent to the said transfer and sale to the Corporation, the company shall be entitled to retain the sum of £50 in respect of their costs incident to this agreement, and shall repay the balance of £50 to the Corporation. (4) The Corporation shall support the confirmation of the order before the Board of Trade, and use their best endeavours to secure the confirmation being obtained."

PROVISIONAL PATENTS, 1899.

APRIL 24.

8510. Improved method of running electric telegraph or telephone wires or pipes of any kind. Wilson Rowan Meikle, 154, St. Vincent-street, Glasgow.

8522. Improvements in and relating to storage batteries. Robert Welford, Hunter's Hall, Sunderland.

8564. Improvements in combined joint or service boxes and fuse-boxes for concentric and other electric cables. Allan John Lawson, Joseph Gershom Childs, and James Douglas Dallas, 4, South-street, Finsbury, London. (Complete specification.)

8565. Improvements in electric brakes. George Henry Bingham Hooper, 4, South-street, Finsbury, London. (Complete specification.)

8570. Combined electric light reflector and advertising tablet for the interior of shop windows and like positions. Frank Edward Beeton, 40, Chancery-lane, London.

APRIL 25.

8605. An improved portable electric riveting machine. Frederick Scheer Dudgeon, 73, Cheapside, London. (Frederick von Kodolitsch, Austria-Hungary.)

8629. Improvements in wireless telegraphy. Sidney George Brown, Van Buren, Poole-road, Bournemouth.

8641. Improvements in apparatus for rectifying alternating electric currents. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Elihu Thomson, United States.) (Complete specification.)

8651. New or improved safety appliances for overhead and other electric conductors. Joseph Unsworth, 6, Lord-street, Liverpool.

8672. Improvements in and relating to electric meter carriages or vehicles. Arthur Lewis, 45, Southampton-buildings, Chancery-lane, London.

8693. Improvements in converting transformers. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (La Société Anonyme pour la Transmission de la Force par L'électricité, France.)

APRIL 26.

8726. Improvements in switches for electrical purposes. Alfred Watson, 24, Temple-row, Birmingham.

8762. Improvements in desks and registers for attachment to telephones. Percy Richard Julius Wills, Fairfield, Kingston-on-Thames. (Horatio F. Forrest, Canada.)

8775. Improvements in and relating to electric incandescent lamp fittings. Maurice Lachman, 6, Bream's-buildings, Chancery-lane, London.

APRIL 27.

8820. Improvements in electric signals or indicators. Alwyn Walter Staveley and Isaac Hardy Parsons, Faraday Works, Leicester. (Complete specification.)

8840. Improvements in incandescent electric lighting systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Albert G. Davis, United States.) (Complete specification.)

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8857. A new or improved quicksilver electric current interrupter. Georg Hirschmann, 18, Buckingham-street, Strand, London. (Complete specification.)

8873. Improvements in lighting trains by electricity. Chaimsonovitz Prosper Elieson and William Slater Naylor, 4, South-street, Finsbury, London.

APRIL 28.

8887. Improvements in electric traction. William Bullen Day, 2, Rostrevor-terrace, Rathgar, Dublin.

8913. Improvements in cut-outs, fuse-boxes, and analogous electrical fittings, and in connections for such fittings and other electrical purposes. Robert Frederick Hall, 24, Temple-row, Birmingham.

8949. Improved starting mechanism for electric motors. Reginald Belfield, 322, High Holborn, London. (Thomas S. Perkins, United States.)

8957. Improvements in or connected with connecting devices for electric conductors. Henry Reason and the Mutual Electric Trust, Limited, Norfolk House, Norfolk-street, Strand, London.

8961. Method of and apparatus for effecting the storing up of speech or signals by magnetically influencing magnetisable bodies. Valdemar Poulsen, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

8963. Improvements in the production of a filling paste or active material for the plates of secondary batteries. Carl Friedrich Philipp Stendebach and Heinrich Maximilian Friedrich Reitz, 40, Chancery-lane, London. (Complete specification.)

APRIL 29.

8975. A safeguard against screw loosening on electric incandescent lamp shadeholders. Wilhelm Schloesser (holder of the firm Kammgarnspinnerei Eitorf) and Hermann Moeres, 40, Heumarkt, Cologne, Germany.

8990. An improved contact breaker for induction coils. Harry William Cox, 10, Cursitor-street, Chancery-lane, London.

8995. Improvements in or connected with electrolytic means and apparatus for converting metals and metallic ores into oxides or other like compounds. Thomas Gerrard Hodgson and Ernest Bailey, 33, Chancery-lane, London.

9019. Electrical door opener. Johann Futterknecht, 70, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1897.

17266. Electromotors. Robinson. (Amended.)

1898.

7963. Electric switches. Soulé.

7961. Electric switches. Wilson.

8278. Fuse-box for electric light cables. W. T. Henley's Telegraph Works Company, Limited, and Strang.

8901. Electrostatic machines. Société A. Cohendet et Cie. and Archat. (Date applied for under International Convention, Nov. 22, 1897.)

10346. Apparatus for automatically cutting off current of electric overhead or other like wires. Bostock and Cheetham.

10765. Electric motors and meters adapted for use with alternating currents. Davis and Conrad. (Date applied for under International Convention, Nov. 22, 1897.)

12631. Tell-tale indicator for electric mast-head and side lights of ships. Turner.

12774. Electric railways on a sectional conductor system. Redfern. (Falk.)

12784. Electrical rheostats and resistances. Steele.

12839. Electric glow lamp fittings. Siemens Bros. and Co., Limited. (Siemens und Halske, Aktien-Gesellschaft.)

12840. Electric glow lamps. Siemens Bros. and Co., Limited. (Siemens und Halske, Aktien-Gesellschaft.)

12841. Contact rings for electric glow lamps. Siemens Bros. and Co. (Siemens und Halske, Aktien-Gesellschaft.)

12890. Method of and means employed for connecting the guard wires of electric cables and for disconnecting same in case of breakage. Bostock and Cheetham.

13325. Means for ventilating enclosed or partially enclosed electric motors. Hartnell.

17883. Arc lamps. Booker.

18907. Electric switch device for the temporary lighting of staircases, floors, cellars, and the like, also for indicating the heating of shafts and bearings and for fire-alarms. Blanckenhorn.

26930. Automatic telephone exchange and means relating thereto. Preismann.

1899.

1901. Electric heaters. Porter.

4878. Case for electrical transformer connections, also applicable to street electric light standards. Wilkinson.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1899.	Corresponding week 1898.	Increase or decrease.	Total receipts for half-year. 1899.	1898.
		£	£	£	£	£
Birmingham Tramway Co.	April 29	4 019	3,667	+ 351	65,311	61,162
Blackpool and Fleetwood Tramroad	,, 29	292	—	—	3,941	—
Bradford City Tramw	Feb. 5	145	—	—	6,733‡	—
Bristol Tramways and Carriage Co.	April 28	3,063	2,694	+ 369	—	—
City and South London Railway	,, 30	1,032	988	+ 44	19 358	18,757
Dover Tramways	,, 29	158	130	+ 28	2,579	1,951
Dublin U.T., elec. cars	,, 28	998	854†	+ 144	15,534	12,505†
Dublin S.D. Electric Tramways	,, 28	708	505	+ 203	11,300	7,318
Halifax Corporation Tramways	Mar. 29	312	—	—	10,712*	—
Liverpool Overhead Railway	April 30	1,408	1,451	- 43	24,154	24,934
South Staffordshire Tramways	,, 28	657	579	+ 77	10,467	10,083

* Since June 30, 1898. † Including horse cars. ‡ Since July, 1898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	24½-25½
Bournemouth and Poole Electric Supply, Limited, Ord.	10	13½-13¾
—— 4½ per cent. Cum. Pref	10	10½-11½
British Electric Traction, Limited, Ordinary, Nos. 1-80,000	10	18½-19½
—— 6 p. c. Cm. Pf., 80,001-40,000 (all paid)	10	13½-14½
—— 5 per cent. Perpetual Debenture Stock	100	126-129
Brush Electrical Engineering Limited, Ordinary	2	1⅞-2⅛
—— Non. Cum., 6 per cent. Pref.	2	2⅛ 2⅜
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	102-105
Callender's Cable Company, Debentures	100	114-117
—— Ordinary	5	12½-13
Central London Railway, Ordinary	10	10-10⅛
——	8	8 8⅛
—— Pref. Half-Shares	3	3¾-4
—— ,, ,,	5	4½-5
Charing Cross and Strand	5	11-12
—— 4½ per cent. Cum. Pref.	5	5⅞ 6⅛
Chelsea Electricity Company	5	7⅛-8¼
—— 4½ per cent. Debentures	100	114-116
City of London, Ordinary	10	17-18
—— ,, 90,001-100,000	10	17½-18½
—— 6 per cent. Cumulative Pref.	10	15-16
—— 5 per cent. Debenture Stock	100	124-129
City and South London Railway, Consolidated Ordinary	100	68-70
—— Ordinary	3	4⅜-5⅛
—— 4 per cent. Debenture Stock	100	13⅜ 13¾ xd
—— 5 per cent. Pref. Shares	10	14½ 15½
—— ,, ,, '96	10	13½-14½
County of London and Brush Prov. Elec. Light Co., Ord.	10	11-12
—— ,, ,, No. 80,001-40,000	10	11-12
—— 6 per cent. Cum. Pref.	10	14-15
Crompton and Co.	3	3⅛ 3⅜
—— 5 per cent. Debentures	—	98-101
Crystal Palace District, Ordinary 5 per cent. Stock	100	130 135
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2-2⅛
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	96-98
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5⅛-5⅜
Electric Construction, Limited	3	2⅞-3⅛
—— 7 per cent. Cumulative Pref.	3	3-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	103-106
W. T. Henley's Telegraph Works, Ordinary	10	24-25
—— 7 per cent. Preference	10	18-20
—— 4½ per cent. Debentures	100	113-115
House-to-House Company, Ordinary	5	8½-9½
—— 7 per cent. Preference	5	9-10
Imperial Tramways, Limited	6	24½-25½
India Rubber, Gutta Percha, and Telegraph Works	10	21½-22½
—— 4 per cent. Debentures	100	101-105
Kensington and Knightsbridge Ordinary	5	12-13
London Electric Supply, Ordinary	3	3⅛-3⅜
—— 6 per cent. Pref.	5	6⅛-6⅜
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	106-108
Metropolitan Electric Supply, Limited, Ord., No. 1-62,500	10	16½-17½
—— ,, ,, No. 62,501-85,000	4	12½-13½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-121
National Telephone, Ordinary	5	4½-5
—— 6 per cent. Cum. First Pref.	10	11-13
—— 6 per cent. Cum. Second Pref.	10	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	4½-5½
—— 3½ per cent. Deb. Stock, Red.	100	99-102
Notting Hill Electric Lighting Company, Limited	10	16½-17½
Oriental, Limited, 1879	1	1⅛-1⅜
—— £5 Shares	5	7⅛-7⅜
—— £4½ Shares, New	4½	6¼-6½
Oriental Telephone and Electric Company	1	⅞-1 xd
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6½-7
Royal Electrical Company of Montreal	1½	105-106
—— 4½ per cent. First Shares Mortgage Debentures	100	105-107
South London Electric Supply, Ordinary	3	3⅛-3⅜
St. James's and Pall Mall, Limited, Ordinary	5	17-18
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	34-38
—— 5 per cent. Bonds	100	106-108
Waterloo and City Railway, Ordinary	100	109-112
Westminster Electric Supply, Ordinary	5	15-16

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NOTES.

Institution Conversazione.—At the meeting of the Institution of Electrical Engineers last week, Prof. Silvanus P. Thompson, who presided in the absence of Mr. J. W. Swan, announced that the date fixed for the annual conversazione of the Institution was Thursday, June 15, and that the halls of the Natural History Museum would be utilised for the occasion.

Electric Train-Lighting.—We understand from *Indian Engineering* that the Stone system of train-lighting has been tried now for more than a year on a train on the Godpbore State Railway, and that it has been found to work most satisfactorily. Extensions of train-lighting in India are hence likely to be expected. We learn from the same contemporary that electric light is shortly to be introduced into the Government House at Naina Tal.

Personal.—We are informed that Dr. Nicholson, who for some years has been the professor of mechanical engineering of the McGill University of Montreal, has been appointed head of the mechanical and engineering department of the new technical school being built by the Corporation at Manchester. Dr. Nicholson has done good service to the Canadian institution, and is in every way fitted for the much larger sphere which will be opened up to him by his new appointment.

Society of Arts.—The annual conversazione of this society will be held in the Natural History Department of the British Museum, Cromwell-road, on Tuesday, June 20. The following portions of the building will be open—*i.e.*, the central hall, British saloon, the bird gallery, the east and west corridors on the first floor, and the lecture room. The reception is timed to commence at 9 p.m. Any member requiring additional tickets for friends will be able to obtain these previous to the day at a cost of 5s. each.

Electric Tramways in Germany.—Electric traction is rapidly finding favour amongst the smaller towns in Germany, which are profiting by the successful working of tramway systems in the larger towns. Thus, we gather from a consular report issued by Consul Harris, of Eibenstock, that electric tramways are in course of construction at Meissen, Weimar, and Eisleben; while the following towns are likely to place orders for the construction of electric tramways very shortly: Pforzheim, Trier, Ratisbon, Colmar, Jena, Kaiserlautern, and Worms.

Royal Institution.—A general monthly meeting of the Royal Institution was held on the 8th inst. (the Duke of Northumberland, president, presiding), when the following were elected members: Mr. A. Cooper, F.R.C.S.; Mr. A. W. Porter; Mr. S. Stephenson; and Mr. T. Uzielli. The special thanks of the members were returned to Mr. Hugh Dewar for his donation of £200, to Mr. Thomas H. Sowerby for his donation of £5. 5s., and to Mr. John H. Usmar for his donation of £50 to the fund for the promotion of experimental research at low temperatures.

The Corporation and Mr. Henniker Heaton.—We gather from the *Times* that a committee of the whole Corporation of London met *in camera* at the Guildhall a few days ago, under the presidency of Alderman Sir David Evans, to consider a motion by Mr. A. C. Morton to bestow the honorary freedom of the City upon Mr. Henniker Heaton, M.P., in recognition of his services in relation to the establishment of Imperial penny postage extending over many years. The resolution was seconded by Mr. Alderman and Sheriff Alliston, and was eventually carried with but few dissentients.

Wayleaves.—We notice that the Kingston and Surbiton Fire Brigade have been complaining that certain of their call wires have been cut by landowners in consequence of their being placed over certain lands without permission. At the annual meeting of the Joint Fire Brigade Committee this fact was brought up, and it was urged that the occupier of the land had imperilled his own protection against fire by the course adopted. We quite agree with this fact, but we are sure that in the abstract it is only right that municipal authorities should conform to the law, and not invade without permission private property for public ends.

Congo Rubber Trees.—The *Journal* of the Society of Arts mentions that the Government of the Cango Free State, with the object of preventing the threatened destruction of the indiarubber trees in that country, has promulgated a decree by which it is provided that for every ton of rubber yielded annually there shall be planted not less than 150 trees. A bureau of control of rubber forests is created, and charged with the enforcement of the decree of 1892, which prohibits, on pain of a £400 fine or imprisonment, the gathering of rubber in any other mode than through incisions in the bark. Guide books for its cultivation are furnished by the district commissioners on request, and agricultural inspectors will be placed temporarily at the service of the private owners.

Fence-Wires as Conductors.—We see that the *Globe* is making much of a statement to the effect that the stockmen of South-Western Kansas and North-Western Texas and Oklahama are using their barbed-wire fences as telephone conductors instead of erecting new wires for that purpose. Our contemporary accordingly waxes eloquent on the advantages which these stock-keepers gain from telephonic connections, neglecting, we think, the consideration that in certain seasons of the year, particularly in wet weather, these wires will not give good results. From the statement of our contemporary, however, it appears that successful speaking over 10 miles of barbed-wire fencing has been accomplished, but we do not see in the article any reference to the climatic conditions prevailing at the time.

A Large Electric Lift.—We understand from *Kuhlow's German Trade Review* that the large lift at Henrichenberg, on the Dortmund and Ems Canal, commenced working recently. This lift, which is worked entirely by electric motors, is capable of taking 600-ton barges. Its working depends on a system of cylindrical floats, which exert a constant ascensional force corresponding with a load of 3,000 tons. The movable portion is so loaded that it is made to descend by the addition of a comparatively small quantity of water, but rises directly the same quantity is abstracted. Regularity of motion is ensured by four enormous steel screws, 81ft. long by 11in. in diameter, the nuts of which are fitted to each corner of the movable portion. The screws are rotated by electromotors, while other electromotors open the sluices and work the pumps; and the cost of the lift with accessories is about £125,000.

The Pacific Cable.—In reply to Mr. A. D. Provand in the House of Commons on Monday, Mr. Chamberlain said an agreement was made on Oct. 26, 1893, between the Secretary for the Colonies and the Eastern Extension, Australasia, and China Telegraph Company for the laying and maintaining for 25 years, at their own cost by the company, of a second submarine telegraph cable connecting Singapore, Labuan, and Hong Kong. The fourth article provides that in consideration of the engagements entered into by the company in this agreement, and of the strict

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fulfilment thereof, her Majesty's Government undertakes to secure the company against competition within limits which the agreement specifies. If in the public interest it should be decided that new cables were to be laid, the company would, all things being equal, have the preferential right, but nothing in the agreement is to prejudice or affect existing rights of the Great Northern Company.

Electric Coal-Cutting.—The colliery industry of South Africa is rapidly advancing, and the opening up of coalfields will do much to hasten the development of that continent generally. We notice from the columns of the *British and South African Export Gazette* that the Elandslaagte mine, Natal, is about to introduce electric coal-cutters of the Jeffrey type, which are manufactured by the Derby firm of John Davis and Sons. The complete electrical installation will be at the pithead from which conductors to the electric motors and coal-cutters will run. These machines are the first of the class to be introduced into Natal, and should prove exceedingly valuable in replacing the untrustworthy labour at present used. In addition to the saving in labour these coal-cutters effect, great economies result in regard to the coal itself, as there is nothing like so much small coal made with them as with hand labour.

"Cassier's Magazine."—The May number of our above-named contemporary contains the first part of a biographical sketch of Lord Kelvin, written by Mr. J. D. Cormack, M.I.E.E. Any biography of Lord Kelvin is bound to be interesting reading, from the fact that so much new and original work has been crowded into his professional career. In glancing through Mr. Cormack's sketch we must admit that he has done his part well, and that the inventions he has selected illustrate well the versatility of his subject. Great attention is paid to the early work and training of our greatest scientist. The other electrical features in the May issue of *Cassier's Magazine* consist of an article by Mr. Alton D. Adams on the "Selection of Incandescent Lamps," in which the author advocates the careful grading of lamps, and that these should be disconnected from the circuit and thrown away when their watts per candle-power have fallen below a certain figure depending upon the cause of the lamps and of the energy supplied.

Electric Printing.—We have received a cutting from the *Rangoon Times* to the effect that for the last 15 months the printing presses belonging to this newspaper have been worked by electricity. The cutting was sent to us to show that in the East the advantage of electrical printing is fully appreciated. A description of the plant reads as follows: "A high-speed automatic engine operates a 30-h.p. dynamo, from which current is supplied to the various motors which are directly geared to the printing presses and paper-cutters. To the right of the operator of each press a controller is placed, by means of which the press may be started, stopped, or the speed varied as desired by the operation of one lever only. The engine being automatic in speed regulation, the stopping and starting of any number of motors does not affect the speed. The motors operate the presses smoothly, and are readily manipulated by the ordinary press hands. The absence of shafting or belting of any kind in the press-room is a feature of very great importance in point of power consumed and general convenience."

Robespierre and Marat as Electricians.—Our contemporary, the *Electrical World*, comments on the singular fact that the names of two or three leaders who were responsible for the Reign of Terror during the French Revolution, have some connection with electricity. Robespierre was probably the first lawyer engaged in electrical litigation, having been counsel in a suit to a man charged with sacrilege, on the ground that he had put up a lightning rod to avert the fire of heaven. There is no record of the pleadings, but that they were effective is evident from the fact that the defendant was acquitted at a time when religious intolerance reigned supreme. Marat, besides being a physician, was an author of scientific books, one of his works being on electricity. A letter has recently come to light in which Marat gives to a friend an account of medical cures effected by electricity. He mentions one case of a man whose sight had gone for 33 years, and which was recovered through a course of electrical treatment. The letter speaks highly of electricity as a remedial agent when administered by a physician versed in its application.

U.S.A. Cable Ship.—We see from the *Electrical Review* of New York that the United States of America have, in consequence of their newly-acquired territories, added a cable ship to their marine forces. The ship in question, which is called the "Hooker," is now about to sail for the Philippines to lay local cables, which will act as a useful aid towards the establishment of a firm government. It is interesting to know that the cable ship in question originally belonged to Spain, and was captured during the late war. After her capture she served as a transport ship for the army. In altering the vessel to make it suitable for a cable ship many structural changes have been made. The forward cable-tank is 13ft. in diameter and 8ft. high, and has a capacity for 60 tons of cable. The midships tank, 24ft. by 13ft., has a capacity for 400 tons, and the after tank, 26ft. in diameter and 6ft. deep, will contain 240 tons, the total capacity thus being 700 tons of cable. These tanks are circular and slightly conical in shape, and are built of boiler iron with caulked joints, so as to be watertight. The usual gear for paying out and covering cables have been installed on the ship, the paying-out drum being 8ft. in diameter.

Electric Traction in Austria.—In an interesting communication to the *Street Railway Journal* of New York, Mr. E. A. Ziffer refers in detail to the light railways and tramways in Austria during 1898. These during that year did not receive any great impetus, either from the possibilities afforded to them of cheaper means of transportation or from the development of city traffic. The reason assigned for this is partly on account of disturbed political conditions, and partly on account of the money market. The tendency toward Government administration of tramways also, says the author, prevents the owners of light railways from making any very radical changes in their equipments. The ordinance on Dec. 31, 1897, has also had a deterring effect on the enlistment of private capital in these undertakings. After an exhaustive review of existing and proposed lines and their equipment, the author points out that at the end of last year there were in Austria 15 electric railways, with a total length of about 48 miles. This shows an increase since 1897 of, say, 10 miles. By the ordinance of Dec. 21, 1898, however, the installation is authorised of 500 miles of line, estimated to cost about £5,100,000. This length of track is divided into 10 districts, and under the ordinance these roads will be built with Government assistance.

Power Distribution Schemes.—We regret to find our contemporary, the *Journal of Gas Lighting*, exulting over the defeat of the Highland Water Power Bill, which was thrown out by the House of Commons Committee last week. Our contemporary declares that the scheme fell through on account of the promoters' estimates being mere guesswork, and because they failed to establish a need for the sanction of the scheme in the public interest. It con-

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cludes that the "result is a strong condemnation of the promoters, who went to Parliament to ask for statutory sanction for what was merely a big experiment. The world, therefore, still awaits satisfactory proof that electricity generation in bulk is economically feasible in the United Kingdom." After carefully reading the evidence before the committee, our conclusions are distinctly opposed to those of our contemporary. It seems to us that the Bill was rejected on account of the opposition of local landowners, who wished to keep all such work, if it is to be done at all, in their own hands. To talk of the whole scheme being an experiment is absurd in the face of the success of the British Aluminium Works at Foyers. On the other hand, the world will have to wait many years for the proof "that electricity generation in bulk is economically feasible," if powers to distribute in bulk are refused each year by Parliament.

Motor Control.—Mr. F. A. Johnson contributes to the *Electrical World* an article on a method he has devised of controlling the speed of electric motors. For small sizes Mr. Johnson uses the two-pole type of motor with internal poles. These poles are formed in the cast-iron shell in such a way that their centres are hollow. In the central parts of the poles wrought-iron cores are made to slide in such a way that the strength of the field can be easily varied. When these wrought-iron masses are partially removed, the magnetic flux will be decreased and the speed raised. With the construction adopted by the author, the magnetic induction at the pole-tips will not be varied, and hence sparkless commutation is expected. In larger motors, Mr. Johnson somewhat varies these details by keeping the iron circuit constant and introducing secondary magnetising coils to reduce the magnetisation of the central core. Here, again, he aims at keeping the flux at the pole-tips constant. Experiments made with a 1-h.p. motor with the removable core are given in the article, from which it is gathered that a movement of 2½in. of the core increased the speed from 830 to 1,170 revolutions per minute. The author adds that this machine ran sparklessly in either direction under all loads up to 50 per cent. overload. The only point which strikes us as adverse to the author's proposals is the cost of construction is much increased.

Wave Forms and Transformer Losses.—An interesting article, contributed by Messrs. Duncan, Keidel, Hodges, and Frank, on the "Effect of Alternating-Current Wave Forms on Transformer Losses," appears in the recent number of the *Electrical Review* of New York. The investigation itself is not novel, as some four years ago Dr. Roessler, of Berlin, after exhaustive experiments, came to the same conclusions as the authors. Notwithstanding this, the information given in our contemporary is very useful, especially as the wave forms of the different alternators experimented with are furnished. The transformer in question was of the Westinghouse type. We gather from the tabulated results that no less than 13 different wave forms were experimented with. In each case the watts on no load were measured, and the current required when the transformer was running on open secondary is given. The watts consumed at no load varied from 11·25 up to 19·5. The low values corresponded to curves having exceedingly abrupt changes and peaks, while the high values were for flat curves. In fact, the peaked curves were considerably better as regards iron loss than even the waves of the sine form. As regards the current with open secondary, this also was lowest with peaked curves. But, judging from the table, there does not seem to be any fixed ratio between hysteresis loss and the wattless current.

Electrostatic Lines of Force.—In the *Proceedings* of the Royal Society of Edinburgh, issued last month, there is a communication by Mr. David Robinson on "Dust Figures of Electrostatic Lines of Force. He wished to show students the identity of the laws of force for magnetism and for electricity at rest, and for this reason he desired to get diagrams analogous to those obtained from magnets by means of iron filings. The difficulty arises that in electrostatics the small particles tend to lose their charges of electricity, and hence their attractive force. The ideal material for the construction of the particles would be long-shaped grains, having a conducting interior within an insulating shell. After an extended trial, the author found that sawdust gave the best result of any material experimented with. A piece of tinfoil, or in some cases two discs of tinfoil, were cemented to glass plates, which were placed horizontally with the discs underneath. It was found best to put the sawdust on the plates before charging the foil, and then by tapping the plates some interesting diagrams of electrostatic lines of force were produced. These were fixed in the usual way by covering the upper surface of the glass with a layer of paraffin wax and vaseline. After the particles had arranged themselves in curves, they were fixed by melting this layer. Three of the diagrams so produced are illustrated in the volume before us.

An Improved Dipping Needle.—At the meeting last week of the Iron and Steel Institute, Prof. Henry Louis, M.A., read a paper on an improved dipping needle. Prof. Louis, who conducts the mining department of the Durham College of Science at Newcastle-on-Tyne, refers in his paper to the errors found in other dipping needles used to prospect for iron ores. The new instrument consists of a circular brass box, 3in. in diameter and 1½in. deep, the two flat sides of which consist of plates of glass. A flat-bottomed brass block screwed to the base of the box enables it to stand firmly on a level, or tolerably level, surface. The needle, 2½in. long, is suspended, as in the Swedish prospecting compass, from a little stirrup; the latter is made of aluminium, and hung from an ordinary agate cap. The needle proper balances horizontally on delicate steel pivots, supported in the limbs of the stirrup by means of two watch-maker's jewels, so as to reduce friction to a minimum. Behind the needle is hung a graduated semi-circular arc; this is not fixed, but is pivoted on a horizontal pin passing through its centre, so that in whatever position the brass box is placed the arc always hangs with its diameter horizontal. This diameter forms the zero point of the graduation, the pivots of the needle being exactly opposite the point of suspension of the semi-circular arc. The needle is fitted with a brass slider so that it can always be adjusted in a horizontal position; the front glass plate is held in a pull-off cap, so as to enable this adjustment to be readily made. Above the needle is a long brass screw, which can be brought down on to the cap of the stirrup so as to hold it safely whilst the instrument is being carried. In the field the stirrup is released, and the instrument can be carried slung from a short piece of silk cord. As the graduated arc is suspended, and therefore self-adjusting, the amount of dip of the needle can be at once read off from it. This construction obviates the necessity of carefully levelling the stand before making observations.

An Exciting Time.—The staff employed at the electrical power station at Carbondale, Pennsylvania, have had a lively experience. According to the Chicago *Street Railway Review*, a gang of half a dozen masked burglars one night towards the end of March broke into the office attached to the plant and took the cash-box. This, however, only contained about £15, as the great bulk of the day's receipts had been previously removed. The

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desperadoes next decided to rob the men in charge of the plant, which was operated until 1.30 a.m., with an engineer and fireman in charge. Two men were accordingly stationed in front, one took up a position at the back, while three entered the boiler-room. After knocking the fireman insensible and roughly handling and blindfolding the engineer, the watchman entered upon the scene, and fired until he had exhausted his ammunition. Missing his aim every time, he was himself eventually shot in the foot. The firing awoke the rest of the staff, who had gone to bed upstairs, but whenever one of these went to the window, the guard outside delivered a volley. On an attempt being made, however, by the burglars to force an entrance into the sleeping-room, this was repulsed, and the ruffians eventually left, carrying the cash-box with them. The police authorities were immediately apprised, and telegrams forwarded to all the neighbouring towns, while a freight train in which the gang were travelling was stopped at a little station some 10 miles off. At this place, a quiet old man, who had been formerly sheriff, was awoke and informed of the circumstance, with the result that when the train pulled in the old man was there with his rifle. When the six desperadoes climbed out of a box-car he informed them that he wanted to converse with them, upon which the gang opened fire. He escaped being hit, however, and in returning the fire he killed one at the first shot, mortally wounded another at the second, and brought down a third with the next. A fourth surrendered, and two escaped, but were captured later in the day. All were heavily armed.

Electrolysis of Solutions of Zinc Chloride, etc. The *Journal* of the Chemical Society contains the following condensation of an interesting communication by Fritz Foerster and O. Günther to the *Zeitung fuer Elektrochemie*, 1898, v., 16-23, on "Electrolysis of Solutions of Zinc Chloride and the Nature of Spongy Zinc": A perfectly neutral solution of zinc chloride containing 54·6 gr. of zinc per litre was electrolysed with a cathodic current density of 1·4 amperes per square decimetre. The anode consisted of pure electrolytic zinc. For several hours the deposit consisted of smooth, light-grey zinc; after 20 hours, the solution became turbid owing to the separation of zinc oxychloride, and zinc sponge was deposited. The solution then contained one molecule of ZnO to 14 $ZnCl_2$. By using a small subsidiary platinum anode, a small quantity of chlorine was continuously supplied to the solution; this did not, however, prevent the formation of the sponge. Zinc chloride solutions, whether acid or alkaline originally, always become basic after a time, owing to the energetic oxidation of the zinc electrodes by atmospheric oxygen in presence of zinc chloride, and the formation of the zinc sponge always begins when the solution is saturated with zinc oxide. From a solution containing $\frac{1}{20}$ to $\frac{1}{30}$ gram-molecule of hydrochloric acid per litre, zinc may be deposited in any quantity without the spongy deposit appearing. Under these circumstances, some hydrogen is evolved, the bubbles of which remain persistently attached to the cathode, producing unevenness in the deposit. The presence of a little free chlorine (0·2 gr. per litre) is useful in preventing this prolonged adherence to the same point. By this method perfect deposits of zinc, quite free from arsenic, were also obtained when impure zinc anodes were used. Schnabel has stated that Ashcroft obtained considerably (50 per cent.) more than the theoretical amount of zinc in the electrolysis of solutions of basic zinc salts. The authors have failed to obtain any indication of such results. It is finally shown in detail that all definitely ascertained facts relating to the formation of spongy zinc point to the conclusion that it is produced whenever the condition of the solution at the cathode is such that basic zinc salts or zinc hydroxide may separate out there.

Electrosynthesis.—We notice in the *Journal* of the Chemical Society an interesting abstract of a paper by Mr. W. G. Mixter, which appeared in the *American Journal of Science*. The author refers to some previous work on the action of the electric globe discharge on different gaseous mixtures, and explains how he has carried further researches. His view, previously expressed, that the heat resulting from the combination effected by the feeble glow discharge does not cause further combination is confirmed. The use of a solution of potassium hydroxide in place of the solid does not influence the rate of change produced by the current through hydrogen and oxygen. It has been proved that in the case of hydrogen and oxygen the greater the pressure the more rapid is the combination. A mixture of ammonia and oxygen undergoes decomposition, about five-sixths of the nitrogen being liberated as such, whilst the remainder goes to form a deposit of ammonium nitrite on the side of the tube. Methylamine is oxidised more slowly than hydrogen, and a certain amount of nitrite is formed. Dimethylamine behaves in a similar manner, but trimethylamine does not yield nitrous acid. A mixture of aniline vapour and of oxygen at 30deg. under a pressure of 100mm. contracts very slowly indeed, a brown condensation product being formed, but no nitrous acid. A mixture of dry cyanogen (one vol.) and oxygen (two vols.) first increases a little and then slowly contracts to about its original volume, and a considerable amount of carbonic anhydride, but no nitrous acid is produced. When nitrous oxide itself is subjected to the glow discharge, complicated changes slowly occur, nitrite, and probably nitrate, being formed in the presence of potassium hydroxide. A mixture of nitrous oxide and hydrogen yields nitrogen and water. Nitric oxide, in the presence of potassium hydroxide, yields higher oxides when subjected to the glow discharge, and a mixture of nitric oxide and hydrogen reacts in a similar manner, but more slowly, nitrite being produced. A mixture of nitric and carbonic oxides yields but little carbonic anhydride.

Three-Phase Motors.—In a recent paper by Mr. Machter, contributed to the *Elektrotechnische Zeitschrift*, the author discusses the question of three-phase motors having a large starting torque and capable of standing a large over-load. This contribution is abstracted as follows in Mr. Carl Hering's digest. The author discusses particularly the question as to how, with the same iron frame, these properties can be best given to a motor. He shows analytically that the maximum output, torque, and starting torque are inversely proportional to the first and second power of the impedance, and it is therefore necessary to make the impedance as small as possible in order to obtain these results. He shows that to regulate a motor with a short-circuited armature by placing resistances in the stator circuits, is a very bad method; by putting the resistances in the rotor circuits, however, the impedance may be made small without weakening the starting torque. In order to show the effect on these properties of a motor, of lowering the impedance, he made some tests on a motor on which he changed the number of windings on the stator in the ratio of 4 to 3, testing the motor under both conditions; the results are given in curves and tables for both cases, and it is shown that the resistance and impedance for no load were reduced almost to a half; the best efficiency and power factor is then at double the load while the maximum torque increases in proportion to the decrease of the impedance. The exciting and no load current also increased in proportion to the decrease in the impedance. The maximum output of the motor

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at the point when the speed will fall rapidly was 3·8-fold, and the motor will start with a load representing five times that at normal speed and load. The curves showing the dependency of the output and the torque on the current, show that for the modified motor at the same current strength both of these have increased to more than double. The reactance has increased about twofold and the inductance has diminished in about the same proportion. Some similar tests are given briefly for a smaller motor. He shows that for every size of motor there is a particular reactance and inductance which may be considered characteristic of it; the table of these constants for various motors is given. It is assumed that the air-space remains constant; by increasing it the reactance may also be diminished, but this is objectionable, as the cosine of the angle of lag then becomes less.

Wireless Telegraphy.—We have received from Prof. D. E. Hughes copy of a letter he has sent to Mr. J. J. Fahie with respect to some experiments in aerial telegraphy carried out by the latter in 1879. We regret that we have not space at our command to give the whole letter in full. The following brief *résumé* will be of interest: It seems that in the year mentioned, when experimenting with his induction balance, Prof. Hughes came across some unexpected effects due to the extra current produced in the primary coil of the induction balance when the currents were interrupted. Further researches proved that an interrupted current in any coil through which an electric current was sent gave out at each interruption of the primary current such intense extra currents that the whole atmosphere in the room, or in several rooms distant, would have a momentary invisible change, which became evident if a microphonic joint was used as a receiver to a telephone. This led him to experiment upon the best form of a receiver for these invisible electric waves, which evidently permeated great distances, and through all apparent obstacles, such as walls, etc. He found that all microphonic contacts or joints were extremely sensitive. Those formed of a hard carbon, such as coke, or a combination of a piece of coke resting upon a bright steel contact, were very sensitive and self-restoring, whilst a loose contact between metals was equally sensitive, but would cohere, or remain in full contact, after the passage of an electric wave. Following up these results, Prof. Hughes found that very sudden electric impulses, whether given out to the atmosphere through the extra current from a coil, or from a frictional electric machine, equally affected the microphonic joint, the effect depending more on the sudden high potential effort than any prolonged action. Thus a spark obtained by rubbing a piece of sealing-wax was equally as effective as a discharge from a Leyden jar battery of the same potential. The rubbed sealing-wax, or charged Leyden jar, had no effect until they were discharged by a spark, and it was evident that this spark, however feeble, acted upon the whole surrounding atmosphere in the form of waves or invisible rays, of which he could not at the time determine. Prof. Hughes goes on to describe how he found that the microphone had the power of rendering these invisible waves evident. A number of prominent men, such as Mr. W. H. Preece, F.R.S., Sir William Crookes, F.R.S., Sir W. Roberts-Austen, and others, saw these experiments in 1897, and Prof. Hughes tried to develop from them an aerial system of telegraphy. He succeeded in transmitting signals easily for 60 yards, and 500 yards appeared to be about the limit of the effects he could produce. A deputation from the Royal Society called to see the experiments in 1880, but after careful examination Prof. Stokes concluded that all the results could be obtained by well-known electric magnetic induction effects, and that he could not accept Prof. Hughes's view that actual aerial electrical waves, unknown up to that time, had been discovered. This led to the researches being discontinued. Prof. Hughes also thought that he had evidence of nodal points in the distribution of waves.

Carbon Electrodes.—The following abstract from an account of Dr. Zellner's extended researches with carbon electrodes is taken from Mr. Carl Hering's digest (the original article appeared in the *Zeitung fuer Elektrochemie*): One of the principal features suggested by the author was the destructive effects on various carbons of electrolytic work. He found that the specific gravity of carbon is no measure of its value for electrolytic purposes; the Girard and Street carbon, for instance, which is treated by the electric arc and has a specific gravity of almost 2 gr. per cubic centimetre, suffers greater loss than other carbons of lower density; this is true even to a greater extent of those made of Ceylon graphite; a much better indication of the quality is a determination of the porosity which is determined by taking the true specific gravity in the pulverised condition, being careful to boil it in water, and then determine the apparent gravity of another sample from the weight and volume; from these two measurements a factor called the porosity may be determined. He gives the values of these two quantities for 15 different carbons, all apparently made on the Continent. The true specific gravity of retort carbon is 1·89, which seems to be a little higher than the average of the others; the lowest porosity was 4·5 for a glass-hard carbon, and the greatest 22 for a certain arc light carbon; for retort carbon it was 8·5. This porosity factor is obtained by dividing 100, less the difference of the two, by the true gravity determined from the pulverised material. Carbons with low porosity are better for electrolytic purposes, as there is less room in their interior for the development of gases. He does not favour the carbons made of wood charcoal. The raw carbons, with the exception of graphite and retort carbon, have a very high specific resistance, more than 2,000 ohms; the variations between different samples of the same carbon are very great. The consumption of the carbon is not uniform and depends on the relation of its resistance to that of the bath. The specific resistance in ohms for a number of different kinds is given; that of natural Ceylon graphite is 2 to 8, of retort carbons 50 to 80, and of electrodes from charcoal 150; the others vary greatly, but are similar to retort carbon. Those carbons will last longer in which the wear is uniform, which was shown by experiment. The consumption is nearly proportional to the time and to the current density, but is very different in different electrolytes; the consumption during different times is given. In alkaline or neutral solutions there is less loss than in acids; a table gives the behaviour of different kinds and in different electrolytes. Sulphuric acid at 30·4 per cent of the monohydrate has a maximum conductivity, as he shows; there is then a minimum consumption of carbon. The sawed retort carbon is exceeded for electrolytic purposes by several of the artificial forms. The value of the carbon does not depend on its specific gravity, but on its structure; low porosity is in general favourable, but is not an indication of its capability to withstand consumption. The consumption of carbon depends within limits on the voltage and current strength and is independent of the form and active surface or, in other words, current density and consumption of carbon are proportional. Carbon plates will last longer the higher the conductivity of the electrolytes, and, therefore, the lower the voltage and temperature. The proper relation between the resistance of copper and that of the bath increases the life.

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THE PRACTICAL TESTING OF ELECTRICITY METERS FOR CENTRAL STATIONS.

BY C. A. L. PRUSMANN, A.M.I.E.E., ASSISTANT ELECTRICAL ENGINEER, BRADFORD.

(Continued from page 462.)

Resistances (continued). — This resistance is shown diagrammatically in Fig. 16. It consists essentially of a slate slab some 24in. long by 13in. wide. At the top left-hand corner will be noticed five terminals, each one of these being connected to the positive pole of one of the cells on the town supply. These five terminals are also connected to the five contacts on the cell-regulating switch (C R S in diagram), over which contacts the switch moves, cutting out or putting in cells as required. The particular

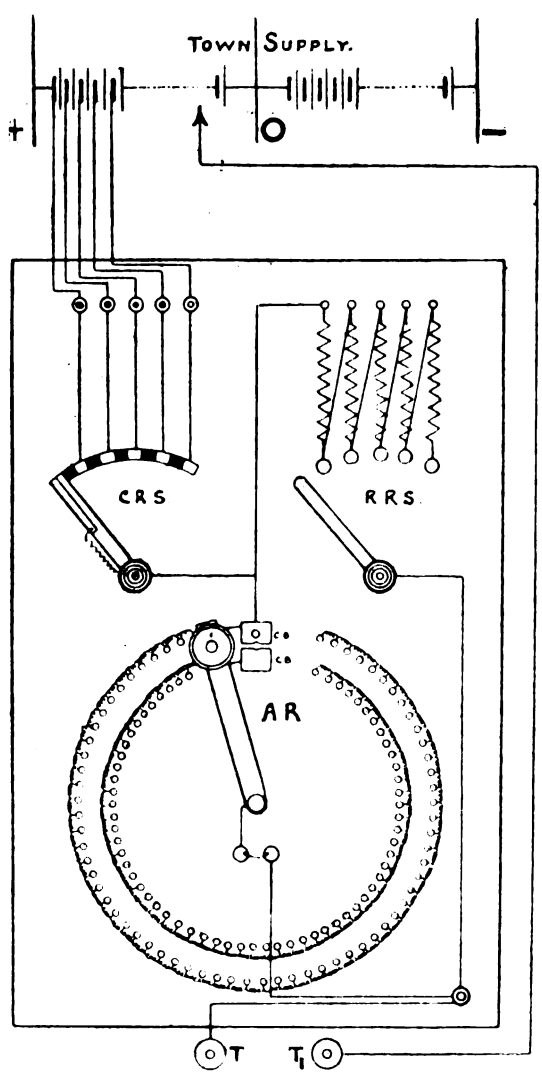

FIG. 16.—C R S, Cell Regulating Switch; R R S, Resistance Regulating Switch; A R, Adjusting Resistance; C B, Connecting Blocks; T T_1, Test Terminals.

case shown in the figure is where one cell per contact is cut in or out, but it will readily be seen that the value of each step may be altered to suit any case, according to where the five terminals are connected on the battery. The author has found, however, two-volt steps—that is, of course, for each cell—to be most convenient for general use, the switch, therefore, giving a total range of adjustment of eight volts. The switch itself is made in two parts, insulated from each other by means of a thin strip of ebonite or fibre, and get connected through a small coil of resistance wire as shown, having a resistance of one ohm and a sectional area such as to carry two amperes. By this means a cell is never short-circuited when moving the switch from one contact on to another, the two-volt circuit being closed through the resistance wire for the short space of time necessary. Neither is the circuit ever broken during an adjustment. From the centre of this regulating switch the circuit splits into two, one being carried to the stud at the left-hand side of the series of studs at the top right-hand corner of the board. There are five of these studs connected, as shown, to contacts, over which a switch moves. The resistances are fixed at the back of the board, each one having a resistance of 1·5 ohms. From the centre of this switch the circuit runs to a terminal as shown, and thence to the terminal connecting the meter shunts. The second portion of the circuit on this board after leaving the cell-regulating switch is connected to a brass block marked C B, and thence through a certain number of fine resistance coils shown in the outer circle, according to what position the adjusting handle is in. A second brass block is fixed below the first one so as to enable a plug to be inserted between them, thus connecting the outer and inner circle of resistance coils in parallel. From the centre of the adjusting handle of this resistance the circuit passes through a fuse, and finally joins the other circuit, traced out above, at the terminal, as shown. The fine adjusting arrangement consists of two sets of some 50 coils each, having a total resistance of 75 ohms in each set. It must be understood that the wire used for these resistances need not be of large section, the size being, in fact, solely determined by the current taken by the largest number of meters' shunts ever connected in parallel at one time. If then these resistances are so arranged as to safely carry this amount of current, there is nothing further which need be taken into consideration. The other test terminal is connected to any part of the battery as required, and as shown in the diagram. We will now see what adjustment this board is capable of giving us at the test terminals, T and T_1. In the first place we are able to obtain any voltage as may be required from a fraction of a volt to the full pressure across the "outers" of the town supply, in two-volt steps, by moving the movable contact made on the cells, and the handle of the cell-regulating switch. As a rule, however, the supply voltage, or something very near it, is the only voltage required for meter testing, and in that case the movable contact is connected to the centre point of the two sets of cells on the town supply in the case of a three-wire system being in use. The cell-regulating switch enables the voltage to be regulated to the extent of eight volts in two-volt steps. If the resistance regulating switch is in the "off" position, the circuit is made through the adjusting resistance, with either one set of coils in alone or the two sets in parallel. The voltage at the test terminals when the regulating resistance switch is in the "off" position is, of course, lower than when this switch is "on." In the latter case the regulating resistance is in parallel with the adjusting resistance, and the drop in volts over the whole board for a given number of meter shunts is lower than if only the adjusting resistance is in circuit. Hence the available E.M.F. at T and T_1, or, what is the same thing, the E.M.F. at the ends of the meter shunts, is higher. It will, therefore, be seen that the value of the regulation obtained by the movement of the adjusting resistance handle depends on the number of meter shunts connected, and also on the position of the resistance regulating switch. When a large number of meters is under test, and a larger current therefore being used, the value of each step on the adjusting resistance is greater than when a smaller number is being tested. For instance, if only one meter is connected, the resistance connected across the test terminals is so high that any adjustment on the resistances makes no appreciable difference on the voltage. In fact, the drop in volts across the adjusting board is not sufficient to make any difference at the test terminals, and the only adjustment available would be on the cell-regulating switch. But such an adjustment is a great deal too coarse for accurate meter testing. To overcome this difficulty, all that is required is to connect across the test terminals some apparatus which absorbs a considerable current in comparison to the amount taken by, say, one or two meter shunts. An incandescent lamp of 8 c.p. or 16 c.p. answers this purpose satisfactorily, for by this means a drop in volts is brought about on the board, and consequently any variation in the adjusting switches brings about an appreciable difference at the test terminals. Of course, when meters are being tested in large numbers the resistance of the shunts in parallel is low enough to

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admit of sufficient current to enable adjustment to be carried out very satisfactorily, and the voltage on the meter shunts kept practically constant, even though the voltage across the cells may vary slightly. The resistance regulating switch, however, must never be in the "off" position if there is any chance of the current, due to the meter shunts, becoming too large for the adjusting resistances to carry safely. Very little practice with this form of pressure board will enable the best arrangement of the switches to be obtained for different numbers of meters, so as to enable adjustments and regulation to be carried out to the best possible advantage. From the test terminals leads are carried to two wall plugs, fixed one in either corner of the room. By means of these plugs it is an easy matter to connect the pressure circuit to either or both sides of the meter-room, using for this purpose the leads carried round the room, and which are fitted at intervals with terminals to which the meter shunts are connected. A very useful form of terminal for this purpose is one similar to that shown in Fig. 17. A certain

FIG. 17.

number of the leads connecting the meter shunts may be clamped under the centre portion and others under the top. When large numbers of meters are being tested at once this is often a great convenience, particularly if the pairs of terminals connected to the pressure circuit are somewhat far apart. It is also an excellent plan to have all terminals distinctly marked positive (+) or negative (−) as the case may be. In the case of the terminals in Bradford, all + terminals are bright brass, while all − terminals are bronzed over. However the distinction is made, a proper and systematic method in this direction will obviate a considerable amount of trouble and annoyance, and may even prevent accidents. The pressure circuit leads were referred to in the first section of this series of articles. It will be understood that the sectional area of these leads to supply the shunts of the meters must be such that there is no appreciable drop in volts between the test terminals shown in Fig. 16, and any of the pairs of terminals to which meter shunts are connected. The voltmeter used is connected across the test terminals, and is fixed in a position near the pressure board, so as to enable the scale of the instrument to be readily inspected while operating the different switches and resistances on the board itself. It may be found necessary to provide testing racks with pressure terminals, where meters using a shunt circuit are employed, and are so designed to have to be screwed down on to a support instead of against one. Each station uses certain makes of meters, and of course arrangements must be made accordingly to suit the particular meters adopted. We are now provided with both series and pressure circuits, as far as source of energy, adjusting resistances, terminals, etc., are concerned. Our next consideration must be given to the instruments to be used on the different circuits, and this will form the subject of the next section of these articles.

(To be continued.)

ÆTHERIC TELEGRAPHY.*

BY W. H. PREECE, C.B., F.R.S.

On Feb. 21, 1894, I read a paper in this room on "Electric Signalling Without Wires," in which I attempted to show how at that time "we were gradually by patient plodding creeping along towards the period when I hope we shall be able to make real practical use of electromagnetic disturbances." To-night I hope to show you that we have attained that object. The experimental stage in wireless telegraphy had been passed in 1894 and we were then entering the commercial stage. I said in that paper: "The conditions are now so clear that, given the localities between which it is desirable to communicate, it is a mere matter of calculation to show what has to be done It would be quite easy to speak between France and England across the Straits of Dover."

In March, 1895, the cable connecting the Island of Mull with the mainland was broken, and as some time might elapse before the repairing ship could reach the locality communication was set up with that island by my system of ætheric telegraphy. A guttapercha-covered copper wire, 1½ miles long, was specially laid on the Argyllshire coast, and the ordinary iron wire connecting Craignur and Aros in Mull was used. The mean distance separating the two wires was about three miles. There was no difficulty in communicating. Public and Press messages were regularly transmitted until the cable was repaired. It created as much sensation at the time as Mr. Marconi's recent experiments from Dover to Boulogne have excited during the past week or two. Signalling through space without wires became a practical operation. The question at once is how is it best done?

In 1896 a cable was laid for the War Department from Lavernock near Cardiff to the island of Flat Holm in the Bristol Channel. There are two important forts protecting the Channel at these two points. The cable crossed a very much frequented route and an anchorage ground. It was speedily broken. The communication being very necessary, the cable was replaced early in 1898 by an ætheric telegraph, and since that time to the present day this communication has been maintained uninterruptedly, and is in daily use by the soldiers who work it.

I will show you the principle on which it is worked. It is due to the formation of electromagnetic waves of induction. These waves, as they rise and fall, set up electromagnetic disturbances in conductors in their neighbourhood, and if these conductors form part of a telephone circuit musical sounds are produced in the telephone if the disturbances are rhythmical. Vibrations of about 400 per second give the most pleasing and effective note, and when the note is broken up into dots and dashes messages can be sent by the Morse alphabet.

You will perceive how simply the thing works, but you will also learn how rapidly the effects observed diminish as the distance increases when we use coils. The law regulating this distance is very simple. Indeed, in practice, and when the distance between the coils is considerable compared with the diameter of the coils, the effect diminishes as the cube of the distance. The distance to which communication is possible by overhead wires is limited by the length of the wire on each side, and by the delicacy of the receiving apparatus.

Attention is called at Lavernock and Flat Holm by a very ingenious invention of Mr. Sydney Evershed. The vibratory currents are not used to produce sound, but they set up at the distant station vibratory movements in two loops of fine wire oscillating in a strong magnetic field at the low frequency of 16 per second in opposite phases. When these loops are properly timed, and the vibrations have sufficient amplitude, they make contact, complete a local circuit, and ring a trembler bell.

Prof. Oliver Lodge has devised another mode of calling attention. He proposes to produce loud sounds by making the coil of the telephone vibratory instead of an iron diaphragm, and transmitting these vibrations directly to a sound-board. The magnetic field in which the coil vibrates is produced by a powerful horseshoe magnet. The Post Office is going to give this new call a practical trial. It is hoped that it will develop into a new receiver.

I am by no means satisfied that we have reached finality in this form of ætheric telegraphy. There is vast room for improvement. We can increase the energy emitted at the sending end, we can enlarge the primary circuit by using heavier copper and increasing the size of the coil. We can vary the frequency of the currents and also the

* Paper read before the Society of Arts on May 3, 1899.

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character of the receiving apparatus. Indeed, there is a potentiality of research and invention in this field for those who have leisure and inclination. If it had any serious commercial value before it, it would doubtless be exploited by enterprising manufacturers. Perhaps, unfortunately, I did not patent it, and I have therefore no financial interest in it. The Post Office up to the present have used it practically only twice. It failed to act through sea-water, owing to the rapid absorption of the energy by the sea, and therefore it failed to be useful for lightships; but in the meantime a new method of doing the same thing in another way has been devised by Mr. Marconi, which has created a great sensation, and to which I must now refer.

Instead of using electromagnetic waves of low frequency (400 per second) as I do, he uses Hertzian waves of very high frequency—probably of as many millions per second. He employs an ordinary induction coil, such as is used to illuminate vacuum tubes or to excite Röntgen rays. The primary circuit contains an accumulator of eight cells and a Morse key, which can direct through it currents of long and short duration so as to form the Morse alphabet, as in ordinary telegraphy, to send messages. The secondary circuit ends in a radiator composed of two metallic spheres, between which sparks pass. One sphere is connected to the earth and the other to a vertical wire, whose length varies with the square root of distance through which it is desirable to communicate. This wire is suspended by a pole or mast. Each spark is composed of extremely rapid oscillations of electricity, setting up those electric waves which are known as Hertzian, though they ought to be called Maxwellian, for it was Maxwell who indicated their existence, while Hertz experimentally detected their presence and showed us how to measure them. By this apparatus every depression of the key causes rays of electric waves to be emitted through the æther in every direction from the radiator as long as the key is held down. Thus those electric waves are transmitted through space exactly in the same way as light waves, and they follow precisely the same laws. Messages flashed by the heliograph from the Himalayas to the plains are signalled in the same way and by the same medium as Marconi's messages across the Straits of Dover. The first recorded message from Agamemnon to Clytemnestra, announcing the fall of Troy, was sent by the same agency. There is nothing wonderful in this. The wonder is that these electric waves should be detected at great distances through all weathers and seasons, during day and night, and in spite of fog and snow and rain.

They are detected by a very simple apparatus. It is called a coherer, and it forms a telegraphic relay. A small glass tube, about 1½in. long, has inserted in it two small pole-pieces which tightly fit the tube, but which are separated from each other by a space of about $\frac{1}{50}$in. This space is filled by a mixture of fine nickel and silver filings, with just a trace of mercury. The pole-pieces have wires attached to them which enable the tube to form part of a circuit, and which are sealed in the tube when the latter has been exhausted. In its normal condition this metallic powder is virtually an insulator. The particles very slightly touch each other—so slightly that no current passes. They lie higgledy-piggledy, anyhow, in disorder. But let them be placed in an electric field, let electric waves pass through them, they are instantly "polarised"; they are installed in marshal array; their mutual contact is increased; they are subjected to pressure; they "cohere," as Prof. Oliver Lodge expresses it; they become a conductor, and an electric current passes if the coherer forms part of the circuit of a local battery. They will continue to act as a conductor until they are "decohered" or restored to their normal insulating condition by mechanical shaking. Mr. Marconi causes a small hammer to strike the glass by the very current the coherer has caused to pass. If the waves have ceased, the tube is instantly decohered. If the waves continue, there is no apparent decoherence. This current can at the same time emit either a sound or record signals on paper by ink, which in each case can be read. One side of the coherer is connected to a vertical collecting conductor similar to the transmitting conductor, and the other side is connected to the earth. The coherer is an extremely reliable instrument—stable and certain in its action. I have one given to me by Mr. Marconi in 1897 that has never failed to act. I am using it to-night.

It will be seen that the apparatus is characterised by extreme simplicity. The vertical conductor is common to the transmitter and the receiver. At each terminal there must be both transmitting and receiving apparatus, but the effect is improved if the receiving wire be thin and the transmitting wire thick. When signalling from A to B the vertical conductor at A becomes a wing of the radiator, while that at B is a wing of the coherer. The reverse takes place when signalling from B to A. The coherer is protected from the influence of its own radiator by being encased in an iron shield.

The rays can be directed in any given direction by parabolic reflection, but this is effective for only short distances, for a long vertical conductor cannot be used with reflectors. For long distances, tuning or syntonising is the most probable effective mode of securing secrecy; but Mr. Marconi is still in the experimental stage in this branch of the subject. Syntony is attained when the transmitted impulses of a vibration recur in the same period as the natural period of vibration of the receiver, and thus increase the amplitude of its vibration. When we sing any particular note into a piano the strings of the piano emit only the same note that the voice sounded.

The vertical conductor is an essential feature of Mr. Marconi's system. It determines the distance to which signals can be transmitted. A conductor 20ft. high will signal well to a distance of a mile, 40ft. to four miles, 60ft. to nine miles, 100ft. to 25 miles, and 120ft. to 36 miles. The height of the conductors used in the Boulogne experiment is 150ft.; those used between Alum Bay, in the Isle of Wight, and Poole, a distance of 18 miles, 80ft. high. The law as determined by experiment is this, that the distances increases as the product of two vertical conductors of different heights. This, of course, is the above law of the square when the lengths of the two conductors are alike.

The effects are distinctly best when signalling across the clear space covering the sea. The sea, like a sheet of metal, reflects these waves, but what does the irregular surface of the earth do? Mr. Marconi has obtained very satisfactory signals between positions which have been screened from each other by hills. French officers on board the "Ibis" at Sangatte, near Calais, on Monday, succeeded in speaking to Wimereux, 20 miles away, over Cape Grinez, a lofty promontory. We do not know at present much about the absorbing influence of the earth upon electric waves. There is room for experiment here. Indeed, the whole subject bristles with new fields for research. It is a misfortune that our physicists have done so little in this direction. Many of them seem to think that there is more importance in discovering priority of invention than in making an invention itself.

Mr. Marconi has been very busy in experimenting between the Isle of Wight and Bournemouth, and with moving ships in the Solent. He maintained communication between the Queen at Osborne House and the Prince of Wales on board the Royal yacht "Osborne." The proceedings of the yachts in the Kingstown Regatta of July last year were signalled from a following steamer, and regularly printed every evening in the *Daily Express* of Dublin. Lloyd's signalling station at Rathlin Island, in the North of Ireland, was placed in communication with Ballycastle. The two places are 7½ miles apart. On March 27 communication was made through a distance of 30 miles between the South Foreland and Wimereux, near Boulogne. Communication has also been established and continuously maintained between the South Foreland, near Dover, and the East Goodwin Lightship, a distance of 12 miles. There was a collision on Friday last between a steamship and this lightship during a thick fog. The fact was immediately communicated to the shore. Fortunately the damage was slight, but, of course, the most was made of such a stroke of luck. Although I had watched and assisted Mr. Marconi in his experiments from his first introduction to me in 1896, and the Postmaster-General had taken the greatest interest in the system, it was thought that independent experiments should be made

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to confirm our opinion of the practicability of the system. They were made in September, 1897, near Dover. Mr. Marconi's results were confirmed. I reported on the practicability of the system, and the Wireless Telegraph Company, who had secured Mr. Marconi's services and his inventions, were informed that they could connect Sark with Guernsey and the Post Office would open Sark as a public office. They were also informed that the Board of Trade and the Post Office, with the consent of the Trinity House, would be glad if they would connect the South Sand Head Lightship with Dover. Neither of these extensions have yet been done. The company preferred to experiment elsewhere, as I have narrated, to prove what was not necessary to be proved, that it was possible to signal across the Straits of Dover, and to show that great distances could be connected. The result is that for nearly two years after its practicability was affirmed, not one single independent commercial circuit exists. The operations of the Wireless Telegraph Company are mysterious and inscrutable. Their attentions are apparently more concentrated upon the operations of the Stock Exchange than upon the business establishment of useful circuits.

Captain Jackson, R.N., in December, 1895, commenced at Plymouth working in the same direction, and he succeeded in getting Morse signals through space before he knew anything of Marconi or his system. His reports to the Admiralty, however, were confidential. Had they been published he would have anticipated Mr. Marconi.

When Mr. Marconi was showing the working at the South Foreland to the officials of the Post Office, he received a sharp shock. There was atmospheric electricity about, and Mr. Marconi repeated Franklin's experience. Sharp sparks were elicited from this miniature lightning, and at the same time erratic signals were observable at Boulogne. The speaking to Boulogne was not interfered with. The officers on board H.M.S. "Vernon" at Portsmouth one day observed similar disturbances, and obtained distinctly the letters A R E. Was this due to Mr. Marconi's experiments at the South Foreland, or was it due to atmospheric electricity? I think the latter, for I have frequently read letters, especially R, on Morse telegraphs when lightning was about.

There can be no question of the commercial value of the system for lightships, isolated lighthouses, shipping generally, and for naval and military purposes, but for commercial uses, such as telegraph communication with France, the system is at present nowhere. A single cable to France could transmit 2,500 words a minute without any difficulty. A single Marconi circuit could not transmit more than 20 words a minute. It is not wanted in this direction. Its name has led to the popular illusion that the poles and wires which disfigure our house-tops will disappear, but there is no evidence at present that a single wire can be dispensed with. It may add to our systems at work. It cannot diminish the number of circuits at work. There may be many outlying islands that can be connected to the mainland, but this can be equally effective by my own electromagnetic system. It must not be forgotten that this system of mine is in active practical use, and that its use can be largely extended. It is also open to all, and it is not restricted by patent rights. It is, perhaps, unfortunately for me, not in the hands of an enterprising band of capitalists. If it were, it would not have been so soon forgotten. Wireless telegraphy is many years old. It is capable of great improvement, and if an electromagnetic receiver can be devised as sensitive as the coherer, it would work to equal distances, for the waves in each case extend precisely as far in the one case as in the other. Now, we require parallel wires that extend to some distance on either side of a channel—a more sensitive magnetic receiver would reduce this to very short lengths. Other minds are at work on the subject. I have not sufficient leisure to devote the requisite time to develop it, but it has a potentiality of public use that is far beyond the dreams of newspaper writers.

Mr. Marconi is to be very sincerely congratulated on the success of his experiments. He has attracted the attention of the public to a very fascinating field of electrical development, and thereby has indirectly served the progress of scientific education.

INSTITUTION OF ELECTRICAL ENGINEERS.

Capacity Measurements of Long Submarine Cables.

BY J. ELTON YOUNG, MEMBER.

(*Concluded from page 567.*)

In Fig. 3, then, the influence of the leakage during the period of charging is approximately proportional to the insulation resistances, R, r, which alter the potentials of the battery poles (A D) by amounts dependent on the parallel resistances $\frac{a\,R}{a+R}$ and $\frac{b\,r}{b+r}$. This effect is independent of the time of charge since, by hypothesis, R and r stand for the true leakage resistances, and the apparent change of the D.R.'s of cable and condensers with time is treated as absorption. The potential of the junction (B) between the cable and condensers does not change, this point being connected to earth. The ratio of the capacities thus becomes

$$\frac{a\,R}{a+R} : \frac{b\,r}{b+r},$$

instead of $a : b$. This is approximate, because on a long cable the distribution of the leakage along the line somewhat modifies the problem. Taking this into consideration, Schwendler gives the following formula: multiply the apparent I.C. arrived at by the ratio $\frac{l}{\lambda}$, where l = length of line in miles,

$$\lambda = \frac{1 - \frac{1}{K}}{m},$$

$$\log K = m\,l \times 0{\cdot}4343,$$

and

$$m = \sqrt{\frac{r}{i}},$$

r and i being the conduction and insulation per mile, both in ohms.

Another point to be noticed here is that the slide resistances, a b, must themselves be well insulated, since they commonly consisist of 100,000 ω, so that a leak of 10 megohms on the higher branch would mean, were the ratio of the arms, say, 4 : 1,

$$\frac{80{,}000}{20{,}000} : \frac{79{,}365}{20{,}000} :: 4 : 3{\cdot}9682,$$

nearly 1 per cent. error.

In Fig. 4 B is insulated during charging. Its potential therefore alters with time under the operation of leakage, producing a positive variation through R and a negative one through r; thus we have an error proportional to the time of charge, unless the leakages be balanced. Corrections of Gott's test for this error have been tried in the following ways: (1) By Dr. Muirhead's method already referred to of earthing the condenser (f) immediately after balance, and then measuring the difference from zero of the potential at B. This, although correct under certain conditions, has proved quite unreliable on a very long cable of unknown I.C. (2) By compensating the cable leakage exactly by adjusting the insulation resistance of the condensers so that $f\,R = F\,r$, R and r having been previously measured. This is a very satisfactory plan when capable of employment, either f or R being varied as most convenient. (3) By calculation of the loss of charge during the interval between battery contact and balance. An analysis of the problem by Mr. E. C. Rimington was published in 1887, but the formula arrived at does not appear to be what is wanted. A formula for the purpose was published by Mr. H. W. Ansell and myself in 1890, taking into account leakage on the cable side only. Although it was evident that the error on the condenser side could be eliminated by a similar calculation so long as it acted alone, yet when both branches leaked simultaneously the problem did not appear to admit of a simple suggestion. Recently, however, Mr. Walter J. Murphy suggested to me taking the difference of the two errors, computed separately, which on trial I find yields practically exact results, at least in dealing with

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large capacities, such as those of long cables. The formula is then as follows: Let R, r be the true insulation resistances in megohms of the capacities f, F microfarads, and let t be the time of charge in seconds. Let

$$\log k = \frac{\cdot 4343\, t}{f\,\mathrm{R}}, \text{ and } \log \mathrm{K} = \frac{\cdot 4343\, t}{\mathrm{F}\, r}.$$

Then $$\text{true I.C.} = \text{apparent I.C.} \times \frac{k}{\mathrm{K}}.$$

This is the system of leakage correction applied to the results in Table I. Appendix. Experiments with shunted capacities of only 10 microfarads or less showed a slight departure from the rule. Having indicated the calculated allowances for dielectric leakage to be made in the Thomson and Gott balances, I now come to what seems to be a more satisfactory mode of exact I.C. measurement than either of them, as regards correction not only for leakage but also for difference of rates of absorption. Being merely a modification of Lord Kelvin's original method, it has been termed the "modified Thomson" test. It appears to have occurred to more than one investigator, but to my friend Mr. W. J. Murphy belongs the credit of having proved its superiority as the most practical means of arriving at uniform results on long ocean cables, without the necessity for calculations; and my own experience has lately confirmed this conclusion.

In this method both leakages and absorptions are balanced by observation and adjustment during charging, absorption in this case being treated as apparent improvement of D.R.—that is to say, the condensers are shunted by a resistance which is adjusted till it approximately balances the apparent D.R. of the cable at any time of charge. The connections for charging are those of Gott's method (Fig. 4), with this important difference: that the key, k_2, is closed during the charge. The effect of this is to keep the potential of the point B constant, as in the Thomson balance, while at the same time the deflection on the galvanometer shows whether or not there is a balance of (apparent) insulation resistances in the bridge system. Since this balance is required to be such that $\frac{\mathrm{R}}{r} = \frac{\mathrm{F}}{f}$, it must be observed when $\frac{a}{b} = \frac{\mathrm{F}}{f}$ nearly—that is to say, we must commence with an approximately correct position of the slider, C. Then R, the leakage shunt across the condensers, is adjusted till G shows a resistance balance, as nearly as possible, at the end of any desired time of charging. For this purpose a set of plumbago resistances is useful, or it can be done roughly by the application of a pocket handkerchief across the terminals of the condenser more or less closely as required, but it is preferable to estimate approximately the proper resistance, and to arrange it beforehand.

Having thus charged and balanced the apparent D.R.'s by observation, the test proceeds in the same way as the Thomson—viz., by short-circuiting and mixing the charges, and observing if any outstanding quantity remains on earthing the junction of the two capacities through the galvanometer. An additional advantage over the original Thomson balance is that there is no serious vitiation of results by battery leakage. Moreover, it admits of allowance being made for "cable current" by false zero observation, a most important point on long submarine lines. It should be remarked that in the modified, as in the original method, the mixing period must be sufficiently prolonged to discharge the cable, or variable results will ensue. On a section of 1,850 nauts I have found 15 seconds' mixing sufficiently long, within the limits of appreciation, even after a full minute's charging—*i.e.*, there was no difference between a 15 and a 25 seconds' mixing interval.

By means of a measurement thus carried out, it is possible to arrive at the same result for all times of charge, and any values of the dielectric resistance, and to dispense with all calculated allowances for leakage. Thus the desired uniformity of results is ensured, taking the constant value of the balancing condensers, determined by Dr. Muirhead's method, as a basis. With this value the latter should be marked, as well as with the temperature at which it was measured. Care must then be taken to correct the condensers for their temperature changes, by means of the coefficients furnished by Dr. Muirhead. It only remains to determine the very small coefficient of temperature variation applicable to the specific I.C. of guttapercha. I have attempted to deduce this from the series of careful tests of two long cables appended to this paper, and arrived at a coefficient closely corresponding to that for paraffin, but Dr. Muirhead thinks it must be smaller than that. The search for such a minute residual phenomenon, where so many sources of error exist, must necessarily be elusive in common with determinations of residual quantities in other departments of exact measurement.

TABLE I.—Gott Method, Corrected for Leakage by Calculation. Mean Temperature of Cables in every case, 5deg. C. Condensers, 147·2 ϕ. D.R., about 20 Ω. Temperature, 29·4deg. C.

I.C. by factory data at 24deg. C. Cable A. 596·5 ϕ.

Time of charge.	Appt. D.R.	Appt. I.C.	$\log \frac{k}{\mathrm{K}}$.	Corr. I.C.
	Ω	ϕ		ϕ
5″	—	583·4	- ·00193	580·8
10	—	600·5	- ·00387	595·2
15	0·5	606·2	- ·00580	598·2
30	0·98	618·0	- ·01161	601·7
45	1·10	631 4	- ·01741	606·6
60	1·20	638·0	- ·02322	604·8
300″	1·40 = value taken for corrections.			

I.C. by factory data at 24deg. C. Cable B. 724·8 ϕ.

	Ω	ϕ		ϕ
5″	—	721·3	+ ·00014	721 55
10	—	725·4	+ ·00029	725·9
15	1·0	729·05	+ ·00043	729·8
30	2 0	733·3	+ ·00087	734·8
45	2·36	736·5	+ ·00130	738·7
60	2·7	741·2*	+ ·00174	744·2*
300″	5·0 = value taken from corrections.			

* Approximate.

TABLE II.—Thomson Method, Corrected for Leakage by Calculation or Balance. Condensers, 146·3 ϕ. D.R., about 20 Ω. Temperature, about 25deg. C.

I.C. by factory data at 24deg. C. Cable A. 596·5 ϕ.

Time of charge.	Time of mixing.	True D.R.	Appt. I.C.	Corrected I.C.
		Ω	ϕ	ϕ
30″	15″	1·0	577·8	598·6
45	15	—	586·0	598
60	15 and 25	—	594·6	604·1
120	20	—	about same.	
180″	30″	—	about same.	

I.C. by factory data at 24deg. C. Cable B. 724·8 ϕ.

		Ω		
30″	15″	20	727	No correction required, as leakages balanced (but not absorptions).
40	20	—	731	
60	20	—	735·2	
180	30	—	742·8	
300″	30″	—	745·9	

TABLE III.—Modified Thomson Method, Absorption and Leakages Balanced by Observation, approximately. Condensers, 119·25 ϕ. D.R., 140 Ω. Temperature, 24·4deg. C.

I.C. from factory data at 24deg. C. Cable A. 597·5 ϕ.

Time of charge.	Time of mixing.	Appt. D.R. of cable.	Leak on condensers.	Constant I.C.
		Ω	Ω	ϕ
15″	10″	0·3	2·3	599·1
30	15	0·60	3·3	599·1
45	20	0·62	3·3	601·3
60″	25″	0·63	3·3	601·3

I.C. from factory data at 24deg. C. Cable B. 724·8 ϕ.

		Ω	Ω	ϕ
15″	10″	0·92	6	741·8
15″	10	0 92	12	too large
30″	15	1 7	12	741 8
60″	20″	2·5	51	about same

In conclusion, since it may be asked of what practical utility are these researches after the exact I.C. of long submarine cables, their possible importance in connection with repairing operations may be alluded to. It must be

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remembered that on ocean cables a microfarad means some three nautical miles, so that a mistake in measurement of 1 per cent. in the distance to a sealed break on a section of, say, 700 microfarads—if for any reason localisation from the other end were impracticable, as sometimes happens—would amount to an error of 20 nauts, and would not satisfy the standard of modern practice.

APPENDIX.

On a Standard Time of Charge for Electrical Measurement of Long Submarine Cables.

To ensure the greatest possible accuracy and uniformity of measurement it is desirable to fix some definite time of charge in observing the C.R. and the I.C. of a long cable, as well as for the D.R. test. In the last of the three measurements one, two, or more minutes have been adapted according to requirements, but for the other two no such standard is generally recognised. It has been proposed (*vide* Darby and Fisher's "Submarine Cable Testing") to fix a period of $\frac{K R}{10^6}$ seconds, where K is the I.C. in microfarads, R the C.R. in ohms of the cable under test. This, however, is too short a charge, for referring to Fig. 1 it is evident that the steady state is not sufficiently approached. The value, $\frac{K R}{10^6}$, of the line from which this diagram was derived is 3·75 seconds. Its C.R. when observed at 30 seconds was 5,155·5 ohms, but when observed at 10 seconds was 5,152 ohms, and would have been considerably less at 3·75 seconds; whilst above 30 seconds no rise of apparent C.R. was appreciable. Since absorption becomes thus approximately negligible after an interval of 30 seconds, this would appear to be a suitable period of charge to adopt in C.R. measurements, affording as it does convenient time to adjust the bridge balance. If seeking the C.R. of an insulated loop of two very long cables, 60 seconds might be advisable; but this is much better done by earthing the junction of the lines, when the time of charge of the loop becomes sensibly the same as for a single cable.

Moreover, on a long cable the observed C.R. not only requires time to become steady, but also needs correction for leakage. This again involves the selection of a definite value of the D.R. for the purpose. Thus it will not do to correct the apparent C.R. of a very long cable observed at 10′ by its apparent D.R. at 10″ charge, since the usual formulæ for distributed leakage are not applicable after so short an interval. On the other hand, the fifth minute D.R. is somewhat too great, but its value at 30″ charge yields a closely correct result. Hence 30″ seems to be the proper standard time for D.R. observations taken for the purpose of correcting the apparent C.R.'s at 30″.

As regards I.C. measurements, although it has been shown in the foregoing paper that the "modified Thomson" method yields a constant I.C. value for all times of charge, yet a 30″ charge would be a very suitable one to fix for such observations, because the balancing condenser shunt can then be calculated for the standard 30″ D.R., and its final adjustment can be conveniently made during this interval without undue hurry. If any other method of I.C. measurement be employed, a definite time of charging becomes necessary for purposes of uniformity.

DISCUSSION.

The discussion on this paper, which stood adjourned from the 27th ult., was resumed on Thursday, May 4. Prof. Silvanus P. Thompson (vice-president) occupied the chair.

Mr. W. J. Murphy said that it did not seem clear to Mr. Siemens, and was probably not so to the rest of the members present at the previous meeting of the Institution, that the test which was submitted to them actually did separate the absorption and leakage components of the total dielectric capacity from the true or free charge capacity. He had asked to be allowed to add a few further remarks to point out that the real object of the discussion should be to decide whether the claims made for the method in this respect was a good one. It seemed all the more desirable to make the matter clear, because there was an evident danger of the discussion taking a course wholly irrelevant to the matter dealt with by Mr. Young's paper. He mentioned that Mr. Young and himself were not quite in accord as to whether the absorption factor was completely eliminated from results obtained by his (Mr. Murphy's) method of manipulating the test. His contention was that if a battery was applied to a cable or to a condenser it absorbed directly—and not in cascade, as in Gott's method, a portion of the instantaneous charge, which was absorbed by, or which leaked through the dielectric as continuously kept constant. This was true not only with regard to the cable, but also with respect to the condenser, so that if the index circuit was kept closed, or if the resistances, R and r, were in the proper ratio during the time the battery was applied, the free charge of each condenser, including the cable under that term, was kept constant and at its full value until the moment to mix. It was only in the mixed stage of the test that any doubt arose as to the action of the absorption upon the result. The condensers were then arranged as in Fig. 4 [shown in our issue of May 5], and R and r now merely acted as sheets. The question was, Did the absorbed charge leak out of the cable during the few seconds the mixing period lasted so far as to add to any appreciable extent to the true free charge of the cable? In his opinion, the discharge of the residual charge was so slight that the small amount which might be given out would not seriously interfere with the accuracy of the result, and was probably in any case proportionate to the length of core in circuit, and so would not induce errors in calculation. Having advanced further arguments in support of his contention, he submitted that the problem Mr. Siemens had put to young students was for practical purposes at least solved. Might he venture to say that his appeal to young students was evidently justified by the fact that the old students, to whose school he (Mr. Siemens) was so bright a light, had not, in spite of their long innings, been able to devise a test which would separate the three components for them.

Mr. Charles Bright said it was rarely the case that the Institution had a telegraphic paper to deal with, and it seemed to him that when they did get this chance they should make the most of it. Quite apart, however, from Mr. Young's paper and Mr. Murphy's explanation and "duplicate" of the paper, they had got some most important data from Mr. Siemens, and he (Mr. Bright) proposed to say a few words with regard to his rather interesting and important observations.

Prof. Thompson, interposing, said that although the remarks of Mr. Siemens at the previous meeting were very interesting, they were not strictly germane to the subject.

Mr. Bright pointed out that Mr. Siemens was nevertheless allowed to proceed without being called to order, and that he himself would proceed until he was stopped.

Prof. Thompson said if everyone answered something that was said by every other speaker, there would be no end to the discussion.

Mr. Bright still thought that as Mr. Siemens was in order, he (Mr. Bright) ought to be allowed to proceed with his criticisms, and he proceeded to do so. Attention had been called, he remarked, to a table of which, he dared say, a good many of them received a copy some months ago. When he first received this table it struck him that it was a great pity the speed tests were not made by the same impartial individual under precisely similar circumstances—starting from the battery and ending with the receiving instrument. The only cables that could be compared were, of course, the same cables of the same year, and with one of them the actual slip with which its speed was obtained was given showing the degree of definition. It was the custom of people connected with submarine telegraphy to have a certain regulation with regard to definition. Almost any speed could be obtained, but the question was, were the readings readable or not? It would be most interesting to see a similar slip of the other cable, and then they could arrive at an excellent comparison. Mr. Siemens seemed to attach great importance to absorption having something to do with the increase and speed of cables within recent years. Anything he told them naturally had very considerable weight. Personally, he would be rather disposed to think that the difference in the proportions of copper and guttapercha had really more to do with it probably—that is to say, that nowadays it was the custom with most people to increase the copper and decrease the amount of guttapercha. Manufacturers so seldom came out of their shells that when they did it seemed an excellent opportunity of obtaining a little more information from them, and he felt certain that if they pressed Messrs. Siemens Bros. they would come forward with a great deal more. He ventured to think, however, that at present they had not sufficient data to go upon to say for certain that decrease of absorption and a decrease of capacity tended to decrease the retardation, and therefore to increase the speed. With regard to what Mr. Siemens said about the K R law, he (Mr. Bright) thought all of them would agree that that certainly did not apply in the present day to long submarine cables, and it was rather an important matter just now in view of the possible extension of submarine telegraphy on an Imperial basis. The important point with respect to the K R law was the effective capacity—that is to say, what proportion of the total capacity was really affected in the question of speed. He thought that anyone, or at least most people, who studied the question of capacity would admit that what was meant was instantaneous capacity in working a cable according to its particular length. He thought the great point in Mr. Young's paper was the very clear and concise treatment of the subject, which was quite in keeping with the matter of testing generally. Mr. Young began by referring to Hopkinson's formula, but he (Mr. Bright) was glad to see that his ideas were based on surface or instantaneous capacity. The speaker was continuing his observation, when Prof. Thompson again interposed, and he then resumed his seat.

Mr. T. A. Taylor would like to be permitted to add a few words to that interesting discussion from the point of view of one who

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had had considerable experience in the practical working of submarine cables. It appeared that Mr. Murphy had explained to them a method of taking the capacity of a cable which, by eliminating the effects of absorption and leakage, enabled them to arrive at the instantaneous value of the capacity quite irrespective of the time of charge. In other words, his test eliminated the last two factors in the quotation mentioned in Mr. Young's paper, and gave them a constant value, which might well be taken as a basis for calculating future values for the localisation of insulated values and disconnections, but which for signalling purposes was not the true capacity of the cable. In this latter connection it was impossible to dissociate the three factors which went to make up what he might call the working capacity, and it seemed to him that a K R based upon the instantaneous value of K would not be the true one, and would, if applied to the working speed of any cable, give a higher rate than could be obtained in actual practice. If, however, the value of K be the true one, that was a value arrived at by the inclusion of all three factors in the quotation, and it ought, perhaps, to be borne in mind that even this might be approximately true. It seemed to him that K would vary with the speed. Then, if they could employ a receiving instrument having no mechanical or electric magnetic inertia, he took it that they would obtain speeds which would be universally proportional to K R. It had been the practice, without calculating the speed, for any cable to take as a basis an empirical standing derived from the actual observed speed on some other cable of an entirely different K R value. Some experiments which he had recently had the pleasure of carrying out on behalf of the Eastern Telegraph Company's office might think this was an entirely erroneous method of procedure. Having regard to the magnetic inertia of the signalling coil, to the elasticity of the fibre suspensions, and to the opposing E.M.F. set up in the coil by its magnetic field, which last effect was more marked as the speed was increased, he found that the present receiving instruments were unable to respond fully to the extremely rapid impulse which could be imparted to them through short cables, but were not in a position to fully respond to the smaller impulses of longer ones. The consequence was that if they took the fastest observed speeds that legible signals upon K R's—say from 1,000,000 to 8,000,000—using in every case the same instrument, and adjusting it so as to give the highest possible speed in every case, and they then multiplied those speeds expressed in words per minute by K R through which they had been obtained, they got a sliding scale of constants differing widely in value and increased with the K R. From this, he might say in conclusion, it was evident that until they had a receiving instrument whose inertia was negligible, one could not arrive at a constant which would be equally applicable to all K R's; therefore, at present, conclusions based upon the common constant must necessarily be misleading.

Mr. Willoughby Smith congratulated Mr. Young and Mr. Murphy upon the useful method they had given them; but he must confess that he really rose to break a lance with Mr. Siemens. He wished to ask this one question, whether the remarks made by Mr. Siemens were to be printed in the *Journal*?

Prof. Thompson said this was a matter which lay clearly with the Council.

Mr. Smith remarked that so strong a statement as had been made by Mr. Siemens should be answered.

Prof. Thompson had no doubt that if Mr. Smith sent a request to the Council anything he had to state on the point would be inserted in the *Journal*; but he did not think it would be relevant for remarks to be made by one speaker and another on a matter which was irrelevant to the paper.

Mr. Murphy said he could only reply in so far as to speak of cables. He thought he could explain how Mr. Siemens had obtained the astonishing figures he had ventured to quote to that Institution. In the first place, it had been clearly proved by Mr. Taylor, than whom probably no one had had a greater experience in measuring the speed of cables, that the longer a cable, or the higher its K R, the better the speed constant will seem to be. This was in a great measure due to the fact that the slower working speed of long cables was less affected by the disparities of the receiving instrument which handicapped the shorter cables to a marked extent, even if measures were taken to modify the adjustment of the instrument and otherwise assist it to give the best signals procurable under each condition. There were at least two other points which Mr. Siemens had omitted to consider. He was wrong in any case to estimate the K R by multiplying the capacity and conductor resistance per knot by the lengths, because the greater proportion of a long cable would probably lie in deep water, and consequently have a lower K R than a shorter one. The actual observed K R only was worthy of acceptance for calculation. In his further criticisms he remarked that the self-induction of the core was another important factor, remarking that it was now a custom, introduced by Messrs. Siemens, to build a conductor up to 10 strands of copper.

Prof. Thompson would like to add one word before the debate closed—namely, that they must distinctly acknowledge how much they owed to Mr. Oliver Heaviside's suggestion that in cables they could not neglect the effect of self-induction of the copper core, and Mr. Heaviside had even suggested that the signalling should be accelerated by adding to the self-induction. This was very significant, more especially when they took into account modern methods of submarine signalling, which were getting more and more a matter of alternating impulse, and therefore of waves and alternating currents.

The thanks of the Institution were then cordially extended to the authors by acclamation.

MISCELLANEOUS NOTES ON THE CHELTENHAM MAINS.*

BY HAMILTON KILGOUR, MEMBER.

Among engineers who have had to do with central-station work, it would probably be impossible to find a dissentient from the proposition that the means of distributing the electric energy are quite as important as the means of obtaining this energy from the source of energy available at the station, and it would be difficult to find many who could say that nine-tenths of their troubles and anxieties do not come from the outdoor works. It seems strange, then, to find that engineering societies have devoted so much attention to the machinery and accessories of a station, and so little, in comparison, to its outdoor works, especially when it is remembered that the larger part of the station machinery is similar to that in common use for many other purposes, while the distributing works involve the use of plant of an almost entirely novel character.

The foregoing considerations, coupled with the invitation of your secretary, have led the author to write a few notes regarding mains more with the view of inducing a discussion and a useful interchange of information among you, than in the hope that he can contribute anything particularly interesting or useful himself.

At Cheltenham, electric supply is given for the most part by 100-volt and 200-volt distributors fed by sub-stations, which are themselves fed by 2,000-volt feeders from a principal sub-station, to which the large feeders from the works run untapped. There are two or three short independent low-pressure distributors supplying groups of houses in outlying districts and fed by street-box transformers, which are supplied from high-pressure distributors; in certain roads, where the houses are few and far between, high-pressure distributors supply house transformers. The 100-volt distributors are being converted by degrees into 200-volt distributors, and the disadvantage of the increased cost of energy to the customers changed over is being met by giving a special rebate of 8½ per cent. to all supplied at 200 volts pressure.

The works lie at a distance of rather more than 2,000 yards from the principal sub-station, which is situated near the business centre of the town, and quite away from the residential and business districts; the plan of running untapped feeders to the principal sub-station and of distributing the energy from there by minor feeders has the advantage of practically placing the works at the principal sub-station in respect to pressure regulation, of giving the assistant in charge of the mains complete control of the whole system at a convenient place in the town, and—as happens from the configuration of the town—of reducing the cost of the feeders.

At the works duplicate high-pressure 'bus bars, on to either of which any dynamo can be switched, are provided on a single-pole machine board: these two 'bus bars are connected through switches and meters to duplicate high-pressure 'bus bars on a Ferranti feeder board. A Ferranti board has normally one high-pressure 'bus bar, and the means of coupling together, independently of this bar, the inners of any two adjacent feeders, as it is of some importance to us to be able to put any dynamo on any circuit we have added a second 'bus bar above the first. In order to decrease the rate of accumulation of dirt on the 'bus bar insulators, and to make it impossible for the chain of the overhead traveller to touch high-pressure metal a horizontal slate slab has been fixed above the Ferranti board. The outers of all the feeders are coupled by links to a low-pressure 'bus bar, as is usual on these boards, and this bar is permanently connected to earth; one pole of each dynamo is permanently connected to a bare copper strip, laid in a trench under the switchboard passage, and connected to the feeder board low-pressure 'bus bar—the other pole of each dynamo being connected through its switch, fuse, and ammeter to one or other of the duplicate 'bus bars on the machine board.

A second and quite independent earth connection is also provided, and it is easy to test the resistance from one earth to the other, and so to ascertain at any time that both are

* Paper read before the Northern Society of Electrical Engineers.

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good. The advisability of this duplicate earth with a simple means of testing its efficacy became apparent when the original earth wire of galvanised bullock cable (about $^{19}/_{16}$) was found to have rotted through after a couple of years' use. The present earth wires are composed of heavy copper strip, and the one earth is made to a 3in. water service from the town mains, and the other to an earth-plate below the natural water-level of the ground. I may add here that we have found galvanised iron cable quite useless for earth wires in many parts of the town, and now use large (about $^{19}/_{15}$ to $^{19}/_{14}$ iron-wire cables thoroughly treated with a composition similar to that of Angus Smith.

The station meters are of the Thomson-Houston type, and the meters for the arc lighting feeders are of the new Westinghouse type. Hookham meters are quite unsuitable for arc lighting or motor circuits on account of their inaccuracy on inductive loads.

There are at present four feeders—viz., two $^{37}/_{16}$ to the principal sub-station, and two $^{19}/_{18}$ to the arc lighting system for the west of the town. A fitted panel for a third feeder to the sub-station has been provided on the Ferranti board, and also three unfitted panels for future extensions.

All cables, other than those used for services, are concentric and are insulated with bitumenised fibre and manufactured by Callender's Cable Company, and I may say that our experience with these cables has so far been very satisfactory. In a few of the principal streets unarmoured cables have been used, and these have been drawn into conduits composed of cement concrete with bitumenised paper tube ducts. In most of the streets and roads, however, armoured cables have been used, and these have been laid—according to the nature of the soil—either direct in the ground or in wooden troughs filled in with bitumen. All armoured cables laid under roadways, whether in wooden troughs or not, have been protected with a layer of bricks placed across and above them, and in many cases—where there has been sufficient available depth—this protection has also been given to armoured cables laid under footways.

The sizes of high-pressure cables used are $^{37}/_{16}$, $^{19}/_{16}$, $^{19}/_{18}$, and $^{19}/_{20}$; the first two sizes mentioned are used for feeders, the $^{19}/_{18}$ only for the feeders from the works to the arc lighting system of the western section of the town, and the $^{19}/_{20}$ for arc lighting circuits and for the riding mains referred to hereafter. All high-pressure cables are tested *in situ* with an alternating current at a pressure of 4,000 volts, and no faults have occurred other than those caused by external damage, except on the $^{19}/_{20}$ cables. In the $^{19}/_{20}$ cables first laid the outer wires are not in contact with one another round the inner insulation, and this not merely renders this cable very susceptible of injury during laying, however great the care taken may be, but also causes, on any single wire parting at a factory joint, a difference of pressure between the slightly separated ends sufficient to produce sparking, with a gradual destruction of the neighbouring insulation, and finally a fault. Further, this bread-and-butter construction allows a greater freedom of motion to the wires of the outer conductor, and if a joint on one of these parts when the cable is coiled on the drum there is a considerable danger of one or other of the free ends penetrating the inner insulation when the cable is paid off the drum during laying. Several faults occurred on testing the arc lighting circuits with 4,000 volts pressure, and we now use $^{19}/_{20}$ cables with a sufficient number of outer wires to completely surround the inner insulation, although this makes the outer conductor of considerably larger cross-sectional area than the inner in consequence of it being inadvisable to use wires smaller than No. 20 gauge.

In two or three cases it has been necessary to lay considerable lengths of feeders along roads having few probable customers, but with good districts at their remote ends. In each of these cases a $^{19}/_{20}$ cable has been laid alongside the district feeder, in order to pick up customers on the way without tapping the feeder itself. About every 400 yards, more or less, as has been necessary in different instances, a four-way box has been fixed in these roads, and the four ends of the cables are coupled together in these boxes—the outers permanently to a low-pressure 'bus bar and the inners through switch fuses to a high-pressure 'bus bar. All customers in these roads are connected to the $^{19}/_{20}$ riding main, and by pulling out the switch fuses at each end of any length of this cable a new customer can be connected without interrupting supply either to the district at the end or to the customers on other sections of the riding main. This arrangement is also useful in localising faults. A drawing of this type of box is shown in Fig. 1. Oil insulation is employed, and has been found fairly satisfactory.

Almost all high-pressure services, whether to customers or to arc lamp transformers, are connected to the mains through double-pole switchboxes; the spindle of each switch projects through a gland in the top cover of the box, and is covered by a little screw cap when not in use; to use the switch the cap has to be removed and a box spanner key applied. A slightly modified form of this box is used where an arc lighting circuit splits into two through a branch being taken down a side road; a concentric socket is then provided and connected to the branch main, and this socket is rendered accessible by a screw cap in the top cover above it. By means of a long concentric wall plug

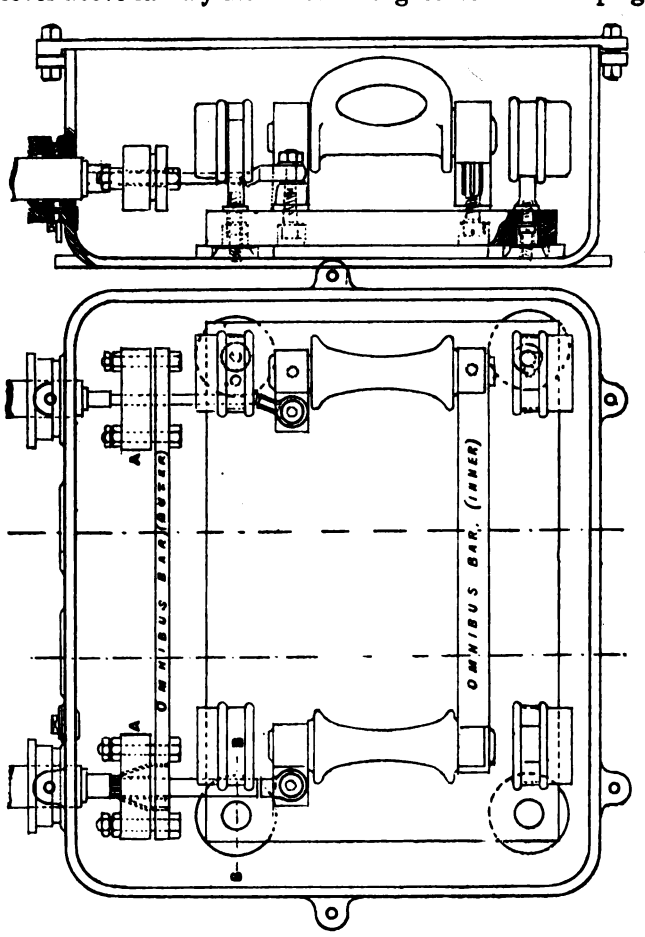

FIG. 1.—Four-way High-Tension Feeder and Riding Main Switch and Fuse Box.

any branch main can be directly connected to testing apparatus after the switch has been opened. It will be obvious that the use of these boxes, one of which is exhibited, greatly facilitates the localisation of any fault, whether in the main, a branch, or a service. A modified form of the ordinary water-hydrant box is placed over each box in order that the screw caps may be accessible without taking up roadway or pavement. These switchboxes, the hydrant boxes, and all other joint-boxes are earthed, and in practically all cases the earth-plates are the town water-mains.

High-pressure services to house transformers are made with $^{19}/_{20}$ armoured concentric cable and services to arc lamp transformers with $^{7}/_{18}$ armoured concentric cable. In each case, in all recent work, the outer conductor completely surrounds the inner insulation, and in every case the lead and the armour of the service cable are earthed both at the service joint and at the transformer.

From the principal sub-station feeders radiate to the sub-stations in its vicinity in the case of the more important in duplicate, and from these sub-stations other feeders supply the more remote sub-stations and the high-pressure distributors. The general arrangements of all the larger sub-stations are similar. Each is divided into two parts—for high and low pressure apparatus respectively—by a wooden rail, and in the high-pressure part are the feeder

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dividing boxes, single-pole switchboards, and, as a rule, the transformers, while in the low-pressure part are the distributor dividing boxes and double-pole switchboard. Each feeder dividing box (Fig. 2) will take three cables, and in it the outers are coupled to a low-pressure 'bus bar, to which are also connected two single cables by which this bar can be coupled to the corresponding bar of another box, or to the low-pressure terminals of the transformer primaries. The inners are jointed within the box, which is filled with insulating oil, to lead-covered, rubber-insulated, single cables leading to a single-pole board on which they are coupled to a high-pressure 'bus bar through switch-fuses. In the older sub-stations a similar switch-fuse board is used for supplying the high-pressure terminals of the transformer primaries—the 'bus bar of this board being connected to the feeder 'bus bar by cable. In the recent sub-stations a six-way board of the type shown in Fig. 3 is used in place of the two three-way boards, and if there are more than three

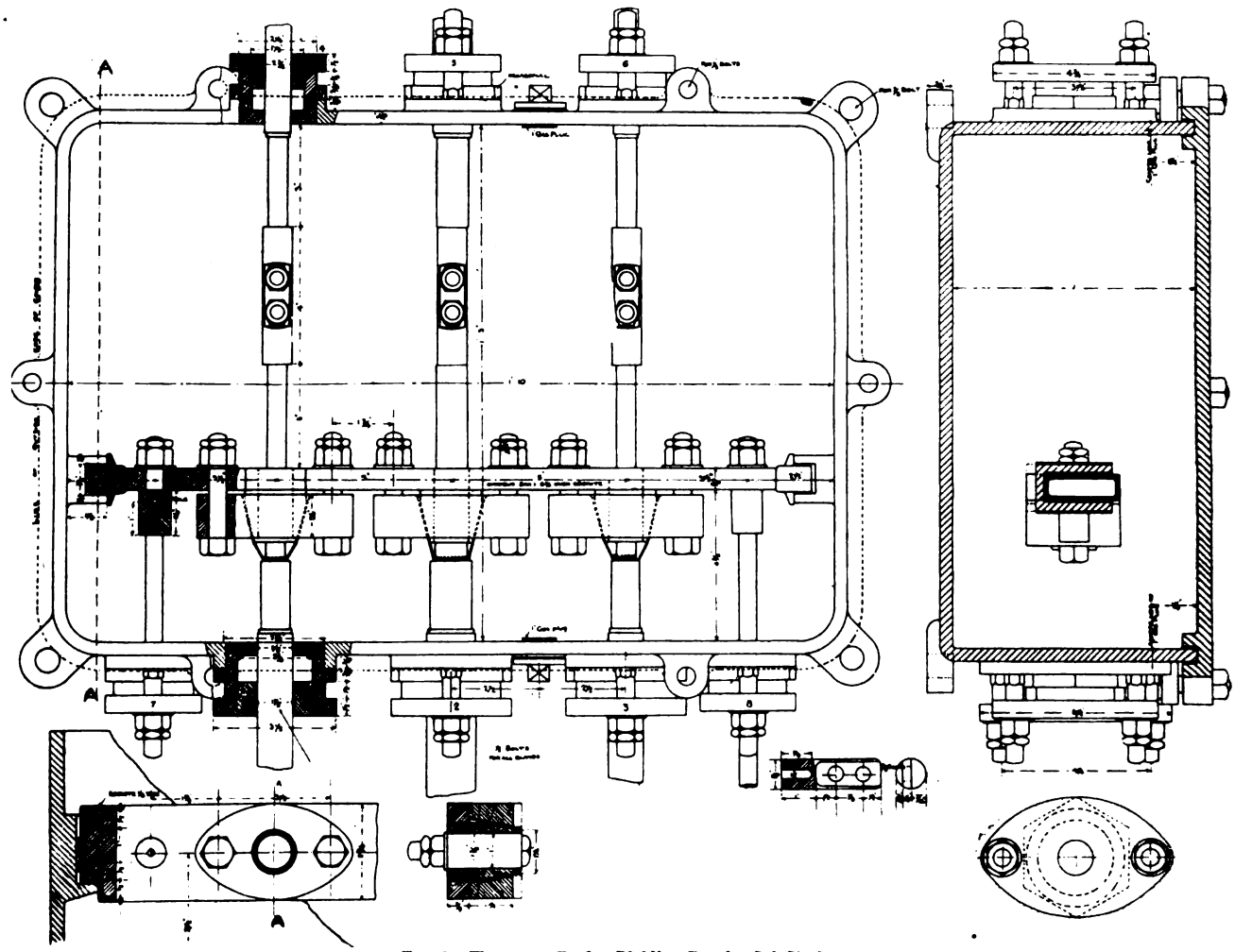

FIG. 2.—Three-way Feeder Dividing Box for Sub-Stations.

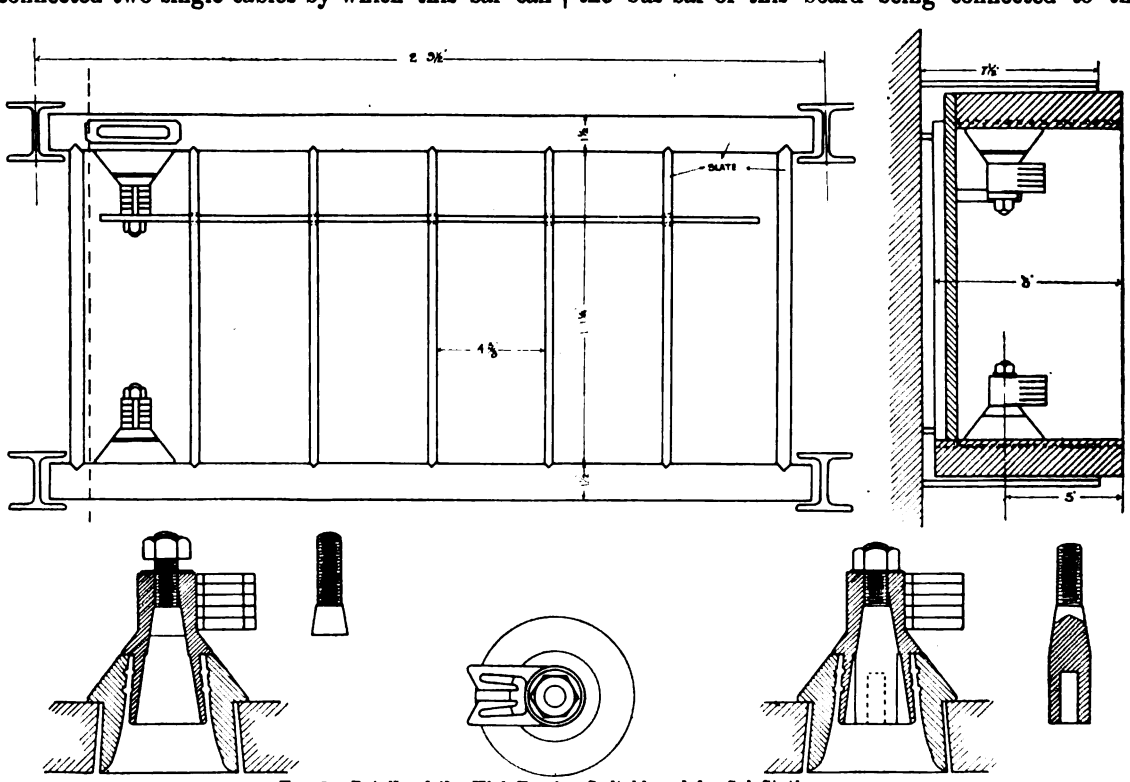

FIG. 3.—Details of the High-Tension Switchboard for Sub-Stations.

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feeders another three or six way board is added. All high-pressure boxes are earthed, as are also the lead coverings of the high-pressure cables and the transformer earth shields. With this mode of connecting the feeders together the effect of a fault is to blow the fuses at each of the two sub-stations, into which the faulty length of feeder enters. When the extensions now in progress have been completed most of the town sub-stations will have two independent sources of high-pressure supply, so that high pressure can be cut off entirely from any one of these sub-stations without interfering with the supply to other sub-stations and without—except at times of heavy load, as in the evenings—affecting the pressure appreciably on the low-pressure distributors.

The sizes of the low-pressure distributors used are $^{37}/_{12}$, $^{37}/_{15}$, and $^{19}/_{14}$, according to the density of the demand and the pressure at which supply is given. In the sub-stations each distributor is jointed, in a small dividing box, to a pair of rubber-insulated single cables, by which it is connected to a pair of 'bus bars through a pair of switch-fuses in the older sub-stations, and through a link and switch-fuse in the more recent sub-stations. Cardew's earthing devices are used in the sub-stations for the protection of the low-pressure circuits.

(To be continued.)

FULHAM VESTRY.

ELECTRIC LIGHTING CONTRACTS.

With reference to the contracts for electric lighting works for the Fulham Vestry, it will be remembered that the committee have not followed the recommendation of their consulting engineer, Mr. Medhurst, but that they recommended the acceptance of the lowest tender, which was that of the General Electric Company. Mr. Medhurst's recommendation was to the effect that the contract should be divided between other two companies which were higher in the list of total amounts. After careful consideration, the sub-committee to whom the matter was again referred by the Vestry recommended, as before, that the General Electric Company should receive the contract, and this recommendation was endorsed by the Electric Lighting Committee as a whole. We regret to note that in consequence of this certain allegations as to undue influence have been made in Fulham. The matter came up for discussion before the whole Vestry in committee on Wednesday last. This discussion was subsequently continued in open Vestry until a late hour. The reasons adduced for not giving the contract to the lowest tenderer are somewhat hard to understand, seeing that in this case the work was not offered to open competition. In fact, one would assume from the previous statements of the consulting engineer that only firms which he considered to be quite capable of carrying out the whole work in accordance with the best engineering practice, were asked to tender. In spite of this, reasons for not giving the work to the General Electric Company were brought forward which would seem to infer that they were not considered to be sufficiently experienced to undertake the work. Amongst other points raised was that of the construction of their dynamos, and the fact that certain of these might be manufactured abroad, while the old and vexed question of trades union rate of wages was also introduced and discussed. In consequence, it is not to be wondered at that the company in question took up the matter strongly. The Vestry had been in committee about an hour, when a representative of the General Electric Company (which had previously intimated to the clerk a desire to submit a statement) was called into the room. After submitting this statement, which dealt generally with the objections raised against the firm, a series of questions, referring among other matters to trades union rate of wages, previous work done by the firm, and so on, were put. The representative explained that he was not there to answer questions, and Mr. H. Hirst, a director of the General Electric Company, was called to discuss the matters at issue. One member of the Vestry said he had noticed that something had been published in the newspapers to the effect that the company did not want to enter into personalities, this gentleman adding that in his opinion the matter ought to be thrashed out. Mr. Hirst then read a statement dealing with the personal element connected with the allegation that his firm had exerted undue influence on the members of the Electric Lighting Committee. He was then questioned with reference to the rates of wages paid by his firm and its financial standing. He was also asked as to whether the reputation of the General Electric rested on contract work, and if not, on what did it rest. Mr. Hirst having supplied answers, it was intimated that his presence could be now dispensed with, and the committee then adjourned to the Vestry Hall.

The discussion which was adjourned from the previous meeting was then resumed on an amendment: "That the contracts for mains be given to the British Insulated Wire Company." Mr. Budd supported the amendment, on the ground that they were advised to do so by the consulting engineer. After a few words from Mr. Green, explaining why he opposed the amendment, it was put to the meeting and rejected. Mr. Baxter then suggested that the whole of the work should be done under trades union conditions. He maintained that if the Vestry accepted this proposal there would be no more bothers of the character of those which had arisen. Mr. Sayers said what the Vestry wanted, and what should be inserted in the contract, were penalties of £10, £50, or £100 for breach of the labour clauses of that contract. After some further discussion, it was decided that contractors should produce sufficient evidence to show that the whole work had been, or would be, manufactured under the trades union conditions of the respective trades, and that a penalty clause of £10 should be placed in the contract, such penalty or penalties to be recovered from the principal contractor. Mr. Sayers advocated that the work should be advertised for in sections. This would result in a considerable saving.

After some further discussion, Mr. Medhurst rose and said he fancied what he had to remark would be a repetition. With regard to readvertising for tenders, he should say that the best plan now would be to do so. He did not believe in advertising usually, as some of the best firms would not tender in open competition, but if it was a question whether he or the chairman of the sub-committee were interested in any contract it would be far better to throw the whole thing perfectly open. When he recommended that what was wanted to be done should be done privately, and for the whole contract, nothing was further from his mind that suspicion should attach to anyone. But, rightly or wrongly, suspicion had attached, and did still attach, from right to left. He would let the tenders now be advertised for the sake of decency. Mr. Lawson said the best thing would be to readvertise. Other speakers followed, one of whom said that, intentionally or unintentionally, the electrical engineer had misled them into making certain blunders. The Vestry had had before them the representative of the General Electric Company, and a better man could not have been sent.

A resolution moved by Mr. Baxter that no tender should be accepted that night, but that the work should be advertised in sections, was lost, the voting being 14 for and 20 against.

The recommendation of the committee that the whole work should be given to the General Electric Company, at a contract price of £45,718, was then put as a substantial motion and carried by 24 votes to 14. At this price the work on the river section is included at £750, as the Vestry have not allowed the General Electric Company to amend their tender by adding on £1,000 as they desired.

[We have had before us the report in the local papers of the previous meeting, containing a series of letters which have passed between Mr. Medhurst and Mr. Green, the chairman of the Electric Lighting Committee. It seems to us that the whole dispute, which has raised much bad feeling, is due to the fact that selected firms only were allowed to tender. We deprecated this from the first, and presume it will lead to the resignation of Mr. Medhurst, as the vote of Wednesday last amounts to one of want of confidence.—ED. *E. E.*]

FORTHCOMING EVENTS.

FRIDAY, MAY 12.

Royal Institution.—At 9 p.m., "Magnetic Perturbations of the Spectral Lines," by Prof. Thomas Preston, M.A., D.Sc., F.R.S.

Physical Society.—At 5 p.m., "Note on the Vapour Pressure of Solutions of Volatile Substances," by Dr. R. A. Lehfeldt, D.Sc.; "Note on the Discussion of their Paper on the Criterion for an Oscillatory Discharge of a Condenser," by Prof. W. B. Morton and Dr. Barton; Exhibition of a Quadrant Electrometer by Mr. G. L. Addenbrooke.

SATURDAY, MAY 13.

Institution of Electrical Engineers—Students' visit to the Telegraph Works of Messrs. Henley and Co. Train from Fenchurch-street to North Woolwich at 9.40 a.m.

Institution of Junior Engineers.—Visit to the Royal Arsenal, Woolwich. Train leaves Charing Cross at 9.20 a.m.

THURSDAY, MAY 18.

Institution of Electrical Engineers (Rooms of Society of Arts).—At 8 p.m., "Electric Locomotives in Practice and Tractive Resistance in Tunnels, with Notes on Electric Locomotive Design," by Mr. P. V. McMahon. Discussion.

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THAT PACIFIC CABLE.

If the subject were not so important, we certainly should not touch it again. The other day it seemed settled, now the end appears as far off as ever. When the *Times* made the announcement that the Government had agreed to fall into line with the Colonies, congratulations were the order of the day. They were premature, for as soon as the conditions accompanying the granting of the subsidy were known objections were taken to them as too stringent, as throwing all the risk upon those less able to bear it, as rendering the scheme too costly, yet carefully picking out the plums for home use. It will be well to give the conditions, and then to refer to the adverse comments on them. The offer is to grant an annual subsidy, not exceeding a maximum limit of £20,000 in any year, under the following conditions:

"1. That the Canadian and Australasian Governments undertake to construct the line, and to provide in each year any further sum that may be necessary for its efficient maintenance and working.

"2. That the subsidy runs only from the opening of the cable for traffic, and so long as it is so open, with the allowance of a reasonable time for repairs in the event of interruption of communication.

"3. That the cable is, in accordance with a specification and samples to be approved by the Treasury and to the satisfaction of an officer appointed by the Treasury for that purpose, constructed, submerged in proper working order, and established with proper stations and offices at such places as the Treasury may approve, and effectually worked with a sufficient staff of proper and efficient officers, being British subjects.

"4. That messages of the Imperial Government are transmitted in priority to all other messages at rates not exceeding one-half of those charged to the general public.

"5. That all rates charged to the general public, whether for messages to, from, or between intermediate stations, or for through messages between this country, Australia, and New Zealand are approved by the Treasury.

"6. That an account, duly certified and audited, is rendered annually to the Treasury as soon as possible after the anniversary of the opening of the cable showing: (*a*) the net traffic receipts in the past year for messages sent over the line after the deduction of money paid out for the further transmission of messages on other lines; (*b*) the expenses incurred in the same year, including interest, sinking fund, maintenance and repairs, and working expenses. The Treasury will cause this account to be duly examined, and will pay over to such person as the associated Governments of Canada and the Australasian Colonies may nominate in their behalf five-eighteenths of the amount by which the net receipts shown by this account, after examination, shall fall short of the amount of the expenses, subject to the maximum limit named above.

"7. That the cable is worked in accordance with the International Telegraph Convention of

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St. Petersburg of July 10 (22), 1875, and the regulations in force for the time being thereunder."

The *Times* of Monday last thus criticises the point of increased cost: "Putting the capital required for the construction of the cable in round figures at £2,000,000, and taking the difference between the price of Canadian 2½ per cent. stock and British 2½ per cent. stock, we get the first cost of the Imperial modification of the original proposal. Canadian 2½ per cent. stock was quoted on Saturday at 91¾. The price of British 2½ per cent. stock on the same day was 103¾, or a difference of £12 on every £100. Twelve per cent. on £2,000,000 represents £240,000. This is the sum which the decision of her Majesty's Government to stand aloof as partners from the scheme must be estimated as adding to the cost of construction of the cable. The interest upon it must be borne for ever by the cable. No one gains by the arrangement, unless it be the existing companies, to whom the extra charge serves as a handicap upon the commercial position of a new competitor. The absurdity from the public point of view is that we who have made the arrangement are interested in the commercial success of the scheme to the extent of promising to pay a share of any loss that may result. The ground on which the refusal to co-operate with the Colonial Governments in the manner recommended by the Cable Committee is based is that the construction of the Pacific cable is a matter of much greater importance to Canada and Australasia than to the United Kingdom, and that in the opinion of her Majesty's Government Parliament can only be asked to aid the project on the ground that its success 'cannot fail to promote Imperial unity.'"

According to the estimated returns, the revenue from the proposed line might be less than the expenses for some years, and the Government would be called upon to pay during that time five-eighteenths of the loss. The revenue may overtake the expense in one year or in five or ten years, but most writers agree the probability is that revenue and expenses will balance within five years, after which the Government would pay nothing. On the other hand, the stringent conditions have increased the cost £240,000, upon which interest has always to be paid, and the Government stipulate for its messages to be sent at half-price in perpetuity. It will be well just at present to restrict expressions of opinion almost entirely to this financial point, for on its solution the whole affair hangs. It must be noticed that, while the Government will take no risks, it will take none of the profits. Do these two things balance themselves? We think not. In our opinion the importance of the cable should induce the Government to take its share of the risk and so reduce the initial cost, and so reduce the subsequent annual interest. Put it another way. The interest on £240,000 at 2½ per cent. per annum is £6,000 a year, and this is a loss in perpetuity. The probable payments of the Government under the conditions formulated would not in the aggregate reach to £50,000. Would it not be the better way to save, if possible, the £6,000 a year?

The danger of making hasty statements at this phase of the negotiations is clearly shown in the issue of the *Chronicle* yesterday. In one column it points out that the Colonies do not possess ships and appliances for surveying, while the Government does, hence the Colonies could not do this part of the work so cheaply; while in another column it states, on the authority of Reuter, that a Government ship has been deputed to do this work. Let us hope that the views that have found expression will assist in bringing to a satisfactory conclusion the negotiations still going on between the Colonies and the home Government.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

REUNION IN SWITZERLAND.

We have received from Mr. W. G. McMillan the following particulars of the proposed arrangements for a visit of the Institution to Switzerland in September next. With the kind assistance of Colonel Huber, Mr. C. E. L. Brown, Prof. Wyssling, and others, the following provisional programme has already been drawn up:

As at present arranged, members will visit the Rheinfelden Works on Saturday, Sept. 2, will proceed on the same day to Zürich, and will remain there until Sept. 6. During this time visits will be paid to the works of the Oerlikon Company, of Messrs. Brown, Boveri, and Co., and of Messrs. Escher, Wyss, and Co., and to certain power stations and tramway and lighting installations in the district, including, as it is hoped, a visit to the Schaffhausen Works. They will then proceed to Lucerne, and, after inspecting the street railways of that town, if time permit, the Rathhausen Works and the Stansstad-Engelberg Railway, will travel *viâ* the Brünig Pass to Interlaken. Here opportunity will be given for visiting both the Jungfrau Railway (*viâ* the Wengern Alp route) and the Burgdorf-Thun Railway, as well as other places of electrical interest in the neighbourhood, and the visit will end on Saturday, Sept. 9. The above programme is of course subject to alteration. It is hoped that alternative excursions will be arranged on some of the days for ladies who may accompany members, but may not wish to visit the works.

For the convenience of members who do not propose to travel independently to and from Switzerland, arrangements will be entered into with one of the tourist agencies for the issue of tickets (available for 25 days) at reduced rates to those accompanying the party starting from London on Sept. 1; and a special train may, if necessary, be provided on the morning of that day for the conveyance of the party. Hotel coupons at fixed charges (available at certain specified hotels in Zürich, Lucerne, and Interlaken) could also, if required, be obtained through the tourist agency employed.

In the event of a sufficient number of members signifying a wish to spend some time in Switzerland before the beginning of the meeting, earlier dates could be fixed for the departure of parties of not less than 30 each, at the reduced rates, allowing time for return to England at the conclusion of the visit on Sept. 10, within the 25 days for which these special tickets are available. It is hoped that arrangements may be made for the extension of the tour, so that members wishing to do so may have the opportunity of taking part in the celebration of the Volta centenary at Como on Sept. 18. It should be noted that members availing themselves of the special tickets at reduced fares are required by the rules of the railway companies to travel with their party only on the outward journey. The return journey may be made individually and independent of the party at any time within the period for which the ticket is available.

In order to complete the preliminary arrangements, it is necessary that the Council should be in a position to estimate the number of members likely to take part in the visit, and Mr. McMillan is, therefore, anxious to hear from those who wish to attend before the end of this month.

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For the information of members, it may be stated that the cost of the visit of 10 days probably need not exceed £12 or £13 for second-class and £15 or £16 for first-class passengers, including railway fares (at reduced rates) and hotel expenses, but exclusive of wine and extras.

We trust that the *réunion* will be a representative one, and that the number attending will be large, as a better tour for seeing Swiss electrical work could not be devised.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. Questions may be sent at any time. Answers must be written on one side of the paper only.

QUESTIONS.

165. Describe any commercial method of ascertaining the E.M.F. curve of an alternator?—J. P. C.

166. What is meant by a system of induced draught for boilers? Describe one such system?—P. T.

N.B.—The Editor will be obliged if R. Dawson will kindly forward his full address.

ANSWERS.

Question No. 159.—In an arc lamp how should the regulating coils be wound (*a*) when the lamp is required for parallel working, (*b*) when it is to be used for series working?

Best Answer to No. 159 (*awarded* 10*s.*).—A short consideration of the motion of the arc-lamp carbons necessary for the satisfactory working of the lamp will make the answer to this question plain.

The mechanism, whatever be its character, must bring the carbons together, or, at least, allow them to come together, and the result of this short-circuiting of the carbons must be utilised in some way to draw them apart again immediately the current is switched on, thus "striking" the arc.

The lamp may be working under one of two conditions—*i.e.*, it may be running in parallel with other single lamps across the mains, or it may be working in series with one or more lamps. In other words, it may be running with a constant potential difference at the dynamo terminals, or it may run with the dynamo giving constant current but varying its voltage in proportion to the number of lamps in circuit.

If the lamps have a constant voltage, as the resistance of the arc increases by lengthening, the current will necessarily diminish. If, on the other hand, the lamps are in a constant-current circuit, the lengthening of the arc will necessitate an increase of potential difference to maintain the same current between the lamp terminals.

It is evident, therefore, that in parallel working *current* is the variable quantity, while in series working *voltage* is the variable; and these variations, in their respective cases, are the determining factors in the winding and construction of the regulating coils.

Consider (*a*) parallel working. In this case one coil only is required in series with the arc. The connections are shown in Fig. 1, where T_1 and T_2 are the lamp terminals. The regulating coil takes the form of a vertical solenoid in most lamps which burn with vertical carbons. Briefly stated, the action is as follows, no account being taken or description given of the mechanism between the solenoid core and the carbon, it being assumed for simplicity, and as fulfilling the requirements of the question, that the carbon is simply directly connected to the core. Normally, then, the carbons touch. This is effected by gravity or by means of weights and pulleys if the lamp should be burning with carbons horizontal. As soon as the current is switched on, the solenoid is energised by the large rush of current which takes place owing to the short-circuited carbons. This causes a sudden jerk of the core, the carbons are held apart, and thus the arc is "struck." The upward force exerted by the solenoid balances the weight of the carbon and mechanism, and the length of the arc is thus determined. As the carbons consume away the arc lengthens and its resistance increasing causes the current to diminish. The solenoid hence pulls less strongly, and consequently the core drops lower until a point is reached—viz., when the arc reaches its original length—at which there is again equilibrium. This action goes on constantly, and so a gradual forward feed takes place, caused by the constant tendency of the solenoid to diminish its pull.

Coming to a consideration of (*b*), it is evident that the conditions are rather different in series working, because the regulating factor tends to increase, as distinguished from the diminishing tendency of the corresponding factor in (*a*).

It is possible in this case also to regulate by means of a single coil wound with fine wire and placed as a shunt across the arc lamp terminals. Note, however, that, owing to the reversal of conditions already mentioned, the carbon can no longer be connected directly to the solenoid because the variation tends to suck the solenoid core further up, while the working of the lamp requires that the carbon should be lowered instead of raised. Fig. 2 shows how this difficulty is overcome. The solenoid core is shown attached to one end of a short lever, pivoted at its centre.

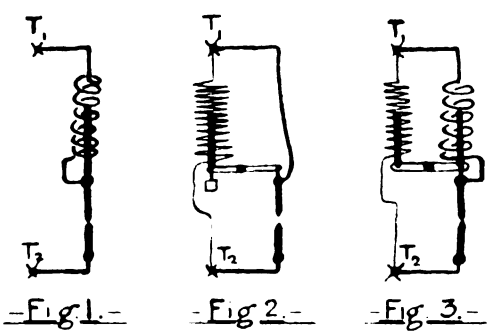

Fig 1. Fig 2. Fig 3.

This end of the lever has also a weight hung on it as shown, sufficiently large, along with the weight of the core, to overbalance the weight of the carbon which hangs from the other end, and so raise the top carbon from the lower when no current is passing. The action should now be clear. Assume, for simplicity, that only two lamps are in series, and denote them by L and L_1. When the circuit is closed, current can only pass round the solenoid coils as the carbons are not touching. This causes a pull, which overbalances the downward pull of the weight, and consequently lets the top carbons down to touch the lower ones. This happens practically simultaneously in L and L_1. As soon as this occurs the voltage between T_1 and T_2 drops because of the short-circuit, and this is sufficient to allow the weight to act again and "strike" the arc by pulling the carbons apart. Then equilibrium is set up between the weight of the various parts and the solenoid pull. As the arc burns longer the potential difference gradually rises, the solenoid is sucked up, the arc shortened, and equilibrium once more obtained.

Fig. 3 shows another method of running arc lamps in series. The weight at the end of the shunt-coil core is replaced by a series coil acting directly on the upper carbon, and also attached to the opposite end of the lever from the shunt solenoid core. This is used merely for "striking," and acts in precisely the same way as the series coil in Fig. 1. When the arc is struck the current remains fairly constant, especially if there are a large number of lamps in series, and for this reason the series coil has little to do, and is quite well replaced by the weight previously described.

It is interesting to note that while the single series coil can only be used for parallel working, the arrangements in Figs. 2 and 3, while specially suited to series working,

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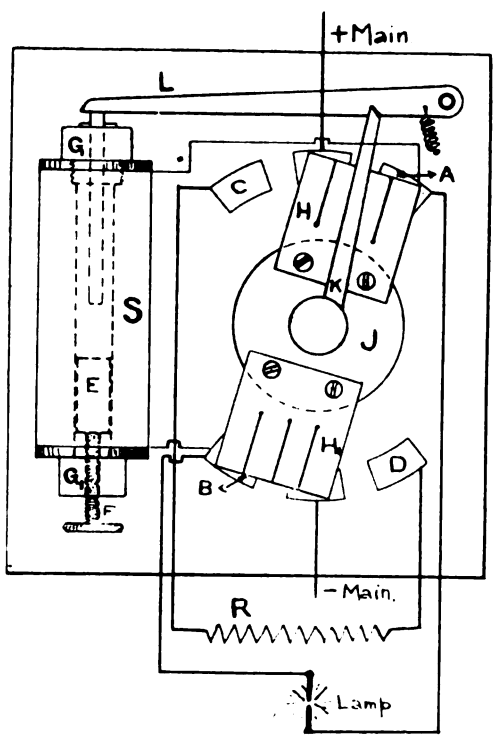
will also work quite well in parallel. The shunt coil alone (Fig. 2) will "strike" the arc quite well, because before the carbons come together the voltage between T_1 and T_2 is practically the full dynamo voltage. This causes the coming together of the carbon, which in its turn causes a reduction of voltage sufficient to separate them again, and so the action goes on. Fig. 3 will also work quite well in parallel, the striking being effected by the series coil and the feeding being performed by both together.

The conclusion, then, is that for parallel working a series coil is all that is absolutely necessary, and for series working there may or may not be a series coil, but there must be a shunt coil; and, further, lamps adapted for series working will work satisfactorily in parallel also, but the converse does not hold.

It is obvious that the connection to the movable carbon from the series coil must be flexible to allow free motion.—T. C.

Question No. 160.—Describe, with sketches, the best form of automatic cut-out you know of for an arc lamp.

Best Answer to No. 160 *(awarded* 10*s.).*—The accompanying diagrammatic sketch shows a form of automatic arc lamp cut-out which has proved very satisfactory in its working. On the left is a solenoid, S, with a hole running



up its centre, all one diameter. In each end of this is screwed a brass gland, G and G_1. The gland at the top has a small hole, about $\frac{1}{8}$in. diameter, drilled through it, and in this is inserted a piece of brass wire, fitting loosely, and prevented from falling right in by the small pin at the end, as shown in the diagram. The bottom of this wire reaches to about the centre of the coil. In the lower part of the coil is a soft iron core, E, also fitting loosely. Its position may be adjusted by means of the small set screw, F, in the lower gland. The core is of such a size as to leave a space between itself and the bottom of the brass wire normally. On the top of the brass wire rests one end of a lever, L, whose other end is pivoted, and which is held down by the small spiral spring shown near the pivot. At the right hand of the slate base, on which the whole is mounted, is a change-over switch. There are six contacts altogether, as shown. J is an insulating piece which works round a central pivot. To J are attached H and H_1, broad copper jaws, made flexible by five saw-cuts towards J, as shown. These are insulated from one another by J, and are wide enough to connect two adjacent contacts, as is evident from the sketch. The top and bottom centre contacts are connected to the + and − mains respectively. The right-hand top and left-hand bottom contacts are connected to the arc lamp + and − terminals respectively, as shown at A and B, while C and D, the remaining contacts, are connected to the terminals of the substitutional resistance, R. The ends of the solenoid coil are connected to the arc lamp contacts, A and B From the central pivot, and attached to it so as to move with J, is an arm, K, which is shown in the diagram, with its end fitting in a catch filed in the lever. There is also a spiral spring (not shown in the diagram) at the centre pivot of J, which tends to pull the switch round from its present position towards C and D, and if the end of K be released by the raising of L, this will actually occur. In its normal position, therefore, the position of the switch is such as to cut the arc lamp out of circuit, and it has to be placed in the position shown by hand. This is seen to, as a rule, by the trimmers in their rounds. In this position the lamp is ready for burning. It "strikes" when the main switch is put on, and, if in proper order, continues to burn all right. If, however, anything occurs which tends to break the circuit, as, for example, the sticking of the mechanism, which would cause the arc to go out by lengthening abnormally the space between the carbons, or if from any other cause the lamp is on the way to extinction, it is evident that the voltage at its terminals will be increased. This, of course, increases the magnetisation of S, because it is a shunt across the arc, and a point is reached at which the core, E, is jerked up, and thereby the brass wire receives an upward knock, which raises the end of the lever and releases the catch, allowing the end of K to be free. The spiral spring round the centre of J then acts, and the switch automatically goes over to C and D, thus cutting out the lamp, and putting the substitutional resistance in series with the main circuit. This action has been arranged to take place before the arc actually goes out by the adjustment of F experimentally so as to make E more when the voltage reaches a certain percentage of excess over the normal pressure required to work the lamp. Thus, the other lamps in series with the faulty one are still supplied with current, and so kept burning. The resistance, R, is supposed to lose the same number of volts as the lamp at the normal current, so that the volts at the terminals of the other lamps in series may not be abnormally increased.

As already mentioned, the solenoid, switch, etc., are all mounted on one slate base, and in the case at present in the writer's mind this was enclosed in a cast-iron cover box with a watertight lid, and the whole was fixed to the arc lamp-post. The connections were taken through holes in the cover box, bushed with insulating material, and filled up with pitch after the cables were in and connected up. The substitutional resistance was of the embedded enamel type, and was also made suitable for mounting on the post. The whole thing was thus self-contained and made an extremely compact and accessible job, giving great satisfaction in working.

It is perhaps unnecessary to mention that these cut-outs are needed only in conjunction with arc lamps run in series, as in parallel working the extinction of any lamp does not affect the other lamps of the installation at all.—T. C.

Answer to No. 160 (*awarded* 5*s.*).—The chief requirments for an automatic cut-out are: (1) definite action, not a quick make and break, like a trembling bell; (2) ability to carry full current for several hours if necessary; (3) to allow the lamp to cut in automatically, if the break is only due to a momentary lengthening of the arc, from any cause whatever; (4) no destructive sparking.

I have found the following cut-out fulfil all the above; it is an ordinary electromagnet with the coils wound in series with the shunt coil of the lamp and of the same gauge. A third terminal leading to a substitutional resistance is carried on vulcanite between the pole-pieces. The iron armature is pivoted at one end on the lamp frame, and has an adjustable contact at the centre.

When the current is passing through the carbons and series coil in the ordinary way the current through the shunt and cut-out is not sufficient to attract the armature owing to its weight, but if the series circuit is broken the whole current of the lamp passes through the shunt circuit, and the armature is immediately lifted, thereby putting the + terminal of the resistance on to the frame, and so cutting the lamp out.

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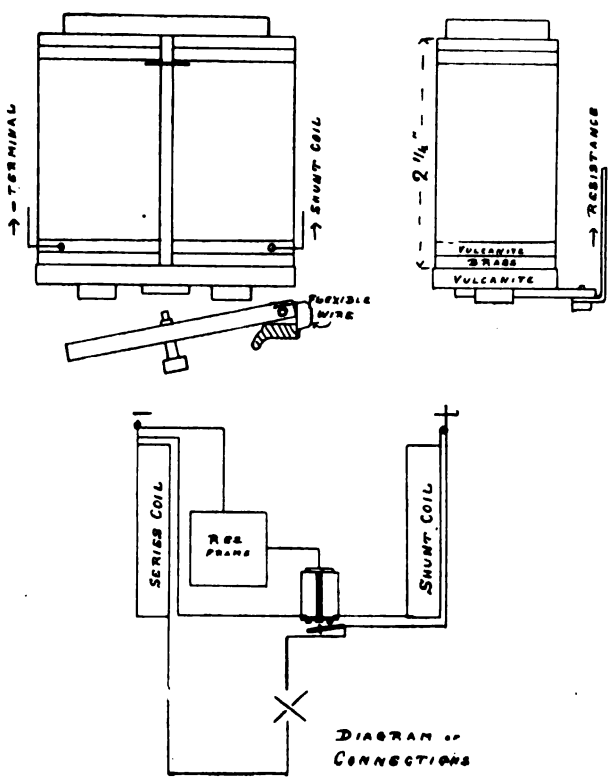
If the carbons can feed together again, the reverse action takes place, and the armature is released.

The armature is "bonded" to the frame in order to avoid all sparking and overheating at the pivot. There is



practically no sparking at the contacts, because the circuit is made and broken in a magnetic field.—B. P.

MAGNETISM.*

BY PROF. JAMES ALFRED EWING, F.R.S., M.I.C.E.

When the council of the institution honoured me with an invitation to deliver the "James Forrest" lecture they suggested "Magnetism" as the subject. I felt at the time that it was like prescribing an ox roasted whole for an invalid's lunch. How could one treat a theme so vast within the limits of a single hour with any hope of making it pleasing or even digestible? But, having nothing better to propose, I weakly acquiesced, and I now find myself confronted by this appalling task. It gives me at least a grain of comfort to reflect that the council must take a large share of responsibility for the choice.

Whatever be his subject, the particular duty of the "James Forrest" lecturer is to treat it as an illustration of the bearing of science upon practice. He has to show how the visions of the philosopher become translated into the matter of fact of the engineer; how observations and theories which at first awaken only the intellectual interest of the scientific enthusiast are in time found to have application to the use and convenience of the man in the street. He has to show that if necessity is the mother of invention, science is often its foster-mother. And there is another side to the matter, for if the lecturer discharges his duty aright, he will show how practice pays back its debt to science; how the progress of invention stimulates the progress of discovery; how the laboratory owes as much to the workshop as the workshop owes to the laboratory.

Time was when it might have been appropriate in addressing an audience of engineers to plead for the better recognition of science as the handmaid or mistress of practice. But there is no need to do that now. The service which each does to the other is recognised; the beneficent reaction between them has, in late years especially, been too fruitful to escape universal notice. Whatever barrier used to be apparent has broken down. Day by day, one may say, more and more points of contact are found, more grounds of sympathy in sentiment, more opportunity for co-operation. To one who, like your lecturer, has his affections distractingly divided between physics and engineering, it is pleasant to note that not simply in education, but in language, in mental habit, in appreciation of experiment, and in many other ways, engineers become daily more and more akin to physicists, while students of natural science grow more ready and more able to observe nature from the standpoint of the engineer. There will always, we need not doubt, remain two extreme schools of intellectual activity, one caring only for abstract truth, the other with no interest save for what promises immediate application. But between those extremes you will find men of more catholic spirit, whose zest for scientific discovery is none the less keen because they have an eye to the uses to which some of it may be put. The achievements in the world of practice of a Kelvin or a Hopkinson are as remarkable as their discoveries in pure science. I mention great names, but these are many lesser men who follow in their footsteps.

Certainly it would be difficult to find a subject that is better fitted to illustrate the harmony of practice and science than this subject of magnetism. Indeed, so intimate is their contact and co-operation here that it would be hard, in giving any account of the subject, to draw a line between matters of industrial application and fruits of research.

The applications of magnetism are older than the science—so old that they are lost in the mists of the remote past. If we cast our eyes far enough back they light on the traditional and shadowy figure of the Chinese imperial navigator Hoang Ti, who, some 24 centuries before Christ, is said to have piloted his fleet of conquering junks by the aid of a floating fragment of loadstone. The loadstone, a natural magnet composed of the magnetic oxide of iron, is found in the magnetised state at many places on the earth's surface, and notably at Magnesia, in Asia Minor, which led Euripides to call it the magnetan stone. Though the writings of Plato and Pliny and Lucretius contain many references to the distinctive properties of the loadstone and many curious legends concerning it, it is remarkable that neither the Greeks nor the Romans were aware of its use in navigation. We are told in the Book of Acts that St. Paul, after staying three days at Syracuse, "fetched a compass" and came to Rhegium, but any student of the institution will tell you it was not a mariner's compass that he fetched.

Though the uses of magnetism were unknown in those classical times, its abuses appear to have flourished then, as they do still. The loadstone was reputed to free women from witchcraft and to put demons to flight. A magnet pickled with the salt of the sucking-fish could draw water from the bottom of the deepest well. Iron rings magnetised by rubbing against a loadstone were a remedy for the gout, and the priests of Samothrace, five centuries before the Christian era, are said to have made a tidy revenue by selling those ancient prototypes of the modern magnetic belt. The mysteries of magnetism have in all ages formed a happy hunting ground for lovers of the occult. Quackery and superstition have found it a name to conjure with. The fact that a thing is unintelligible has been held sufficient reason for dubbing it magnetic. It is no part of my business to speak of "animal magnetism," for whatever elements of fact there are in the reported phenomena which go by that name, we may rest assured that with magnetism they have nothing whatever to do. It is a striking fact that among our bodily senses we have nothing to help us to a perception of magnetic activity. The sense of sight may indeed be called a magnetic sense when regard is had to the principle that light is made up of electromagnetic waves, but you may put your hand or your head between the poles of the most powerful magnet and be unable to tell whether the magnet is or is not in action. We have no direct perception of the magnetic field, and there is no such thing in any legitimate use of the term as animal magnetism.

According to one story it was Marco Polo, the Venetian, who brought the mariner's compass from China to Europe in the thirteenth century. Anyhow, it use was known then, though the attractive influence was wrongly localised, being ascribed to one of the stars in the tail of the Great Bear. The Provençal poet Guiot, in a MS. of the thirteenth century, tells at length, as if it were rather a new thing then, how a steel needle may be magnetised by touching it with a loadstone, and how when put through a piece of straw and set floating it always points to the north:

> "Puis se torne la point toute
> Contre l'estoile sans doute."

A famous letter of Peter Peregrinus written in 1269 contains a remarkably good account of the polar quality of the magnet and of its use in finding the north. By the time of Columbus the compass, with its divided card, was apparently a common appliance in navigation. It was during his first voyage to America in 1492 that Columbus discovered the variable deviation of the needle from the true north. The fact that the balanced needle does not lie horizontally, but dips, was discovered by a London instrument maker called Norman in 1576.

We may take it, then, that applications of magnetism were known certainly 600, perhaps 5,000, years ago. But the science of magnetism is just 300 years old; it dates from the publication, in the year 1600, of the treatise "De Magnete" by William Gilbert. In that remarkable book the speculations of the schoolmen and the "old wives' tales" which had gathered

* The "James Forrest" lecture, delivered before the Institution of Civil Engineers, April 20, 1899.

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about the subject were brushed aside, and the foundations of magnetic philosophy were laid on the safe ground of experiment. Gilbert showed, by means of a model globe cut out of loadstone, that the behaviour of the compass needle was to be explained by regarding the earth itself as a great magnet, surrounded consequently by an "orbis virtutis"—a sphere of influence, or, as we should now call it, a magnetic field. Time would fail me to tell you of the many acute observations described by Gilbert, which entitled him to high rank among the founders of experimental science. Galileo, his even greater contemporary, said, "I extremely admire and envy the author of 'De Magnete'"; and Dryden wrote this panegyric:

> "Gilbert shall live till loadstones cease to draw,
> Or British fleets the boundless oceans awe."

This last line suggests the remark that if Dryden could see the naval estimates for the present year of grace—and of aspiration after general disarmament—he would surely have no misgivings as to the permanence of Gilbert's fame.

It would be easy to occupy the whole of the lecture in telling of the subsequent developments of that first application of magnetism, the mariner's compass; of the new problems which presented themselves when magnetisable metals—iron and steel—took the place of timber in the construction of ships; of the analysis by Archibald Smith of the various disturbing influences which the magnetism of the ship exerts; and of the inventions by which Lord Kelvin brought the compass to its present state of perfection and enabled correcting devices to be applied, by which the effects of the ship's magnetism are neutralised. In Lord Kelvin's compass we have a striking instance of the results that are achieved when profound scientific insight works hand in hand with rare practical instinct and inventive skill. I wish I could dwell on so attractive a theme, but I must hasten on to speak of other developments and applications of the science of magnetism.

The pivoted needle of the compass turns so that it may place itself in the direction of the lines of force of the magnetic field; so long as no local disturbing cause acts, the field is that due to the magnetism of the earth. But Oersted discovered, in 1820, that if a wire conveying an electric current were brought near, the needle became deflected, because (as we now know) the current produces a magnetic field on its own account, whose lines of force encircle the conducting wire. Eleven years later Schweiger showed how this effect could be intensified by winding the conductor into a coil, in the middle of which the pivoted needle was set, and thereby invented the galvanometer. The laws of the phenomenon were investigated by Ampère and by Weber, and thus the way was paved for the introduction in 1837 of the needle telegraph by Cooke and Wheatstone. Our president has lately told us of their pioneer line 1½ mile long, part of which was revived by him and was used, as a relic of the year of the Queen's accession, to telegraph her Majesty's message to her scattered peoples on the day of her Diamond Jubilee. What that lusty infant, the telegraph, has grown to in the intervening 60 years you do not need to be told. Taking British telegraphs alone, the expansion of which owes much to our president's fostering care, there are now considerably more than 1,000,000 miles of wire. Our distant colonies are bound to the mother country not simply by links of loyalty and mutual affection, but by material bonds of copper which have no small port to play in the building up of empire.

The suspended needle, by which Cooke and Wheatstone gave practical application to the discovery of Oersted, did not long remain the sole, or even the chief, instrument in telegraphy. It was almost at once supplemented, and soon, to a great extent, displaced, by the family of instruments which depend on the attraction which an electromagnet exerts on a movable armature, instruments of which the telegraph of Morse was the first to take working shape. But Oersted's discovery met with a second great application at the hands of Lord Kelvin in 1858, when the problem of signalling at a remunerative speed through long ocean cables was solved by his invention of the mirror galvanometer, an invention which at the same time supplied physicists with an invaluable new weapon of research. His later invention of the siphon recorder allowed the delicate fluctuations of current, which constitute the signals in such a cable, to be registered as well as read. In the galvanometer the coil is held fixed and the magnet moves. In the Kelvin recorder the force between the two is still the operative force, but it is the coil that moves while the magnet is held fixed.

Morse's telegraph was the practical fruit of the discoveries of Ampère and Sturgeon. Ampère had shown that pieces of steel might be permanently magnetised by placing them inside a coil of wire, within which a magnetic field was established by passing an electric current through the wire. Sturgeon, in 1825, substituted a soft-iron core for the steel, and pointed out that it acquired strong magnetism so long as the current flowed through the surrounding coil, but lost its magnetism when the current ceased to flow. On establishing the current the iron core underwent, as he says, a "transition from a state of total inactivity to vigorous polarity," and exhibited "an intensity of action far surpassing that of any known permanent magnet." Joseph Henry improved the winding of Sturgeon's electromagnet, and used it by means of a movable armature to sound a bell at a distance from the operator. From this the step was easy to the recording telegraph of Morse. Simplified into the "sounder," this remains one of the most ordinary appliances of the telegraphist, and the principle it embodies finds application in the Wheatstone automatic receiver, in the type-printing telegraph familiar to those who study the "tape," and in a host of other forms.

Faraday's discovery, made in 1831, that a current of electricity is induced in a conducting circuit when it is moved in a magnetic field, in such a way as to vary the number of lines of force which it encloses, led to the invention of the magneto-electric machine, where the movement of the armature of a permanent magnet is used to induce currents in a coil. This has found many uses. It was applied in telegraphy by Wheatstone as the transmitting device in his step-by-step, or A B C, apparatus. Substantially the same principle formed the basis of the original telephone of Graham Bell. There the movement of an iron disc by the speaker's voice induced corresponding currents in a coil through the agency of a magnet to which the disc acted as armature, the movements of the disc having the effect of varying the magnetic field within the coil. These currents passed to the distant end and gave rise to corresponding movements on the part of a second disc in an instrument which was an exact counterpart of the first. I was old enough in 1876 to appreciate the charm of this weird and exquisite invention, and looking back now it seems, as it seemed then, alike in its novelty, in the vastness of its consequences and in the simplicity of its means, to be the most marvellous of all the wonder-compelling applications of magnetism. The magneto-electric method of generating telephone currents, introduced by Bell, gave place, in the hands of Edison and Hughes, to other and better means, but the receiving portion of the apparatus retains substantially the form which he gave it. The varying attraction for its armature of a magnet which is strengthened and weakened by the transmitted currents is still used to cause the vibrations of the disc which convert those currents into speech. The latest advance in telegraphy, the achievement of Marconi in communicating between France and England without an intervening wire, is as much as any other a direct fruit of magnetic research. When an electric current comes into existence, the magnetic field which it induces around it does not spread through space instantly, but with a limited velocity. A current undergoing rapid oscillations, such as a discharge surging back and forth through two plates, consequently sets up magnetic waves of corresponding frequency which travel out into space with a velocity which is, in fact, the velocity of light. These waves of magnetic induction were pictured by the mathematical imagination of Maxwell; and they were demonstrated by the experiments of Hertz, who showed us how to detect their presence at points which might be fairly distant from the source. The researches of Branly and Lodge gave far more delicate means than Hertz had used to discern the arrival of these magnetic waves; and Lodge, who has devoted much attention to the subject, has also been successful in developing appliances for sending and receiving signals over long distances by comparatively long-period waves of magnetic induction, using closed circuits at each end of the system, tuned into electric synchronism, so that the magnetic oscillations sent out by one of them are detected by aid of electromagnetic resonance in the other. But the most striking success which has been achieved in this application of magnetism is Marconi's use of short-period Hertzian waves to signal across the Channel from the South Foreland to Boulogne. Mr. Marconi is to be warmly congratulated on accomplishing this remarkable feat, which has arrested the attention alike of the public and of specialists, and had opened all eyes to the practical capabilities of this new telegraphy.

It is interesting to note in passing, though it is scarcely relevant to my subject, that telegraphy by waves of magnetic induction is the oldest telegraphy of all. Maxwell's conclusion that the waves which constitute light are nothing less than very quick-period waves of magnetic induction was abundantly verified by the work of Hertz, who succeeded in submitting artificial magnetic waves to the reflection, refraction, and polarisation, which we are familiar with in the case of light. Hence the heliograph, the venerable semaphore, and all the visual signals that have been used from the day when Eve first smiled to Adam, are examples of magnetic wave telegraphy, though I cannot claim them as fruits of magnetic research. In the use of that most delicate of electromagnetic receivers, the eye, we must admit that practice came before science.

Faraday's great discovery of the induction of electric currents by moving a conductor in a magnetic field of force led, as we have seen, to the magneto-electric machine. A permanent steel magnet served to produce the field, and the coils in which current was induced were generally wound upon an armature which revolved between the poles. The early machines of Clarke and Pixii were improved upon by Wilde, who used a second machine to generate a current which was employed in magnetising the field magnets of the first. From

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this to the invention of the dynamo was a step so natural that we need not wonder it was taken independently, and almost simultaneously, about the beginning of 1867, by no fewer than three inventors, Wheatstone, Werner Siemens, and Alfred Varley. Up to that time the magneto-electric machine, when considered from the engineer's standpoint as an engine for producing electrical energy by the expenditure of mechanical work, had been little more than a toy. But the abolition of permanent magnets, and the substitution of soft-iron cores excited by the current generated in the machine itself, constituted a revolution, and the dynamo became a means of applying power to generate electric currents on a grand scale. I do not mean that the change came all at once; it is a far cry from the "'A' Gramme" of 20 years ago to the big dynamos of to-day with their 2,000 h.p. or 3,000 h.p. But the introduction of the self-exciting field magnet was the decisive step which made the mechanical production of electric currents a part of engineering—a large part, indeed, as it has since become.

The dynamo machine underwent a course of improvement which was, in part, the necessary consequence of its design being seriously taken up by mechanical engineers, but in great part also the result of magnetic research. To no man did it owe more than to one who was lately taken from us in the fulness of his powers and in circumstances of peculiar sadness. John Hopkinson's contributions to the development of the modern dynamo were many, but I would specially refer here to his part in establishing the theory of the magnetic circuit. Though the idea of the magnetic circuit had been more or less vaguely present, mainly by analogy, in the minds of other thinkers, it was for the first time explicitly formulated in a way to command assent in a paper by the brothers John and Edward Hopkinson, and was further applied by them with remarkable effect to problems of dynamo design. A right appreciation of the principle of the magnetic circuit has been one powerful factor in the evolution of the modern dynamo. Another has been the advance which has taken place, through experimental research, in our knowledge of the magnetic qualities of iron. I shall endeavour, before we have done, to pass in rapid review some of the principal facts in magnetism with which the dynamo builder is concerned.

Imagine a conductor wound into a coil which carries an electric current. Each of the lines of force, or, as we will rather call them for the present purpose, lines of magnetic induction due to the current, passes through the interior of the coil and returns into itself through external space. The path taken by these lines constitutes the magnetic circuit; it is interlocked with the circuit of the conductor, and in this instance it fills all space, for the lines returning outside the coil are spread without limit. Imagine next that the coil is a long helix, and that it is bent round to form an endless ring. The lines of induction are now confined to the interior of the ring; they still form a closed circuit interlocked with the circuit of the conductor, but they now close themselves without spreading into outside space. If we strengthen the current in the coil we strengthen the induction in the magnetic circuit. If we fill the space within the coil full of one substance or another we find in general very trifling variations in the induction within. But if one of the three metals—iron, nickel, or cobalt—be placed as a core within the coil, especially if the one chosen be soft iron, we find an enormous difference. The induction within the coil is then many times greater—it may even be thousands of times greater—than it was before the iron was put in. This familiar fact is expressed by saying that iron and, in a lesser degree, nickel and cobalt possess exceptional permeability to magnetic induction.

A core of iron, however strongly magnetised, would be of no service in a dynamo unless we imagine a gap to be cut in it, where the conductor, whose movement across the lines of induction is to produce current, can be placed. The practical function of the field magnets is simply to produce a strong induction in the narrow gap where the armature coils revolve. The business of the fixed coils, to which the magnetisation is due, is to establish a mixed magnetic circuit, forcing the magnetic induction not only through the iron, but across the much less permeable gap. Hopkinson's discussion of the magnetic circuit showed how it might be arranged in the way most favourable to efficiency, and how, knowing the dimensions of the system and the magnetic quality of the iron, we could predicate what amount of magnetic induction would be set up in the gap by a given current in the field magnet's coils, and hence predetermine the behaviour of the machine.

No sooner was the dynamo introduced than it was discovered that its function could be reversed. Given a supply of electric current, the dynamo, acting as a motor, would serve to convert the energy of the current into mechanical work. This opened up an immense additional field for the industrial uses of magnetism. I need not take up time by referring to matters of everyday observation. No one does not know how the dynamo, acting both as generator and as motor, has given us a new branch of engineering of so vigorous growth that it almost threatens to eclipse the parent stem. It has given us electric lighting and the electric distribution of power. It has taught us to harness Niagara, where I was glad to see that the engineers have still left some water, and other waterfalls, where I am sorry to think they have left none. It has created new metallurgical processes and new chemical manufactures with the aid of the electric furnace and the electrolytic vat. It has given us electric railways and tramways, or, rather, it has given them to our neighbours on the Continent and our friends over the sea, for you will find more electric traction in a single American or Canadian city than in the whole of Great Britain.

Faraday's further discovery, that the induction of magnetism in an iron core by setting up a current in a surrounding coil would induce a current in a second coil wound upon the same core, was the parent of the induction coil and the transformer.

(To be continued.)

ST. PANCRAS ELECTRICITY ACCOUNTS.

The following is the report of Mr. Albert E. Pycraft, chief clerk to the St. Pancras Vestry, on the working of the electricity and public lighting department during the past year. The revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are also appended:

During the year a sum of £22,445 was received from the London County Council, making a total amount of £184,930 received up to Dec. 31, 1898. Of this amount a sum of £13,872. 8s. 3d. has been repaid. Since the closing of the accounts sanction has been given for two further loans for £30,000 and £12,000 respectively. The capital expenditure during the year amounts to £32,936. 1s. 1d., increasing the total expenditure on this account to £241,993. 16s. 6d. From the present capital account items included in the accounts for 1897 for "installations in public buildings and offices and telephone installation" have been omitted, in consequence of the London County Council taking exception to the amounts being borrowed under the Electric Lighting Acts, stating that the expenditure under these heads "must be treated as required for the domestic purposes of the Vestry, and must, if borrowed, be borrowed under the Metropolis Management Acts, with a shorter period for repayment according to the life of the work." Pending the decision of the Vestry on the matter the amounts expended for the purposes named have been transferred to suspense account. The gross revenue for the year amounts to £38,256. 0s. 4d., an increase over the year 1897 of £4,908. 0s. 5d.; the net profit after meeting all interest and repayment charges amounts to £4,175. 2s. 5d., to which is added the balance £1,717. 7s. 2d. brought forward from 1897, making a net profit to carry forward of £5,892. 9s. 7d. It should be borne in mind that during the past year the Vestry have twice made reductions in charges to consumers by introducing the maximum demand indicator system; the charges by that system for the first half of the year being at the rate of 6d. per unit for the first three hours and 3d. per unit after, and for the second half of the year 6d. per unit for 1½ hours and 3d. per unit after. The charge for public lighting and the supply to public buildings was also reduced 1d. per unit from June last—viz., from 5d. to 4d. per unit. These concessions have materially reduced the income for the year, the rebates under the indicator system amounting to £3,300. The increase in gross revenue over the previous year in money value represents 14·6 per cent., but the total units sold show an increase over the previous year of 31·3 per cent. A sum of £658. 18s. 10d. is included in this account, representing the cost of works up to the close of the year for repairs and reinstatement consequent upon the damage done to the Vestry's mains and culverts by the gas explosion last August at Cumberland-terrace, Regent's Park. A further account for reinstatement charges amounting to £63. 12s. 4d. for work executed since the close of the year has been received, making the total cost of these works £722. 11s. 2d., which sum the Vestry should now make application to be reimbursed, in accordance with the committee's recommendation. The following table shows succinctly the progress since the commencement of the electricity undertaking:

Regent's Park Station.

Year ending Dec.	No. of consumers.	Current sold to consumers (not including public street-lighting). 3d. per unit. £ s. d.	4d., 5d., and 6d. per unit. £ s. d.	No. of lamps, etc., applied for. Incandescent. 16 c.p.	Arc.	Motors.
1892	172	—	8 167 7 8	9,990	82	11
1893	238	384 11 6	9 161 6 0	12,851	110	19
1894	349	1,236 13 9	10,819 15 9	15,542	129	22
1895	447	2,142 9 6	12 682 6 0	19,195	139	37
1896	530	2,490 12 9	16,064 4 5	21,511	151	44
1897	615	3,226 6 9	19,878 9 5	23,988	187	65
1898	709	6,524 12 3	18,190 10 3	27,538	215	70
		King's-road Station.				
1896	142	458 2 0	3,369 4 3	4,912	36	3
1897	193	855 3 3	5,342 2 0	8,262	69	13
1898	275	1,890 7 9	5,255 14 11	10,586	77	21

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REVENUE ACCOUNT.

Dr. Generation of Electricity.	£ s. d.	£ s. d.
Coal or other fuel, including carriage, etc.	£7,028 19 9	
Oil, waste, water, and engine room stores	586 12 0	
Proportion of salaries of engineers	443 19 2	
Wages at generating stations	2,859 7 2	
Sundry petty expenses	71 8 1	
Repairs and maintenance, as follows: buildings, £149. 8s. 6d.; engines, boilers, etc., £1,037. 5s. 4d.; dynamos, exciters, accumulators, etc., £528. 3s. 11d.; other machinery, instruments, and tools, £167. 5s. 5d.; less received for old materials, £35 9s. 5d.	1 846 13 9	
		12,836 19 11
Distribution of Electricity.		
Proportion of salaries of engineers, etc.	352 18 5	
Wages of outdoor staff	784 5 0	
Repairs, maintenance, and renewals of mains of all classes, including materials and labour	1,843 0 3	
Rearranging public arc lighting mains	3,892 16 2	
Repairs, maintenance, and renewals of meters, switches, fuses, etc., on consumers' premises	423 8 2	
Water, etc., at sub-stations	10 9 11	
		7,306 17 11
Public Lamps.		
Carbons	230 17 5	
Repairs	381 18 5	
Attending	561 4 11	
		1,174 0 9
To licenses and wayleaves		26 14 0
Rents, rates, and taxes		604 11 10
Management Expenses.		
Salaries: engineer's department	1,140 4 2	
Stationery and printing	219 18 0	
General establishment charges	271 15 8	
		1,631 17 10
Law and parliamentary charges		38 12 10
Special Charges.		
Insurances, etc.	280 17 3	
Expenses testing meters	6 6 0	
Expenses obtaining loans	40 14 6	
Compensation claim	5 0 0	
Hire and erection of temporary plant	246 13 2	
Dismounting and removing plant	96 3 11	
Expenses of rewinding consumers' motors	194 5 0	
		869 19 0
Total expenditure		24,489 14 11
Balance carried to net revenue account		13,766 5 5
		£38,256 0 4

Cr.	£ s. d.	£ s. d.
Sale of current per meter at 6d. per B.T.U.	21,278 11 0	
Ditto at 5d.	656 5 10	
Ditto at 4d.	1,511 8 4	
Ditto at 3d.	8,415 0 1	
		31,861 5 3
Public lighting (sale of current and all maintenance and capital charges)		5,978 19 7
Indicator rentals		45 17 0
Special chargeable works		36 8 5
Fees for testing installations		15 10 6
Rents receivable		40 15 2
Proportion of office expenses chargeable to the lighting (gas department)		277 4 5
		£38,256 0 4

GENERAL BALANCE SHEET.

Dr. Liabilities.	£ s. d.	£ s. d.
Capital account—amount received	184,930 0 0	
On loan from bankers	48 518 19 3	
Sundry creditors	6 237 4 3	
Amounts due under contracts	11,117 7 10	
Interest accrued on loans	1,766 5 6	
Net revenue account	5 892 9 7	
Reserve fund	4,000 0 0	
		£262,462 6 5

Cr. Assets.	£ s. d.	£ s. d.
Capital account—amount expended for works	241,993 16 6	
Stores in hand at Dec. 31, 1898: coal, £101. 4s. 11d.; oils, waste, etc, £113. 12s. 11d.; carbons, £6. 5s. 4d.; general, £3,717. 7s. 2d.	3,938 10 4	
Debtors for current supplied to Dec. 31, 1898, £13,775. 2s. 2d.; less deposit account, £199	13,567 2 2	
Sundry debtors	290 13 3	
Suspense account	2,596 1 4	
Cash in hand	67 2 10	
		£262,462 6 5

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Regent's Park Station.

Quantity generated (in Board of Trade units)		1,534,006
Quantity sold: Public lamps	229,094	1,506,136
Quantity sold: Private consumers (by meter)	1,277,042	
Quantity used on works and testing-room		52,892
Total quantity accounted for		1,559 028
Quantity not accounted for		117 104
Number of public lamps		106
Total maximum supply demanded		19,339

King's-road Station.

Quantity generated (in Board of Trade units)		748,879
Quantity sold: Public lamps	121,254	490,741
Quantity sold: Private consumers (by meter)	369,487	
Quantity used on works and testing-room		65,428
Total quantity accounted for		556,169
Quantity not accounted for		50,584
Number of public lamps		91
Total maximum supply demanded		7,320

HAMMERSMITH.

At the meeting of the Vestry on Wednesday, the engineer, Mr. G. G. Bell, submitted the following report on the results of the first complete year's working of the electricity department:

Most satisfactory progress has been made in the undertaking, and there is every indication that this progress will be continued during the next 12 months. The number of consumers has increased from 132, on March 25, 1898, taking a supply for 8,098 8-c.p. lamps, to 275 consumers, with 19,390 8-c.p. lamps, on the corresponding date this year, and there are still 2,480 8 c.p. lamps being installed and nearly ready for connection to the mains. During the past year our first extension of generating machinery and mains has been nearly completed. The contracts for new engines and machinery contained an obligation to complete by October, 1898, but owing to the fact that the first set was not in working order until Christmas, we have been debarred from making any real use of the same during the year just completed. In consequence of this delay the original plant was very much overloaded, a circumstance which seriously increased the working expenses. For the same reason the department was unable to connect up a large number of consumers, who were compelled to wait until the new machinery was installed and in working order, thus resulting in a considerable loss of revenue. The department has received £1,957. 10s. for lighting and maintaining arc lamps in the public streets This sum represents the supply of 145,438 units of electricity, carbons, cleaning, trimming, and daily attendance on the arc lamps to keep them in working order, and also annual repayment of capital and interest thereon. As this amount works out at the low sum of only 3¼d. per unit, it is clear that profit has not been made by charging an exorbitant sum for public lighting—in fact, it has been done at practically cost price. With regard to the private lighting, the Vestry has sold 372,191 units producing a revenue of £7,181. 9s. 5d., or an average price of 4·6d. per unit. This price is amongst the lowest in the London district. The total cost of supplying is £5,484 (just under 2½d. per unit), or 59·4 per cent. of our revenue, which leaves a gross profit of £3,749. 5s. 3d., or 40·6 per cent., towards paying interest and sinking fund charges. The average annual revenue derived from each lamp was 10s. 10d., each lamp being used on an average 840 hours per annum. The whole of the generating machinery and distributing mains have been maintained in efficient working condition out of revenue. Owing to the coal strike we have been compelled to pay very much more for our coal, the total extra cost being £303. 9s., or an increase of nearly 14 per cent. The gross result of the year's working shows a profit of £3,749. 5s. 3d., and, after the deduction of interest and repayment of capital, will leave a net profit of £1,420. 1s. It will be seen that these are excellent results, and I think the Vestry has every reason to be satisfied with them, considering that the period under review is the first whole year's working. It will be borne in mind that each customer has to invest a considerable sum before he can use electricity, and therefore, in my opinion, it would be prudent policy on the part of the Vestry to make a reduction in the charges to the public, in order to induce them to avail themselves of the supply. In conclusion, I would observe that when the important extensions now in hand are completed, and after allowing for an ample reserve, the department will be in a position to supply a maximum of 30,000 lamps alight at one time, or a further number equal to double our present output.

The engineer also appended a statement as follows:

HAMMERSMITH VESTRY ELECTRICITY WORKS, HIGH-PRESSURE SUPPLY STARTED JULY 1, 1897.

Analysis of Accounts for Year ending March 25, 1897.

	£ s. d.
Capital expended to March 25, 1899	£72,425 11 6
Revenue from electricity supply	£9,138 19 5
Revenue from meter rents and other sources	£94 5 10
Total revenue	£9,233 5 3
Total cost of generation and distribution	£5,484 0 0
Gross profit before setting aside instalments for interest, depreciation, sinking fund, etc.	£3,749 5 3

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Percentage of costs to revenue, 59·4 per cent.
Percentage of gross profit to capital, 9½ per cent.
Interest on loans for year, £1,370 12s. 7d.
Amount of capital redeemed to date, £1,902.
Percentage of capital redeemed to amount borrowed to date, 2·85 per cent.
Financial result after paying all charges, interest, and redemption of capital for the year, etc., profit of £1,420. 1s.
Capacity of dynamos, March 25, 1899, 700 kw.
Maximum load reached, 501 kw.
Capital outlay per kilowatt, March 25, 1899, £100.
Number of 8-c.p. lamps (motors, arcs, and incandescent), 21,825.
Number of units sold, 517,629.
Units sold per lamp, 28.
Revenue per lamp, 10s. 10d.
Statutory price, 8d.
Average price obtained: public supply, 3¼d. per unit; private supply, 4·6d.

The Electricity and Lighting Committee reported that the number of applications received for private lighting is 351 for a total of 23,442 lamps of 8 c p, the number of consumers already connected is 290, with 19.985 lamps, and the maximum number of lamps alight at one time is 17,013 (including street-lighting), and recommended that as from June 24 next the price for current supplied to consumers under Scale A be 6d. per unit for one hour and 3d per unit thereafter, and that the charges for supply to places of public worship, starting from June quarter, be 4d. per unit.

LEGAL INTELLIGENCE.

ALLEGED EXTENSIVE ENGINEERING FRAUDS.

At the Hyde Borough Police Court, on Thursday week, Henry Cleaver, of Southampton, described as an electrical engineer, was charged on remand with obtaining money by false pretences from Messrs. Stanley, Davies, and Pollard, electrical engineers, Hyde. On the application of Mr. Joe Cooke, a sum of £9 found upon the prisoner when arrested was handed back to him. We extract the following from the *Reporter*:

Mr. Bostock, for the prosecution, stated that the prisoner was charged with obtaining by false pretences a cheque of the value of a guinea from Messrs. Stanley, Davies, and Pollard, and with further attempting to obtain from the prosecutors the sum of £25. The prisoner described himself as a consulting engineer, but he thought he should be able to satisfy the Bench that he was nothing of the kind, and that he was simply an impostor. An advertisement appeared in the *Electrical Review* of Feb. 3 this year to this effect: "Electrical installation, generators, and engine, 100 kw., one boiler for the above, electric lighting, etc., tenders required for the above either as a whole or individual portions. Full details and specifications can be obtained on application on enclosing a postal order for a guinea, which sum will be returned on receipt of a *bonâ fide* tender. Specifications will be sent out on Feb. 6. H. Cleaver, consulting engineer, 52, Bridge-road, Southampton." The advertisement, observed Mr. Bostock, said that the guinea would be returned on receipt of a *bonâ fide* tender, so that really the deposit of a guinea with the prisoner was simply a guarantee that the person applying would tender. Prisoner gave his address at 52 Bridge-road, Southampton, but that was not a place of business, but simply a lodging-house where prisoner went to reside on Nov. 9 last year, and represented himself as a gentleman of means, in receipt of £300 a year. In consequence of this advertisement Mr. Pollard wrote on Feb. 8, enclosing a cheque for one guinea, and asking for specification, which he subsequently received. The specification set forth: "Specification of electric installation to be erected at Reading, Berks." But he (Mr. Bostock) should be able to show beyond doubt that no such works were in course of erection, for if works of that description were being erected it would be necessary to submit plans to the local authority, and he had someone from the local authority present who would tell them that there was nothing of the sort. Later, the prisoner stated in a specification that the engines and foundations already existed, and had a good concrete bed, and any further work required for the foundations would be done by the present proprietors, so that tenderers need not go into that question, but merely give inclusive terms for fitting engine and dynamo in the place. Then there was a leaflet which stated that visiting the site of the installation could not be allowed for the present, and that no representatives of firms could be seen except by definite appointment No doubt the prisoner knew better than anyone else the reason why the leaflet was printed and attached to the specification. Mr. Pollard received a specification, and on March 4 the tender was sent in, which amounted to £4,880. From that time till April 13 nothing was heard from the prisoner, when he wrote saying that he should require a cheque for £25, and £25 more on signing the contract. On April 12 the prosecutors found several letters written and sent to different firms offering to give the work if they paid him £25 in some instances, and in others £10, etc. All the tenders were for the same work, and therefore the prisoner could not possibly give the work to more than one firm. He wrote letters on the 12th saying: "If you give me the £25 you will have the work"—and in one instance he succeeded in obtaining £25. Upon the receipt of the letter Mr. Pollard had his suspicions aroused, and enquiries were made, with the result that a letter was written to the prisoner on April 14, and two days later he was arrested. It appeared that the prisoner was a bankrupt. If there was any truth in the advertisement, if prisoner had had any instruction from anyone to do the work, it was the easiest matter in the world for him to have brought evidence. Besides having obtained a guinea from the prosecutors and two other firms, prisoner had obtained in addition something like 100 guineas in a similar way. The guineas were only a guarantee that the firms who applied for specifications would tender. There was no need for prisoner to cash the cheques, and when a *bonâ fide* tender was received it was his duty to return the money, but he had not done so in a single instance. There was a firm at Burton-on-Trent who would tell the Bench that they had also sent a guinea, and in due course received a specification, and ultimately the prisoner wrote to them for £25 in the same way. Prisoner received a cheque for that amount, and he cashed it the following day. Another firm—the Chloride Electric Company, Clifton Junction Manchester—had sent a guinea for a specification, which had not been returned, and on April 13 they received a letter, dated April 12, asking for £10 down, and a further sum when the contract was signed. Fortunately the money was not sent.

Mr. James Pollard (of the firm of Messrs Stanley, Davies, and Pollard), on going into the box, repeated evidence that has already been published.

Cross examined by Mr. Cooke, **Mr. Pollard** stated that the advertisement that appeared in the *Electrical Review* conveyed to him that by sending a guinea for a specification he should have a chance of tendering for a *bonâ fide* installation. If prisoner were a consulting engineer he would be paid by the persons for whom the specification was made.

Mr. Cooke: Was it not probable enough that a scheme could be in existence for a place to be erected at Reading?

Mr. Pollard: I do not know.

Mr. Cooke: Is it not possible that a person might have a scheme in his head, but before he does anything he must have tenders applied for in different sections before the work is carried out?

Mr. Pollard: It would be madness for anyone to ask for an electrical plant unless he were putting up a building I did not send the £25 asked for by prisoner because I found out that he was a swindler. The foundation that the prisoner alleged in his specification to have been put in at Reading was not in. I shall prove that it was not in, and that was the reason why I issued a warrant.

John Adams, stationer and bookseller, carrying on business at 49, Oxford-street, Southampton, gave evidence as to the insertion of the advertisement on behalf of the prisoner.

Frank William Adams, printer, 10, Bernard street, Southampton, son of the last witness, said that on Jan. 31 the prisoner called upon him and asked him to quote a price for printing 50 specifications. Prisoner subsequently gave instructions to insert "Works to be erected at Reading, Berks." Witness gave him a revised proof, and two days later prisoner instructed him to print 70 copies of the specification, and also to attach a leaflet to it. He had not been paid for the specifications

Richard Lloyd, building inspector, Reading, said that no plant of works to be erected by prisoner at Reading had been submitted to the local authorities. If such works were to be executed it would be necessary to submit plans. He had heard it stated by the prosecution that the engine and foundations of the supposed works existed, and that it had a concrete bed, but he did not know of anything of the kind at Reading.

Jane Rebecca Turner, of 52, Bridge-road, Southampton, stated that the prisoner came to lodge with her on Nov. 9. He remained with her up to the time of his arrest, and went under the name of H. Cleaver. Latterly a large number of letters had been delivered at the house, daily, addressed to the prisoner.

Holland Robert Edward Dell, secretary to the Chloride Electrical Storage Syndicate, Limited, of Clifton Junction, Manchester, stated that on Jan. 28, in consequence of an advertisement in the *Electrical Review*, his firm wrote to the prisoner and sent a postal order for a guinea, and he received, in reply, a post card acknowledging the receipt of the order, and stating that the specification would be sent to the company on Feb. 6. On March 3 his firm tendered for the work, and received the following letter from the prisoner: "I am prepared to place the order for the above as per your tender, on the undermentioned conditions—namely, that you send per return a cheque for £10 with the promise to pay another £15 more on the contract being signed, such contract to be signed by my clients and yourselves within 14 days from agreement thereof, otherwise the £10 to be returned, and the matter to be considered void unless otherwise arranged. On receipt of your cheque I will at once forward contract for your perusal, and arrange a personal interview in order to settle all matters of detail. Kindly let me have reply by return, and state if you are prepared to adopt the association's standard clauses." The letter was not answered and the firm received a telegram on April 18, saying "Please let me know your decision—Cleaver."

Henry Watts Cash, of the firm of Cash, Robinson, and Co., Burton-upon-Trent, electrical engineers, gave similar evidence, and stated that on March 4, after having received specification, he sent in a tender complying with all the conditions set forth in the specification. Nothing further was heard from the prisoner until April 14, when he addressed a letter to the firm stating that he would place the order *re* tender for electrical installation on certain conditions. The conditions tallied with those asked to be agreed upon from other persons. As a result of the communication he forwarded £25 to the prisoner, and a reply was sent back saying that the cheque was to hand, and that he (prisoner) would be in Manchester in the course of a few days, when he would call upon the firm. Both the guinea and the £25 had been cashed.

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Fred Smart, of 62, Market-street, Manchester, an expert in handwriting, stated that he was of opinion that all the documents that had been submitted were written by one and the same person.

Detective-Sergeant James Dixon gave evidence of receiving prisoner into custody on April 19 from the Southampton police, together with a large number of documents. On being charged, prisoner replied "It's all right."

Defending the prisoner, **Mr. Cooke** laid stress on the fact that the case was of such a character that it was the duty of the Bench to ascertain from the evidence adduced for the prosecution whether there was a *prima facie* case or not.

The **Chairman** said the Bench thought there was a *primâ facie* case.

Prisoner, on being charged, stated that he had no intention of fraud whatever. The thing was part of a definite scheme, and he could prove it.

The **Chairman**: You will have to take your trial at the next Quarter Sessions on both charges.

Bail was fixed for prisoner, himself in £50 and two sureties of £100 each.

COMPANIES' MEETINGS AND REPORTS.

BROCKIE-PELL ARC LAMP, LIMITED.

The third ordinary general meeting of the shareholders of this Company was held at Winchester House on Monday, May 8. **Lord Suffield** presided, and said he could not expect to see smiling faces there. The directors had had no end of difficulties to contend with, some of which the shareholders already knew of, and some of which they would no doubt hear of in the course of the proceedings, but he felt satisfied that in a short time, probably next year, they would be able to show a better state of things. He was bound to say that they owed this better outlook to the efforts of Mr. Shrimpton, who had been appointed at a rather critical time, and as the result of the deliberations of a committee of the largest shareholders called together by the directors for the purpose of finding someone to take the place of the late managing director. After Mr. Pell left they went through various other crises, but the chairman had received great assistance from Sir F. Dixon-Hartland and the other directors. They saw a light now. But among the past difficulties they had to contend with was the difficulty with the licensees from the old firm of Brockie-Pell and from the company, Messrs. Johnson and Phillips, who had given them infinite trouble. They had taken openly before the whole world the inventions of Brockie-Pell, which the Company had bought, and sold them as their own. At last they had been brought to admit their mistake, so that there need not be any further legal proceedings on that score. In conclusion, he referred to the increase which had been in the number of orders the Company had received. In 1897 they had 535 orders; in 1898, 831; and in the first four months of 1899 358. In 1897 they sold £9 609 worth of lamps, and in 1898 £17,255. He thought this bore out what he had already said, that the Company was in a very prosperous condition. Considering that they had been working desperately uphill the result was very satisfactory. Under the present management, if they were left alone, they would make the Company a great success. He moved the adoption of the report and accounts.

This was seconded by **Sir F. D. Dixon-Hartland, M.P.**

Mr. Alexander L. Waugh said he intended to propose that the report be not adopted, and that the present board of directors be asked to resign. It seemed to him extraordinary that the report and accounts made up to Dec. 31 were not sent out to the shareholders until April 30, and that no time had been given to obtain proxies. He could not help congratulating the Board on the cheerful and optimistic tone of the report. They showed in the accounts a loss of £1,496, but there was also a sum of £500 which had been received for the sale of patent rights, and another of £675 received from persons for infringements. If these two items were taken away, the real loss would have been £2,671. This would represent a great amount, not less than the £4,000 lost in the previous 17 months. What they wanted, was a manager who possessed a practical knowledge of the particular business of the Company. However good a business man Mr. Shrimpton might be, he was lacking in the first qualification for the post. He was delighted to find that the Prince of Wales had patronised the Brockie-Pell lamp, which was beyond doubt the finest in the market. It was the only order that had ever been secured by the influence of the Board, and this order was probably very small. He asked the shareholders to support him in his refusal to adopt the report. The Company could be very well managed by three directors at fees of 50 guineas each a year, along with the electrical engineer at the works and a competent secretary.

Dr. Fagan said before the report was adopted he would ask whether Mr. Brockie had left the Company or whether it was proposed that he should do so.

Mr. W. Boner having at this juncture seconded Mr. Waugh's amendment,

Mr. Clements wanted to know what the exceptional difficulties were which had affected the actual expenses for the past year. If Mr. Brockie were present, he thought the shareholders would be very glad to hear what he had to say.

Mr. Brockie said he had no fault whatever to find with the directors, except in attempting to eliminate the technical element from the business altogether by taking away the authority of the engineer from the control of the works. A dual control was not wanted. It was all very well in theory, but it did not work in practice. A technical man who understood the business must be allowed to attend in his own way to the technical part of the manufacture of the lamps. The fatal fault in this respect was repeated when Mr. Shrimpton, who was a most energetic and clever business man, was appointed. He had usurped every piece of authority in the works. Let Mr. Shrimpton stick to the business part of selling the lamps, but let him or some other engineer attend to the technical part of the work. He had spent £1,500 out of his own pocket, practically for the benefit of the Company, in regard to the automatic lathe. This was a *fait accompli*, and he hoped they would make money out of it.

Dr. Fagan said no one could look at the report without seeing that there was an element of a profitable business in the concern if it were only properly conducted. With good management and avoidance of discord, there was every reason to believe that everything would be placed on a thoroughly sound basis.

Sir F. Dixon-Hartland assured the shareholders that there was no desire on the part of the directors to cling to office. They felt that under their management the results had not been as satisfactory as they might have wished. They had hoped to bring things round in such a way that the shareholders would, at any rate, have concluded that they had done their duty before leaving the board. The £500 referred to by Mr. Waugh was in last year's balance-sheet, and of the £675 received for infringements, there had been paid nearly £400 for legal expenses. They would therefore see that there was not much of a net gain. The friction between the manager and the engineer involved the whole question of the success or failure of the Company. It was the whole cause of the Company's troubles. Mr. Pell and Mr. Brockie could not get on, and Mr. Pell found he could not stop as managing director. Mr. Brockie did not get on any more with Mr. Shrimpton than with Mr. Pell. The directors accordingly felt it absolutely necessary to make a change, and by the appointment of Mr. Shrimpton a great improvement had been brought about. Did the shareholders wish that the directors should manage the business, or that Mr. Brockie should do this? With the present management the Company could be made a success. They had more work now than they could do in their present factory, and would have to take larger premises.

Mr. Waugh: Is it a fact that the works at present are fully employed, and that every room is being used?

Sir F. Dixon-Hartland: Yes, and not only is every room full, but there is difficulty in getting goods out because we have not sufficient room for our work.

Mr. Shrimpton having described the condition in which he found things when he commenced his duties,

Mr. Brockie warmly replied to these and to other criticisms. He denied that he had not properly carried out his duties. Sir F. Dixon-Hartland had stated that he (Mr. Brockie) wanted to control the Company. He did not, because he was not a business man. He did want, however, to manage the technical and working part.

After further discussion the resolution was put, when 29 hands were held up in its favour and 32 against.

A poll was then demanded by the chairman. This, in spite of a warm protest from Mr. Waugh, who suggested that the meeting should be adjourned, was at once proceeded with, with the result that 27,000 votes were recorded for the resolution, and 21,000 against.

The resolution having been declared carried, Lord Suffield was reappointed a director.

NEW GENERAL TRACTION COMPANY.

On Monday the third annual general meeting of this Company was held at the Cannon-street Hotel. **Captain F. Pavy** presided, and said he need only detain those present a few minutes, for as regarded the operation of the Company itself, this had been summarised pretty well and pretty fairly in the report. [This appeared in our issue of May 5.] Commenting upon the more important details contained in this, he said it had been recommended to pay a dividend on the preference capital. One hundred and fifty thousand pounds was outstanding, and at 6 per cent. this amounted to £9,000, which left them with £6 212 4s. 10d. to carry forward to next year, as against the £4,495. 12s. 9d. brought in. He thought they would see that the condition of the Company was very satisfactory. He referred with satisfaction to the interest the company had in three different undertakings—namely, the Douglas Tramway (Isle of Man), Coventry, and Norwich. It was true that most of the cities in England were carrying out works of their own, but where they wanted improvements made, and where it was not always easy for them to raise money, it was far better for them to put themselves in the hands of a company like that, and come to an agreement as to what they required to have done, so that the company might bear the responsibility of building not only the tramway, but making such improvements as the city might desire. In putting up these electric tramways, the Company had adopted the Westinghouse system. He personally had been connected with Mr. Westinghouse for something like 20 years; he had been a director of his brake company, and for some seven or eight years had practically the control of the Westinghouse Electric Company, started quite quietly in London. This company had made great progress, and what he was going to lay before the meeting showed not only what work the Westinghouse Company was doing, but what progress was going on in England with regard to electric traction and work. They had had a large contract with the Metropolitan Electric Company for their works at Willesden, a large contract with the City of

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London Electric Lighting Company, and with the cities, they had had contracts with Plymouth, Glasgow, Bradford, Halifax, Hull, Dudley, Liverpool, Swansea, Manchester, and Aberdeen. This showed better than anything else could how electricity was progressing in England. Mr. E. A. Hopkins, their managing director, who knew more than he (the Chairman) did about the United States, would tell them that there probably, if a town or city of 6,000 inhabitants had not an electric tramway or an electric lighting plant, they would think it was a disgrace. But in England progress was now being made. Perhaps the want of energy had been caused by our not having had any large electric manufacturing works. But even that would be remedied shortly, for he apprehended that the Westinghouse Company, which hitherto had been getting all its plant from Pittsburgh, where Mr. Westinghouse employed 5,000 men in his electrical works alone, would in a short time have a factory started in London. He (Captain Pavy) did not think he would be divulging any secret when he said that arrangements were now being made for this, and they would be able to manufacture their own plant there Having briefly alluded to the issue of new capital, he moved the adoption of the report and statement of accounts.

Baron Emile B. D'Erlanger seconded the motion, which was unanimously carried, and a dividend at the rate of 6 per cent. on the preference capital declared.

The **Chairman** then proposed, and **Baron Emile B. D'Erlanger** seconded, the re-election of the Hon. Arthur G. Brand as a director of the Company.

This having been carried, meetings of the several classes of shareholders were held, at which resolutions were passed consenting to the creation and issue of 20,000 new preference shares.

WEST COAST OF AMERICA TELEGRAPH COMPANY, LIMITED.

The ordinary general meeting was held at Winchester House on Tuesday last.

Mr. J. Denison Pender, who presided, referred to the standstill in the trade on the west coast of America generally, and to the fall of about 33 per cent. in the rate of the Valparaiso exchange in London. A better feeling had, however, taken place between the Argentine Republic and Chili, and if the relations between those two States would settle down permanently, better trade would result. If there was a better feeling and a steadier and improved exchange, they would benefit by it.

Sir A. Cattell seconded the motion for the adoption of the report, which was carried unanimously.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY, LIMITED.

The half-yearly meeting of this Company was held at Winchester House on Wednesday last, Mr. W. S. Andrews presiding.

The **Chairman** said the working expenses were not quite satisfactory, showing an increase of £5,400. Coal had cost £799 more, owing to the strike. Another disadvantage of the coal they had been forced to purchase was that it was not productive of the same horse-power that was obtained by using Cardiff steam coal.

Mr. D. H. Godsall seconded the adoption of the report and accounts, which was carried.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY, LIMITED.

The half-yearly meeting of this Company was held on Wednesday at Winchester House, E C., Mr. W. S. Andrews presiding.

The **Chairman** said the position of affairs was very satiefactory, the accounts showing the prosperous condition in which they were. The arrangements for bringing them into closer communication with the other lines were working well. Referring to statements that the Lisbon-Madeira and the Madeira-St. Vincent cables were faulty, he said no attempts had been made to repair them as it was not advisable to disturb cables laid in deep water as long as they would continue working. It was stated that the cables were failing in electrical value. The fact was that their cables were not getting younger.

Mr. J. D. Pender seconded the adoption of the report, which was unanimously adopted.

OSWESTRY ELECTRIC LIGHT COMPANY.

The fourth annual general meeting of this Company was held on the 18th inst., Mr. A. Wynne Corrie presiding.

The annual report, which was adopted, stated that the profits for the year amounted to £244. 2s. 4d. They now supplied 90 installations, compared with 50 in the previous year, while their profits last year were £244, against £134. Last year they generated 25,000 units; this year it was over £31,000. A dividend of 4 per cent. was declared.

Messrs. Josiah Jones and R. Rhys Lloyd were re-elected directors, and Messrs. Williams and Nicholson auditors.

W. T. Glover and Co., Limited.—This company announce an issue, at par, of £60 000 4½ per cent. first mortgage debenture stock. The list will open on the 16th inst., and will close at or before 3 p.m. on the 18th inst. Full particulars of the issue will be found in our advertisement columns.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Taunton.—The Corporation invite tenders for various plant by June 1.

Birkenhead.—The Corporation invite tenders for 100 electricity meters by 26th inst.

Edinburgh.—The Corporation invite tenders for two steam-driven fans for induced draught by May 22.

Madrid.—The Public Works Department invite tenders for electric tramways for Madrid. Tenders by June 14.

Sappemeer (Holland).—The Municipality invite tenders for the erection of central electric lighting station by June 1.

Bridgend.—The Urban District Council invite tenders with a view to the transfer of their provisional order by 19th inst.

Paris.—The Post and Telegraph Department, Rue de Grenelle, 103, invite tenders for 240,000 porcelain insulators by May 25.

Glasgow.—The Corporation invite tenders for the supply of carbons and cables for the coming year. Tenders by 17th inst.

Lisbon.—The Mozambique Company will receive at their offices in Lisbon tenders for the erection of electricity works by July 10.

Edinburgh.—The Council are prepared to receive tenders for the supply of copper strip for electric conductors. Tenders by May 15.

King's Lynn.—The Corporation are prepared to receive tenders for the electric wiring and fittings of the Lynn Technical Schools by May 16.

Southampton.—The Corporation invite tenders for motorcars and equipment and electrical equipment of lines. Tenders before noon on June 5.

Almden (Ciudad Real), Spain.—The Municipality invite tenders for the installation of electric light and the working of the same for 20 years. Tenders by May 19.

Hackney.—The Electric Lighting Committee of the Vestry invite tenders for trenching, troughing, cables, joint-boxes and jointing, and house services, by June 13.

Talavera de la Reina (Toledo, Spain).—The Municipality invite tenders for an electric lighting installation and the working of the same for five years. Tenders by May 20.

St. Pancras.—The Vestry are prepared to receive tenders for supplying about 22 miles of lead-covered armoured cables of various sizes. Tenders by 12 noon on 23rd inst.

Darlington.—The Corporation invite tenders for the supply and delivery of various plant, together with the fixing of the same, at their electric generating station. Tenders by May 30.

Paris.—The Post and Telegraph Department, Rue de Grenelle, 103, invite tenders for paper-insulated cables as follows: 46½ miles in three lots and one lot of 93 miles. Tenders by May 18.

St. Pancras.—The Vestry are prepared to receive tenders for supplying and fixing additional plant at the Regent's Park electricity works, comprising dynamos, engines, etc. Tenders by 12 o'clock noon on May 16.

London.—The Asylums Committee of the London County Council invite tenders for the installation of telephones, fire-alarms, tell-tale clocks, and call bells at the Heath Asylum, Bexley, Kent, by May 31.

Almaden del Azogue (Spain).—Tenders are invited for an electric lighting installation, and the preliminary deposit required is £60 to £100. Specifications, etc., are to be obtained from, and tenders addressed to, the Syndaco of the above town by noon on May 19.

Tarifa (Spain).—Tenders are invited for public electric light installation, and working of the same for 20 years. The deposit required is 5 per cent. of the tender. Specifications, etc., are to be obtained from, and tenders addressed to, the Syndaco, Tarifa, Spain.

Blackpool.—The Tramways Committee invite tenders for the construction of 10 bogie tramway cars. The type of car required can be seen and specification forms obtained on application to Mr. John Lancaster, tramway manager, Blackpool. Tenders by 20th inst.

Liverpool.—The Select Vestry invite tenders for the renovation and extension of the telephonic and fire-alarm communications of the workhouse, Brownlow-hill. Specification may be seen at the office of Mr. H. J. Hagger, vestry clerk, Brownlow-hill, Liverpool. Tenders by 15th inst.

Russia.—The Secretary of State for Foreign Affairs has received a dispatch from her Majesty's Consul at Taganrog, stating that tenders are invited by the Municipality of Kertch for the supply of materials for the construction of electric lighting plant and tramways in that town.

Bexhill.—The Urban District Council invite tenders for the erection of an electric lighting station and chimney shaft in Bexhill. Specifications, etc., may be inspected at the Town Hall or at the offices of Mr. A. H. Preece, 13, Queen Anne's-gate, Westminster, S.W. Tenders by 12 noon on May 15.

Teneriffe.—Tenders are invited for the erection and working of an electric tramway between Santa Cruz and San Cristobal. The deposit required is about 776,214 pesetas (about £350). Specifications, etc., are to be obtained from, and tenders addressed to, Public Works Department, Madrid, by 1 p.m. on June 14.

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Glasgow.—The Corporation invite tenders for small iron castings for one year from 31st inst. Specification, etc., may be obtained on application to Mr. W. A. Chamen, engineer, 75, Waterloo-street, Glasgow, on payment of £1. 1s., which will be returned on receipt of a bona fide offer. Tenders by 10 a.m. on 17th inst.

Islington.—The Guardians invite tenders for the installation of the electric light at the new infirmary for the parish at Highgate-hill, Upper Holloway. Particulars may be obtained from Mr. William Smith, architect, 65, Chancery-lane, W.C., up to May 20 upon depositing £5, which will be returned on receipt of a bona fide tender. Tenders by June 1.

Darlington.—The Corporation invite tenders for the various works required to be executed in the erection of buildings to be used as an electric lighting station in the borough. Specifications, etc., may be obtained on payment of £2. 2s. (which sum will be returned on receipt of a bona fide tender), from the Borough Surveyor, Town Hall, Darlington, on and after 15th inst. Tenders by 30th inst.

London.—The Guardians of St. Mary, Islington, invite tenders for works of installation of the electric light at the new infirmary for the parish at Highgate-hill, Upper Holloway. Specifications, etc., may be obtained from Mr. William Smith, architect, 65, Chancery-lane, W.C., up to 20th inst. upon depositing £5, which will be returned upon receipt of a bona fide tender. Tenders by 11 a.m. on June 1.

Enniskillen.—The Urban District Council invite tenders for supplying and fitting up gas-engine, dynamo, and complete electric light installation for lighting New Town Hall, Enniskillen. Specifications can be seen at the office of Messrs. Anthony Scott. M.S.A., and Wm. A. Scott, A.R.I.B.A., architects, 16, William-street, Drogheda, or at the Town Clerk's Office, Enniskillen. Tenders by 12 noon on 22nd inst.

Hampstead.—The Vestry invite tenders for the supply, delivery, and erection of electrical plant, including steam alternators and engines, switchboard panels, boilers, feed-water heaters, vertical steam feed pumps, exciter, water-softening plant, air pump and condenser, Green's economiser, and overhead travelling crane. Particulars may be had of Mr. A. P. Johnson, vestry clerk, to whom tenders must be sent by 12 noon on May 18.

Crewe.—The Corporation invite tenders for supply of boilers and economisers, engines and dynamos, centrifugal pump and motor, mains, battery, switchboard, travelling crane. Specifications, etc., may be obtained from the Borough Engineer, Crewe, or from the engineers, Messrs Hopkinson and Talbot, 26, Victoria-street, London, S.W., and 29, Princess-street, Manchester, on payment of £2. 2s., which will be returned on receipt of a bona fide tender. Tenders by June 1.

Fleetwood.—The Urban District Council invite tenders for the following: (Section 1) cast-iron lamp pillars and brackets; (2) street lamps for electric incandescent street lighting; (3) arc lamps and posts; (4) installation of wiring, switchboards, lamps, etc., for the electric lighting of the town hall, Fielden free library, public market, and slaughter-houses. Specifications, etc., can be obtained from Mr. Thomas Barton, Ainsworth-street, Blackburn, on payment of £2 2s., which sum will be returned after a bona fide tender has been received. Tenders by May 16.

Prestwich.—The Committee of Visitors of the Prestwich County Lunatic Asylum invite tenders for steam-pipes, condensers and cooling tower, steam dynamos for 274 kw., mains, switchboards, storage batteries, and wiring for an electric light installation. Firms desiring to tender are directed to send their names, with a statement of the parts of the work they desire to quote for, to Mr. Charles Hopkinson, M.I.C.E., 29, Princess-street, Manchester: or to Messrs. Hopkinsons and Talbot, 26, Victoria-street, London, S.W. They will then be informed when the specifications are ready for issue.

London, S.W.—The Vestry of St. Mary, Battersea, invite tenders for the supply and erection and the carrying out of work in connection with the electric lighting of the parish to specifications as follows: (Specification No. 1) feeders, distributing mains, and arc light leads, including laying and jointing; (2) water-tube boilers; (3) steam dynamos and engines. Specifications, etc., may be obtained from the Vestry Clerk, at the Municipal Buildings, Lavender hill, S.W., on payment of £3. 3s. for each specification, etc., which sum will be returned after the receipt of the specification, etc., accompanied by a bona fide tender. Specifications and drawings can also be seen at (but not obtained from) the office of Prof. Alex. B. W. Kennedy, 17, Victoria-street, Westminster. Tenders by 12 noon on June 7.

RESULTS OF TENDERS.

Bolton.—The tender of the Edison-Swan United Electric Company for three sub-station switchboards has been accepted.

Brighton.—The Town Council have accepted a tender from Messrs. Babcock and Wilcox, at £2,898, for the supply of two water-tube boilers, with fittings.

Aberdeen.—The tender of Messrs. Gall and Walker has been accepted for the supply of bases for the central poles required in connection with the electrical equipment of the Woodside section at £192. 10s.

Derby.—The Electric Lighting Committee have accepted the tender of the London Crane Works, Slack-lane, Derby, at £195, for the supply and erection of an overhead hand crane at their electric station, Sowter-road.

Dundee.—The Electricity Committee have agreed to take British-made engines and dynamos as offered at the following prices—viz.: Contract No. 12, £5 550; Contract No. 14, £4,900. It is stated that these prices are about £700 higher than those previously contracted for, but they are British made.

Derby.—The Electric Lighting Committee have accepted the following tenders: For excavating and building the foundations of extensions to the engine-house, boiler-house, and retaining wall at the electric lighting station, H. Vernon, £20,230. 8s. 8d.; for transformers, the Electric Construction Company, Limited, at scheduled prices for one year.

Kingston.—The Lighting Committee have accepted the following tenders: For painting the outside of the electricity works, Lane and Son, £14. 15s.; Siemens-Belliss 200-kw. alternator, Siemens Bros., £2,100; Siemens Bros., low-tension, concentric, lead-sheathed and steel-armoured cables, £342, £580, and £820 per mile according to the size required (the last two contracts are subject to the sanction of the Local Government Board for the necessary loan for the purpose); Siemens Bros, one mile of high-tension jute-covered cable, £277.

BUSINESS NOTES.

Belfast.—The total sum to be applied for on account of the electric light extensions is £75,000.

Bridlington.—The Urban Council have decided to erect a Beaman and Deas refuse destructor.

Farnham.—A special meeting is to be held to discuss the electric light question in all its bearings.

Waterloo-with-Seaforth.—The public electric lighting is to be discontinued during the summer months.

Bury St. Edmunds.—We learn that the work at the electricity station will be completed by the end of October.

Camberwell.—The report of the Electric Lighting Committee of the Vestry, referred to in our last issue, has been adopted.

Morecambe Electric Launch and Power Syndicate, Limited. This Company has been registered with a capital of £3,000 in £1 shares.

Llanelly.—An application from the National Telephone Company for permission to lay a cable in the main sewer is before the Council.

Burnham.—A memorial is being prepared asking the Mayor to call a meeting of the ratepayers to discuss the proposed electric lighting scheme.

Barnsley.—An extension of the electricity distributing mains from the top of Victoria-road for a short distance along Sackville-street is proposed.

Dorchester.—No action is to be taken at the present time with regard to various communications received relating to the electric lighting of the town.

Redruth.—The Gas Committee of the Council have decided to ask the gas company for terms, and also to communicate with an electric lighting firm.

Bexhill.—Mr. A. H. Preece is acting as the adviser to the Urban District Council in connection with the erection of an electric lighting station.

West India and Panama Telegraph Company, Limited.—The directors have declared a dividend of 2s. 6d. on the ordinary shares, carrying forward £4,920.

Removal.—The British Thomson-Houston Company, Limited, have moved their Glasgow office from 63A, St. Vincent-street to 141, West George-street.

Leeds.—The Council have voted £1 165 towards providing an installation of electric light and a new heating apparatus at the Adel Reformatory School.

Salisbury.—The proposed motion with reference to the purchase by the city of the electric lighting works has been postponed pending further enquiries.

Consett.—The question of providing the town with electricity has been before the Lighting Committee, but has been deferred pending the arrival of certain plans.

Keswick.—The Urban District Council have referred to the Lighting Committee a tender from the electric lighting company for the lighting of their new district.

Canterbury.—The electrical engineer has been allowed to prepare a specification and advise the committee of the East Kent Club in wiring their premises for electric light.

Personal.—Mr. Wm. Maurice, A.M.I.E.E., Swanwich Collieries, Alfreton, has been appointed manager of the Babbington Coal Company's new collieries at Tibshelf, Derbyshire.

Berwick.—The Lighting Committee have before them offers from Edmundsons, Limited, and from English Industrials, Limited, with reference to the electric lighting of the district.

Ashton.—Trial trips have been made with the new electric tramway. We understand that there is only one car yet on wheels, so that some little time must elapse before the cars run for traffic.

Ludlow.—At the quarterly meeting of the Town Council the Town Clerk referred to the fact that the Bill for the powers under the Electric Lighting Act had been introduced into the House of Lords.

Croydon.—The Guardians have referred to the Schools Committee an application for a piece of land in Mayday-road for the

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purpose of erecting an electric sub-station to light that part of the borough.

West Bromwich.—The Electric Lighting Committee have obtained reports on the best methods of lighting the town by electricity from two consulting engineers, which are now under consideration.

Heckmendwike.—At the last meeting of the District Council, it was unanimously resolved to adopt Mr. Hawtayne's report, referred to in our last issue, subject to the approval of a meeting of ratepayers.

Taunton.—The electrical engineer's report states that the second steam alternator has been erected. During the past quarter the equivalent of 1,420 8 c.p. lamps has been connected with the mains.

Sheppey.—The Light Railway Order, 1898, authorising the construction of a light railway in the Isle of Sheppey and Kent, between Queenborough Station and Leysdown, has been confirmed by the Board of Trade.

The Pacific Cable.—Reuter's correspondent at Victoria (B.C.) says it is understood that her Majesty's surveying vessel "Egeria" has been commissioned to survey the route for the laying of the Pacific cable.

Folkestone.—The surveyor has submitted a statement showing the cost of erecting the electric light columns. The columns cost £1,115. 5s., and the fixing £168. 10s. 4d. The total cost per column worked out at £19. 16s. 8d.

Yarmouth.—The Electric Lighting Committee's recommendation for a further expenditure of £27,000 for additional plant has been referred back in order that Mr. W. H. Preece, the Council's consulting electrician may submit a report.

Aberdeen.—The Tramways Committee of the Town Council have decided to construct three additional passing places on the circular route, at a cost of £360, rendered necessary by the acceleration of the service on this part of the system.

Sleaford.—The Urban Council intend to apply to the Board of Trade for a provisional order for an installation of electric light, and to the Local Government Board for sanction to borrow £5,000 for the construction of the necessary plant and works.

Lambeth.—At the meeting of the Vestry last night the General Purposes Committee recommended that the request of the South London Electric Supply Corporation, Limited, to leave in complete certain short lengths of mains be not acceded to.

Chelsea.—From and after Sept. 29, the price for current will be from 6d. to 3d. per unit, on Wright's maximum-demand system, to users on the 200-volt supply. This reduction will not apply to consumers on the 100-volt supply, who will continue to be charged at 6d. per unit.

Rotherhithe.—At last meeting of the Vestry a letter was read from the Board of Trade stating, with reference to the objection lodged by the Vestry against the County of London (South-East) Electric Lighting Provisional Order, that the order was not to be proceeded with.

Walton-on-the-Naze.—The electric tramway, which is now completed, was subjected on Thursday week to the usual Board of Trade tests, conducted by Colonel Yorke, by whom the tramway was pronounced perfectly satisfactory. The line will be opened for traffic on the 13th inst.

Lancaster.—Tenders are to be obtained for the erection of stores and workshop in the yard adjoining the boiler-house at the electricity works. A new main will be laid at a cost of £282. High-street Independent Chapel is to be altered internally, and the electric light will be installed.

Grimsby.—The Council have decided that application be made to the Public Works Loan Commissioners for a loan of the amount required for carrying out the electric lighting works on mortgage of the general district rate, and also to the Local Government Board to make such allowance.

Hull.—The dispute between the Electric Lighting Committee and the Works Committee with respect to the rent to be paid by the former body for a site for a sub-station adjoining the electric power works in Osborne-street, has been settled, each committee having agreed to pay a moiety.

Bridlington.—A special meeting of the Urban District Council was held on Monday to consider the report of the Sanitary Committee and the plans prepared by the surveyor (Mr. Matthews, C.E.) of a refuse destructor and electric light installation on a site recently purchased by the Council.

Bolton.—The Electricity Committee have decided to lay new cables. Another application for a supply of electricity will be dealt with at the next meeting, and in the meantime enquiries are to be made as to the probable number of consumers in the event of a main being laid for such supply.

Hanley.—The Town Council intend to apply to the Local Government Board for a consent order to the issue of stock for the purpose of raising £4 000, required for the purposes of electric lighting. The sanction of the Local Government Board to borrow the money has already been obtained.

Sheffield.—On the minutes of the Electric Light Committee coming before the Town Council on Wednesday the Chairman withdrew the recommendation that an order be given to Messrs. Ferranti, Limited, for a 1,000-kw. steam alternator for the sum of £9,500. The other minutes were agreed to.

Tunbridge Wells.—The Town Council have received an application to meet the representative of a provincial electric tramway company to discuss the advisability of the proposal to introduce tramways in the Tunbridge Wells district. The matter is now before the General Purposes Committee for report.

Maidenhead.—Application is to be made to the Local Government Board for permission to use for purposes connected with the electric lighting certain land being a portion of land purchased by the Council for the purpose of sewage disposal, for which purpose such portion of the said land is not nor will be required.

British Electric Traction Company.—The directors have decided to allot to the shareholders on the register on April 27 (both preference and ordinary) 15,000 of the new ordinary shares of £10 each at the price of £15 per share in the proportion of one new share for every four ordinary or preference shares held.

Barking.—The official opening of the electricity works will take place as soon as the large public lamps have been fixed. Although the works are not yet opened officially, we understand that light is being already supplied to various houses. The applications up to date total to an equivalent of 3,700 8-c.p. lamps.

Walker.—The electric lighting order came before the Court of Referees of the House of Commons on Thursday, the point for decision being whether the Walker and Wallsend Union Gas Company and manufacturers and others in the urban district of Walker have a *locus standi* entitling them to be heard against the scheme.

Sowerby Bridge.—The Council have decided to apply for a provisional order empowering them to supply electricity within the area of the Council gas supply. The Soyland and the Midgley District Councils intend to oppose the application, the former intending to apply for an order to provide their district with electricity.

Hammersmith.—The Electricity and Lighting Committee's report states that the total number of applications received for private lighting is 341 for a total of 23 145 lamps of 8 c.p.; the number of consumers already connected is 287, with 19,921 lamps, and the maximum number of lamps alight at one time is 17,013 (including street-lighting).

Portrane.—With reference to a report from the *Dublin Evening Mail* quoted in our last issue, in which it was stated that Mr. Drennan, of Belfast, had subsequently withdrawn his tender for the electric installation owing to a rise in the price of materials, we are informed that the estimate was not withdrawn, but merely amended for the reasons adduced.

Darlington.—At the quarterly meeting of the Town Council, the adverse action of the County Council to the tramway proposal was referred to. It is believed that the Council will not persist when they have the additional information which will be placed before them, though the tramway company will under no circumstances use an underground system.

Carrickfergus.—At the last meeting of the Urban District Council, the members were asked to consider the electric lighting of the town. It was stated that it would take at least £6,000 to put in an electric light installation to suit the town. Once it was in, however, as much light could be obtained by it for 4s. as was got by gas for 5s., or something over.

Bournemouth.—The report of the Electric Lighting Committee, adopted on Wednesday, stated that the Board of Trade were not prepared to grant the order for "private purposes," but for "public purposes" only, and had submitted an order amended as approved by the Board. The committee recommended that the draft order as amended be proceeded with.

Catalogues.—We have received a new illustrated catalogue of electric light material from Messrs. C. W. Treacher and Co., manufacturing electricians 165, Queen Victoria-street, E.C., which contains besides lamps, cables, volt and ammeters, testing instruments, etc., advice on wiring, erecting and running dynamos, and erecting and running accumulators.

Bath.—At the last meeting of the Town Council, the Clerk presented a report on the subject of the loan of £24,000. Reductions in the charge for current were suggested as follows: less than 300 lamps, the charge to remain as at present, 6d.; for 400 and over, 5½; and for 500 lamps and over, the minimum charge of 4½d. The matter was referred to the Works Committee.

Stockton.—At the last meeting of the Town Council the Town Clerk reported that the Local Government Board had sanctioned the use of certain land for the purpose of the electric light station, and laid before the committee the formal approval and consent of the Department. The Gas Committee recommended that the work be proceeded with by the manager at once. The report was adopted.

Elland.—The Council have referred to the Electric Lighting Committee a letter from the English Industrials, Limited, Manchester, asking whether the Council were open to deal with the question of erecting an electric station for light, power, and eventually tramways purposes for their district. The general opinion appears to be against allowing a company to have the monopoly.

Kirkburton.—At the last meeting of the Urban District Council the subject of electric tramways was discussed. It was stated that if the Council were to approach the Huddersfield Town Council, it was very likely that the proposed Huddersfield tramways would be extended from Waterloo to Kirkburton. A deputation was appointed to meet the Huddersfield Corporation Committee.

Durham.—With regard to the correspondence between the Council and the Board of Trade, we note that the Corporation have passed a resolution affirming that the powers contained in

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Section 11 of the Electric Lighting Act, 1882, are insufficient for their purpose, and desire to press for the insertion of Clause 39 in the provisional order giving the authority power to lease electric lighting works.

Metropolitan Asylums Board.—At Saturday's meeting the Works Committee's estimate, amounting to £11,831, of the total cost of the works in connection with the electric light installation at the Northern Hospital, was approved and adopted. It was decided to ask the Local Government Board to issue an order sanctioning the expenditure, and authorising the raising of the amount on loan.

Stirling.—The work in connection with the laying of the electric lighting cables has been begun. The cables have been manufactured by Callender's Cable Construction Company, Limited, and are being laid by them. The proposed scheme for the construction of an electric tramway from Stirling to Tillicoultry has been informally submitted to the Lighting Committee and the Works Committee.

The Telephone Dispute.—The appeal of the Corporation of Edinburgh against Sheriff Rutherfurd's decision in the dispute between the Corporation and the Postmaster-General has been fixed by the Railway Commissioners for hearing in Edinburgh on July 11, and it has been arranged that the appeal from Glasgow will appear on the roll of the same Court immediately after the Edinburgh case.

Automatic Telephone Company.—At a recent extraordinary general meeting of shareholders the resolutions passed on the 6th ult. were confirmed. Mr. A. W. Cohen protested against the legality of the meeting, and demanded a poll on behalf of himself, Mr. Max Margowski, Mr. Moore, Mr. C. Penney, and Mr. J. W. Cohen. The poll will take place at Winchester House, E.C., on Friday next, at 12 o'clock.

Halifax.—Good progress is being made with the construction of the Free School-lane, the Illingworth, and the Pellon branch tramlines. The first-named is expected, indeed, to be open for traffic by Whit-Monday. The Board of Trade have been requested to send an inspector to go over the line before that date. Some two months in all probability will elapse before the Illingworth route will be ready for the inspector.

Rothesay.—The British Electric Traction Company, Limited, having entered into an arrangement with the Rothesay Tramway Company with the view of converting, and if necessary extending, the line by electric working, a committee of the Town Council has been appointed to deal with the question. The Council have appointed Mr. Robert Gordon, Glasgow, as inspector of electric lighting and electrical engineer.

Govan.—The Govan Commissioners have now been granted permission for the erection of part of the proposed buildings in Helen street in connection with the installation of electric light in the burgh. The estimated cost of the whole installation, including mains, machinery, etc., is £20,000. Building will be commenced immediately, and it is expected that the principal streets will be lighted about the beginning of October.

Kidderminster.—The Town Council have sealed a deed of transfer of the Kidderminster Electric Lighting Order to the Kidderminster and District Electric Lighting and Traction Company. The Board of Trade have agreed to the contract with the addition of some clauses which will be to the advantage of the Corporation. At the end of 14, 21, or 31 years the Corporation can acquire the undertaking on terms specified.

Great Northern Telegraph Company, Limited, of Copenhagen. During the year 1898 the total receipts, including the balance brought forward, amounted to £463,853, and the net profit to £378,722. The directors propose to place £116,666 to reserve and renewal fund and £3 889 to pension fund of staff, and to pay a final dividend of 7½ per cent., making a total of 12½ per cent. for the year, the balance carried forward being £61,417.

Indian Contracts.—Efficient and regular ventilation in India is almost one of the necessaries of existence, and cannot be ignored or left to chance, as is so often the case in England. The scheme of ventilation of the new Catholic Schools in Calcutta was a matter for careful consideration, and the decision has been in favour of Messrs. John King, Limited, ventilating engineers, Liverpool, who have received the order to supply their ventilating appliances.

Bristol.—At Tuesday's meeting of the Town Council the report of the Electrical Committee was considered. The Council was asked to sanction the first section, whereby the committee would be empowered to borrow £14,100 to provide two steam alternators, and it was stated that it was because the orders would be given to English firms that the committee asked for the money so early. If they went to American firms they might obtain the machinery earlier. The request was assented to.

City (London).—At the Court of Common Council yesterday, Mr. C. G. Algar presented a report from the Streets Committee on the question of civic electricity, and also a communication from Sir Courtenay Boyle asking for a further letter on the subject at an early date. It was recommended that the resolution of the 27th ult. be rescinded, and that the debate on the suggested conference should be resumed and the decision arrived at forwarded to Sir Courtenay Boyle without delay.

London Gazette.—Appointment of trustees: *in re* J. S. Blackwell (trading as the Central Electrical and Engineering Company), Leicester, Mr. W. Marsden Richards, 52 Belvoir-street, Leicester, has been appointed trustee; *in re* J. E. Stott (trading as James E. Stott and Co.), Huddersfield, Mr. T. Hubert Kaye, Blandford, has been appointed trustee. Dividends: the first and final dividend of 11½d. in the £, payable 18th inst., has been declared in the estate of F. Jones (carrying on business under the style of F. Jones and Co.), Wandsworth).

Warwickshire.—The County Council have received the following report from their Roads and Bridges Committee: "We have carefully considered the Leicestershire and Warwickshire Electric Supply Company's Bill which proposes to empower the promoters to supply electric light and energy over a very large part of this county, and to make use of the roads for this purpose. In our opinion the proposals of the Bill were beneficial to the ratepayers and inhabitants of the county, and we did not propose, on behalf of the Council, to oppose the preamble of the Bill."

Lowestoft.—A public meeting was held on Tuesday evening with regard to the route which the proposed electric light railway will take after passing the bridge. A resolution was passed to the effect that the route along the Marine-parade would be prejudicial to public requirements, and would fail to be of any material benefit to the ratepayers; that the company be requested to modify the route so as to bring it through the main thoroughfare of South Lowestoft (London-road) and that one of the councillors of the ward be requested to appear at the enquiry on Friday and support the resolution.

Blackburn.—At the last meeting of the Town Council a long discussion ensued upon the recommendation of the Electricity and Tramways Committee that Mr. Giles, the electrical engineer, should also receive a salary of £200 a year as tramways manager. It was stated that the electricity and tramways undertaking had grown to enormous proportions since the Corporation first undertook it, and still further expansion was contemplated, and it was highly necessary, therefore, that there should be a responsible man at the head of affairs On a division an amendment to refer the matter back to the committee was carried.

Beckenham.—Colonel W. R. Slacke, R.E., has held a Local Government Board enquiry into the application of the Council for power to borrow £37,100 for purposes of electric lighting. The loan for which sanction was applied for is made up as follows: the British Insulated Wire Company's tender, £25 054; estimated cost of buildings and chimney, roadway, dust destructors, £12,046—total £37,100. The land on which the works will be erected is held by the Council on a 999 years' lease. Mr. London has been re-elected chairman and Mr. A. J. Baker deputy-chairman of the Electric Lighting Committee for the ensuing year.

Spen Valley Tramways.—The authorities of the Spen Valley have decided to submit to the Light Railway Commissioners a joint alternative proposal for the construction of a tramway. Officials representing the Dewsbury, Heckmondwike, and Cleckheaton Councils held a conference last week, and decided upon joint action. It is suggested that the main line shall be from Dewsbury Market-place through Staincliffe to Heckmondwike, and thence to Cleckheaton, but if strong opposition is offered by the Batley Corporation concerning the short strips of Batley territory at Staincliffe the route will be diverted by way of Dewsbury Moor.

A New Desk Fitting.—The Edison and Swan Company are now placing on the market an improved desk light, which has been specially designed to uniformly scatter the rays of light in all directions without injurious effect upon the eye. An eye-shade, which serves as a reflector as well, is supplied, and it may be moved by a touch to any desired angle, so that the desk alone may be illuminated. The inner glass cylinder has one clear surface and one obscured to soften the light if desired, it being turned by a knob provided at the side. The light may be drawn forward or pushed back at will, and the fitting can be clamped on the desk without injury.

York. The City Council have accepted a proposal made by Messrs. Porte, Sykes, and Co., of Dublin, for the free-wiring of any premises in the city. The firm are to receive 1d. per unit for three years, the consumer having the option to purchase at the expiration of that time, the purchase price to be the prime cost plus 20 per cent., less 1½ per cent. per annum for depreciation. The Corporation are not to undertake any liability further than the collection of the 1d. per unit, and to bind themselves not to enter into any contract with private consumers to wire their premises. The appointment of a resident electrical engineer, at a salary of £200 per annum, is contemplated.

Notices.—The following notices have been advertised: (1) of a provisional order under the provisions of the Electric Lighting Acts 1882 to 1890, having been issued to the Corporation of Rawtenstall; (2) that the Ingleton Electric Lighting and Power Company, Limited, and whose address or registered office is at the Greta Printing Works, Ingleton, Yorkshire, intend to apply to the Board of Trade for a license under the Electric Lighting Acts, 1882 and 1888; and (3) that it is intended to make application this month for an order to construct light railways from Haughley to Halesworth, Bedingfield to Debenham, Debenham to Westerfield, and Debenham to Needham Market.

Appointments Vacant. — The Leeds Tramways Committee require a traffic manager, to take complete control of traffic arrangements in connection with the tramway service. Particulars can be obtained from the Town Clerk, Leeds. Applications, containing three recent testimonials, particulars of age, past experience, and salary required, are to be addressed to the Chairman, Leeds City Tramways Committee, Town Hall, Leeds, and delivered by 15th inst.—An assistant engineer is required by the Hampstead Vestry.—The Leeds Corporation invite applications for the appointment of engineer-in-charge. Particulars of these and other vacancies will be found in another column.

Epsom.—At the last meeting of the Urban District Council, it was proposed to fix a time for opening the tenders for

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carrying out the lighting of the district by electricity. A letter was read from the Electric Light and Power Company suggesting that, before the Council undertook the expense of supplying the electric light, they should consider whether this company could not offer them cheaper rates. They offered to take over a lease of the provisional order for 10 years, the Council at the expiration of that period to have the opportunity of taking over the undertaking at a valuation. The Chairman said they could consider this letter when the tenders came in. This course was agreed to.

Sutton Coldfield.—It is proposed in the course of the present month to make application, under the Light Railways Act, 1896, to the Board of Trade for an order for the construction of an overhead electric tramway. The proposed new line will practically be an extension to Four Oaks, Sutton, of the old tramlines which now run from the Old-square, Birmingham, to the bottom of Gravelly-hill. The promoters contemplate that later on, when Aston Manor and the city of Birmingham will have become possessed of the tramways within their respective districts, the entire network will be run by means of electrical power. The entire cost of the undertaking will be upwards of £70,000.

Perth.—The Electric Lighting Committee of the Police Commission have met Mr. Hawtayne, who has suggested that a larger plant than that mentioned in his report should be erected, which would cost some £3,000 more. The committee have agreed to recommend the Commissioners to adopt the site near the smallpox hospital at the shore, and Mr. Hawtayne has been instructed to prepare plans and specifications for the execution of the necessary works—making provision for the larger plant which he suggested should be erected—for the consideration of the Commissioners. At the monthly meeting of the Police Commission on Tuesday the adoption of the above was unanimously agreed to.

Glasgow.—The report of the committee on tramways recommends that a piece of ground at Port Dundas, containing about 18 600 square yards, bounded by the canal, the Caledonian Railway, the North British Railway, North Canal Bank-street, and Old Keppochhill-road, should be purchased at the price of £31,000. Mr. Parshall, the consulting engineer, is of opinion that this is a most suitable site in every respect for the proposed power station, and will afford ample accommodation for future extensions. The level, situation, and railway and canal facilities are such that the power station, the estimated cost of which, with machinery, is about £250,000, could be erected on the ground at the minimum cost.

Brighton.—At the last meeting of the Town Council the Lighting Committee submitted an estimate showing that £64,000 would be required on capital expenditure for the electricity undertaking during the remainder of the year 1899 and the year 1900, being £26,350 for the former and £37,650 for the latter year. The principal amounts were boilers and steam-piping, £6,600; condensers and cooling towers. £7,000; dynamo, etc., £5 500; new feeders, £21 900; new distributors, £7,500; and new house services and meters, £7,500. The committee recommended that application be made to the Local Government Board for sanction to borrow the amount for the period of 25 years. The report was adopted.

South Africa.—An order for two hauling engines of powerful type, to be driven by either electricity or compressed air, may shortly be expected to be placed by the Lancaster West gold mine. The order for a high speed engine, of sufficient power to drive a dynamo of 525 volts and from 60 kw. to 100 kw. capacity, has just been placed by the Johannesburg Town Council. After receiving the report of the borough engineer on the cost of installing an electric lighting system in the municipality of Newcastle, Natal, the Town Council have determined to defer the carrying out of the scheme for the present on account of the cost. It has, however, been decided to acquire a small electric plant to light the town hall.—*British and South African Export Gazette.*

Plymouth.—With reference to the recommendation to apply electric traction to the Tavistock-road route, the borough electrical engineer, Mr. Rider, said at Tuesday's meeting of the Borough Council that the estimate of £18,000 was based on the actual cost of the Prince Rock line, and might be safely relied on. After discussion the recommendation was agreed to, on the distinct understanding that the scheme would be submitted to the Council again when the tenders were received. Upon the recommendation of the committee, that "upon sanction being received the scheme be proceeded with as quickly as possible," an amendment was proposed that the last four words should be deleted. The voting was equal, and the Mayor gave the casting vote for the amendment.

Parliament.—During the past week, in the House of Commons, the following Bills were read a third time: the Great Northern and Strand Railway and the Gateshead and District Tramways. The following Bills were considered and ordered for third reading: Kensington and Notting Hill Electric Lighting, and Kirkcaldy Corporation and Tramways; Greenock and Port Glasgow Tramways Bill was read a second time. The Bill promoted by the Hastings Corporation for the construction of tramways in the borough came before a Select Committee of the House of Lords on Monday, when several doctors testified that the introduction of electric tramways into Hastings would have a disastrous effect on the place as a health resort. After consideration in private for some time, the Chairman said the committee were of opinion that the preamble was not proved.

Aston Manor.—At the last meeting of the Urban District Council a letter was read by the Clerk from Captain Grice-Hutchinson, M.P., acknowledging the communication from the Council over the Telephone Bill, and stating that he understood from Mr. Hanbury that the Government intended to enlarge the Bill to include large centres like Aston within its provisions. A letter from the Birmingham and Aston Tramways Company, Limited, referred to the fact that the Council would in 1901 have the power to either purchase the Aston tramways or grant an extended lease to the company, in which case if the lease was for 21 years, they would be ready to have a project prepared by experts to be submitted to the Council for their approval, and they would be glad to discuss the matter with the Council. The letter was referred to the General Purposes Committee

Kingston.—Several new electric mains are to be laid. The Town Council have asked the Ham District Council whether they had any objection to current being supplied in their district subject to the approval of the Board of Trade. The Town Council has applied to the Local Government Board for their sanction to the proposed loan of £15,000 for electricity works. The consideration of the salary of the borough electrical engineer, together with the particulars received from other towns, has been deferred until after the Local Government Board enquiry with reference to the loan. The question of supplying electricity from Kingston to Hampton Wick has been discussed, and the matter will come before the latter Council. The following reductions in the rent of meters per quarter have been made—viz.: 10s. present rent to be reduced to 5s., 5s. present rent to be reduced to 4s., 2s. 6d. present rent to be reduced to 2s.

Bradford.—At the meeting of the Town Council on Tuesday it was agreed to reduce the charge for electricity for power to constant users to 1d. per unit, and to intermittent users to 2d. per unit. It was stated that the price of 1d. per unit would be charged to those consumers who were using power continuously for eight or ten hours per day, and it was believed that this price would show a profit after paying interest and sinking fund of 10 per cent. This price could not be extended to power for working cranes, because, although there were some cranes in use almost all day, others were only very occasionally in use, and it was impossible to draw a line between them. Neither was it possible to reduce the charge for electricity for lighting purposes, because the use of electric lights did not average more than 15 minutes per lamp per day in some seasons, and it was easy to see that even 4d. or 5d. per unit would not pay under those circumstances.

Monmouth.—At the last week's meeting of the Town Council it was recommended that a third turbine be purchased and fixed at the generating station, as two turbines were not sufficient to produce the amount of electricity required. The Chairman of the committee said that up to the present the demand for private and public lights was equal to 1,608 8-c.p. lamps. Two turbines would produce only 1,120 such lights, and deducting 20 per cent. for waste gave 984. However, as there would never be much more than half the lights required at the same time, they had sufficient power for the present, but fresh orders kept coming in every day, and a considerable saving would be effected by purchasing the extra turbine within the contract year. The consideration of the purchase of a turbine was adjourned for a fortnight The report was adopted. To meet present expenses a temporary loan of £7,000 is suggested, pending powers from the Local Government Board to borrow money.

Wormit.—The formal opening of the electric light installation took place on the 10th inst., when Miss Wedderburn, of Birkhill, turned on the new illuminant. The work has been carried out by the British Illuminating Company, Limited, of Newcastle and Edinburgh, under the superintendence of their engineer, Mr. Joseph P. Sleigh. The system is a direct-current one, working at 230 volts at the lamps. The present engine and boiler, made by Mr. R. G. Morton, of Errol, and dynamo supplied by Messrs. D Bruce Peebles and Co., Edinburgh, are running the present lights direct, but are to be supplemented by a battery so as to increase its working capacity, and is so designed as to light the central portion of Wormit. Arrangements are so made as to duplicate the present plant as the mains are extended. Sixteen houses have been supplied, and for public lighting two arc lamps of about 600 c.p. each, as also two 50-c.p. incandescent lamps, have been put up.

Newcastle.—At a special meeting of the new Tramways Committee of the Corporation on Tuesday, it was decided to accept Mr. Hopkinson's terms, as consulting engineer, subject to the passage of the Bill and to the approval of the Council. The committee intimated that they would proceed to appoint a resident engineer, but would submit the names of candidates and advise with him before finally deciding on the same. Mr. Hopkinson suggested that it would be better to have an architect for constructing the new buildings required. A deputation was appointed to proceed to London and support the Tramway Bill. Mr. Hopkinson stated that he was going to Brussels to see the system in vogue there, and he would then be able to more fully deal with Newcastle. The National Telephone Company have lodged a requisition at the Private Bill Office of the House of Commons, that their petition against the Newcastle-on-Tyne Trams and Improvement Bill may be withdrawn.

Uxbridge.—The Parliamentary Committee reported to the Council last week that they had lost no time in considering steps to be taken with a view to giving effect to the resolutions of the Council in connection with light railways. They proposed to deal with those districts where the need for light railways appeared to be most pressing, but schemes as regards other districts would be considered in due course. Referring to the London United Tramways (Uxbridge and Hanwell) light railway extensions, the report stated that the Board of Trade had been asked, under the exceptional circumstances of the case, to reopen the question of

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preamble, in order that the County Council might be heard against it. The Board refused this application, and announced their intention of confirming the provisional orders. The county solicitor had asked that a clause might be inserted in the order giving the County Council the option of purchase, and that the County Council might be heard on the form of this clause prior to the confirmation of the order.

Electrical Power Transmission Company.—This Company has been started at Albert Works, Hammersmith, for the purpose of supplying plant for the electrical transmission of power, and also to manufacture a new patent arc lamp and several special electrical appliances, particularly a newly patented automatic motor switch which fulfils all the requirements of the most exacting corporation engineers, and has other points entirely novel. We are informed that from the nature of their contract business the Company will have many orders to give out to the trade, for all classes of electrical work, in connection with indents received from its connections in the Colonies. No company has yet been registered, the business being under the direction and on account of Messrs. Powell-Jones and Co., 7, East India-avenue, but a limited company under the above name will be registered shortly, of which the above firm will become managing agents. Mr. Walter F. Jones, A.M.I.E.E., M.I.Min.E., late of Messrs. P. R. Jackson and Co., and formerly of Messrs. Easton, Anderson, and Goolden, is acting as manager and engineer at the works.

Limerick.—The Corporation have appointed a committee to consider the conditions offered by the Dublin District and Provincial Electricity Corporation for acquiring the Limerick gasworks. The following points are noted: The provisional order for electric lighting granted to the Corporation by the Board of Trade is to be transferred to the syndicate, and the order for lighting by gas to the Electricity Corporation. The syndicate will take over the gasworks at a price agreed upon by qualified valuers. The Electricity Corporation is to supply the public lighting at 3d. per unit, and private lighting at a maximum of 6d. per unit. The application of the National Telephone Company to lay underground wires has been granted on condition that the terms should be the same as those given in Dublin and Belfast. The company propose to expend £5,000 on the work, £1,800 of which will be spent in the employment of unskilled labour. A special meeting is to be held to consider a communication from the Limerick Electric Tramways Company, asking the Corporation to state whether they would assent or dissent or adopt a neutral position as regards the proposed scheme of electric tramways for the city.

London County Council.—The Council on Tuesday decided, on the recommendation of the Finance Committee, to lend the Hammersmith Vestry £4,820 for electric lighting purposes, and for the Strand District Board £14,600 for street improvements and a dust destructor. The adjourned report of the Highways Committee on the subject of the telephone service was again submitted. The recommendations are as follows: "(*a*) That, in the opinion of the Council, the telephone service in the London area of the National Telephone Company should be managed by the Council, the Corporation of the City of London, and the local authorities of districts outside the administrative county of London, but within the London telephone area. (*b*) That, in the opinion of the Council, application should be made to the Postmaster-General by the Council, the Corporation of the City of London, and the other local authorities of districts within the London telephone area of the National Telephone Company, for a license under the Telegraphs Act, 1892, for the establishment of a telephone service in respect of that area. (*c*) That the clerk of the Council do, in conjunction with the town clerk of the City of London, draft an application to the Postmaster-General for the license above referred to, and that such draft application, when prepared, be submitted to the Council for approval."

Edinburgh.—The electric lighting accounts show an increase of £4 465. At Wednesday's meeting of the City Council it was explained that the result of the electric lighting department was so comparatively small in consequence of the very large increase made at M'Donald-road. Exclusive of sinking fund and interest, the total cost of working this year was £31,745. Of that sum £3,325 was for the M'Donald-road station. The total interest and sinking fund for the year was £29,385, and of that sum M'Donald-road was liable for £4,896, or, altogether, £8,311. The expected revenue from M'Donald-road for this year was £4,910. That brought out that in Dewar-place they were making a profit of practically £10,000, and at M'Donald-road they would make a loss of £3,401. The total expenditure on Dewar-place for the first year was £143,000. This year they had included in their estimates £69,600 for M'Donald-road, and of that £10 000 had already been expended. The demand for the electric light was increasing, and the wise policy was to make such provisions for the coming year as would in all probability result in the greater demand being met. The expenditure on Dewar-place, taking the average for the coming year, would be £420,000, and on that expenditure they would make a gross revenue of £35,375. That was equal to about 8½ per cent. The estimates were then remitted back to the committee for consideration.

Poole.—The Tramways Committee's report, adopted by the Town Council last week, referred to a letter from the Light Railway Commissioners enclosing a copy of the order made by them authorising the Poole and District Light Railway, which order had been submitted to the Board of Trade for confirmation. The committee suggested that the work should be commenced within ix months and completed within two years; that wood blocks or other suitable material should be laid down between certain points; that it should be made clear in the order that both as regards service of cars and fares the residents of Constitutional-hill should have facilities for travelling to Poole equal to those which they would have for travelling to Bournemouth; that one waiting-room was insufficient; that the fare should be 1d. a mile or a fraction of a mile; and that the period after which the railway could be compulsorily acquired should be 21 years as provided by Section 43 of the Tramways Act, 1870, and not 35 years as fixed by the order, and that such purchase should be carried out in accordance with the terms of the said Acts. The Commissioners do not agree with these recommendations, and the Council resolved to adhere to the suggestions previously made by them for amending the order, and to instruct the town clerk to prepare and lodge with the Board of Trade objections to the order based on the above suggestions, and to take such steps as he may deem advisable in connection with the hearing of such objections by the Board of Trade.

Yeadon.—At the last meeting of the District Council a letter was read from Messrs. Alf. Dougill and Co., of Leeds, on behalf of a syndicate desirous of negotiating for tramway concessions in Yeadon and district. The letter stated that the firm would allow, if desired, the district councils and people in the district to co-operate in providing the capital, or they would provide the whole of the capital required, and as an earnest of good faith they were prepared to make a deposit of £10,000. A letter from Mr. W. W. McLauchlan, of Manchester, stated that he represented a company which would be willing to put down plant for the district for the purpose of electric lighting, and also to erect a tram system for Yeadon, Menston, and Guiseley, and extend the same to the Leeds boundary. The whole could be supplied on a 35 or 42 years' basis, goodwill not to be considered if on 42 years, and they would maintain the road between the rails and 18in. on each side of the rails, arrange to supply electric current for public and private lighting at a reasonable rate per Board of Trade unit, and establish a sliding scale for a portion of the profits to be applied to the districts in reduction of the rates. It was decided to call a joint meeting of the Horsforth, Rawdon, Yeadon, Guiseley, and Menston Councils to discuss the question. At the same meeting the question of extending the Yeadon Council's provisional order for electric lighting to Guiseley and Rawdon was also discussed. An opinion was expressed that the Council would be able to supply electricity at a price equal to gas at 1s. 9d. per 1,000ft.

PROVISIONAL PATENTS, 1899.

MAY 1.

9101. Improvements in or relating to globes or protectors for electric and other lighting apparatus. James Gray Pennycuick and Frederic William Barrett, 111, Hatton-garden, London.

9134. Improvements in or relating to electric accumulators. François Mouterde, 18, Buckingham-street, Strand, London.

MAY 2.

9209. Improvements in and relating to electric arc lamps. Roger Upton, 11, Southampton-buildings, Chancery-lane, London.

9212. Improvements in electric switches. Joseph Devonport Finney Andrews, 45, Fulham-park-gardens, Fulham, London.

9245. Improvements in electric maximum demand indicators. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Frank P. Cox, United States.) (Complete specification.)

9246. Improvements in apparatus for measuring electric currents. The British Thomson-Houston Company, Limited 83, Cannon-street, London. (Walter C. Fish, United States.) (Complete specification.)

9272. Improvements in telegraphing graphic or other matter automatically without wires and in apparatus therefor. Rupert Greville-Williams, 22, Southampton-buildings, Chancery-lane, London.

MAY 3.

9278. Improvements in dynamo-electric or electro-dynamic machines. John Grice Statter, 68, Victoria-street, Westminster, London.

9290. Improvements in or relating to electrical sparking plugs. Fred Oldfield and James Ward Milligan, 9, Exchange-chambers, New-street, Birmingham.

9351. Improvements in the manufacture and production of elements for secondary batteries or electric accumulators. Hans Herrmann Strecker, 47, Lincoln's-inn-fields, London.

9367. An improved process for the production of accumulater plates. Arthur Lehmann, 18, Southampton-buildings, Chancery-lane, London.

MAY 4.

9401. Improvements in Hertzian-Lodge space telegraphy. Alexander Muirhead and Benjamin Davies, 323, High Holborn, London.

9414. Improvements in controlling electric motors and apparatus for that purpose. Henry Leitner, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

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9424. Improvements in or relating to electric arc lamps. John George Benjamin Petts and James Byrne, 111, Hatton-garden, London.

9428. Improved regulating mechanism for the carbon of electric arc lamps. Josef Rosemeyer, 56, Ludgate-hill, London. (Complete specification.)

9429. Improvements in electrical arc lamps. Josef Rosemeyer, 56, Ludgate-hill, London. (Complete specification.)

9434. Improvements in electric arc lamps. Alfred George Stockwell, 47, Lincoln's-inn-fields, London.

9436. Improvements in electric telegraphic apparatus. Eugenio Cantono, 47, Lincoln's-inn-fields, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Jan. 12, 1899, being date of application in Italy.)

9437. Improvements in electric telegraphic apparatus. Eugenio Cantono, 47, Lincoln's-inn-fields, London. (Date applied for under Patents, etc., Act, 1883. Sec. 103, April 13, 1899, being date of application in Italy.)

MAY 5.

9456. Improvements in or relating to electric storage or secondary batteries. Job Thomas Niblett and Malcolm Sutherland, 61, Chandos-street, London.

9465. A telephone automatic call register. Thurston Briggs and John Walsh, 42, Burlington-street, Blackburn.

9511. Method of controlling several rotary-phase current motors in an electrical railway train from one point of the train. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske, Aktien Gesellschaft, Germany.) (Complete specification.)

9512. Improvements in voltaic batteries. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (La Société d'Etude des Piles Electriques, France.)

9516. Improvements in automatic telephonic switches. Victor Veysy, 55, Southampton-buildings, Chancery-lane, London.

9522. Improvements relating to the distribution of electric currents. Benjamin Garver Lamme, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Oct. 6, 1898, being date of application in United States.)

MAY 6.

9528. Improved electromagnetic apparatus for stopping and starting machinery and vehicles. Charles William Higgs, 75, Chancery-lane, London.

9566. Improvements in and connected with electric safety fuses. James Gray, 121, West George-street, Glasgow. (Complete specification.)

9581. Improvements in or relating to electrical devices or apparatus for controlling the pressure of small currents for electric lighting. Frederick William Smith, 8, Quality-court, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1898.

8495. Electric switches and fuses. McFarlane and Holland House Electrical Manufacturing Campany, Limited.

8832. Electricity meters. O'Keenan.

10446. Means for supporting and connecting arc lamps and other electrical apparatus. Davis.

12016. Systems of electrical control for elevators. Leigh. (Sprague.)

12268. Insulating means for electric furnaces. Wise. (Aluminium-Industrie Actiengesellschaft.)

12461. "Fenders" for electrical and other tramcars, motor-cars, and such like vehicles. Towle.

13037. Electric glow lamps. Spiral Globe, Limited, and Parker.

13689. Secondary electric batteries or accumulators. Hart and Clark.

21216. Trolley for taking electric current applicable to the electric traction of vehicles, boats, and the like. Lombard-Gérin.

22344. Electric arc lamps. Delavau and Brérat. (Date applied for under International Convention, March 24, 1898.)

25670. Electrical induction apparatus. Kinraide.

1899.

580. Telephone station apparatus. Wilson.

764. Hollow or recessed punches used in connection with Wheatstone's automatic telegraphy or other systems of automatic transmission. Willmot.

3051. Electric illuminating apparatus. Bauer.

3754. Electrical wall plugs. Simon, Berry, and Rayner.

4231. Arc lamps. Johnson and Wunderlich.

5217. Construction of commutaters for dynamos and electro-motors. Burke.

5255. Electrical switches. Hall.

5519. Electric brake apparatus. Kinraide.

5570. Closed conduits for electric railways and trolleys therefor. Clark. (Campbell Electric Traction Company.)

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1899.	Corresponding week 1898.	Increase or decrease.	Total receipts for half-year. 1899.	1898.
		£	£	£	£	£
Birmingham Tramway Co.	May 6	4 095	3,746	+ 349	69,407	63 909
Blackpool and Fleetwood Tramroad	,, 6	419	—	—	4,360	—
Bradford City Trams	Feb. 5	145	—	—	6,733‡	—
Bristol Tramways and Carriage Co.	May 5	2,815	2,478	+ 337	—	—
City and South London Railway	,, 7	995	964	+ 31	20 353	19,721
Dover Tramways	,, 6	151	130	+ 21	2,731	2,082
Dublin U.T., elec. cars	,, 5	1,086	794†	+ 292	16,620	13,389†
Dublin S.D. Electric Tramways	,, 5	772	448	+ 324	12,073	7,767
Halifax Corporation Tramways	Mar. 29	312	—	—	10,712*	—
Liverpool Overhead Railway	May 7	1,426	1,541	- 78	25,580	26,438
South Staffordshire Tramways	,, 5	628	577	+ 51	11,095	10,661

* Since June 30, 1898. † Including horse cars. ‡ Since July, 1898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	24-25
Bournemouth and Poole Electric Supply, Limited, Ord.	10	13½-13¾
—— 4½ per cent. Cum. Pref.	10	10¼-11¼
British Electric Traction, Limited, Ordinary, Nos. 1-80,000	10	18½-19¼
—— 6 p. c. Cm. Pf., 80,001-40,000 (all paid)	10	14-14½
—— 5 per cent. Perpetual Debenture Stock	100	126-129
Brush Electrical Engineering, Limited, Ordinary	2	1¾-2¼
—— Non. Cum., 6 per cent. Pref.	½	2¼-2¾
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	102-106
Callender's Cable Company, Debentures	100	114-117
—— Ordinary	5	12¾-13¼
Central London Railway, Ordinary	10	10½-11
——	8	8¼ 9
—— Pref. Half-Shares	3	3½-3¾
—— ,, ,,	5	5¼-5¾
Charing Cross and Strand	5	11-12
—— 4½ per cent. Cum. Pref.	5	5¾ 6¼
Chelsea Electricity Company	5	7¼-8¼
—— 4½ per cent. Debentures	100	114-119
City of London, Ordinary	10	17-18
—— ,, 90,001-100,000	10	17-18
—— 6 per cent. Cumulative Pref.	10	15-16
—— 5 per cent. Debenture Stock	100	124-129
City and South London Railway, Consolidated Ordinary	100	68-70
—— Ordinary	3	4¼-4½
—— 4 per cent. Debenture Stock	100	132 134
—— 5 per cent. Pref. Shares	10	14¼-15½
—— ,, ,, '96	10	14-15
County of London and Brush Prov. Elec. Light Co., Ord.	10	11-12
—— ,, ,, No. 80,001-40,000	10	11-12
—— 6 per cent. Cum. Pref.	10	14-15
Crompton and Co.	3	3¼ 3¾
—— 5 per cent. Debentures	—	96-101
Crystal Palace District, Ordinary 5 per cent. Stock	100	130-135
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	2	2-2¼
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	96-98
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5¼-5¾
Electric Construction, Limited	2	2¾-2¾
—— 7 per cent. Cumulative Pref.	2	2-2¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	102-106
W. T. Henley's Telegraph Works, Ordinary	10	24¼-25¼
—— 7 per cent. Preference	10	18-20
—— 4½ per cent. Debentures	100	113-115
House-to-House Company, Ordinary	5	8¼-9¼
—— 7 per cent. Preference	5	9-10
Imperial Tramways, Limited	6	24¼-25¼
India Rubber, Gutta Percha, and Telegraph Works	10	21¼-22¼
—— 4 per cent. Debentures	100	101-105
Kensington and Knightsbridge Ordinary	5	12-13
London Electric Supply, Ordinary	3	3¼-3¾
—— 6 per cent. Pref.	5	6¼-7
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	105-108
Metropolitan Electric Supply, Limited, Ord., No. 1-62,500	10	16¼-17¼
—— ,, ,, No. 62,501-85,000	10	15¼-16¼
—— 4½ per cent. First Mortgage Debenture Stock	100	118-12?
National Telephone, Ordinary	5	4¼-5
—— 6 per cent. Cum. First Pref.	10	11-12
—— 6 per cent. Cum. Second Pref.	10	11-12
—— 5 per cent. Non. Cum. Third Pref.	5	4¼-5¼
—— 2½ per cent. Deb. Stock, Red.	100	99-101
Notting Hill Electric Lighting Company, Limited	10	16¼-17¼
Oriental, Limited, 1879	1	1¼-1¾
—— £5 Shares	5	7¼-7¾
—— £4½ Shares, New	4½	6¼-6¾
Oriental Telephone and Electric Company	1	¾-1
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,810	5	6¼-7
Royal Electrical Company of Montreal	1½	165-185
—— 4½ per cent. First Shares Mortgage Debentures	100	105-107
South London Electric Supply, Ordinary	3	3¼-3¾
St. James's and Pall Mall, Limited, Ordinary	5	17-18
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	35-39
—— 5 per cent. Bonds	100	105-108
Waterloo and City Railway, Ordinary	100	109-111
Westminster Electric Supply, Ordinary	5	14¼-15¼

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NOTES.

Royal Meteorological Society.—Owing to the public improvements in the neighbourhood of Parliament-street, the Royal Meteorological Society has been obliged to vacate its offices in Great George-street, and find accommodation at Prince's Mansions, 10, Victoria-street. On Tuesday evening, the 16th inst., the president, Mr. F. C. Bayard, LL.M., held an "At Home" in these new rooms, when there was a large attendance of Fellows.

Underground Railways in New York.—Mayor Van Wyck, of New York, has refused to approve of the Rapid Transit Underground Railway Law. His action nullifies the law, and prohibits the City Commissioners from contracting with private capitalists for the construction of the railway. This, says the Central News, is a great triumph for those who favour municipal construction and working of the underground railway system.

London Telephone Rates.—It is stated that the National Telephone Company have decided to apply their ordinary tariff rates of £10 per annum for any distance within the county of London. Hitherto these rates have only applied when the subscriber's premises were within 1½ miles of the company's nearest exchange. If subscribers were at a greater distance, an extra charge was made for each additional half-mile or part of half-mile. It need scarcely be added that this important modification will in many cases meet with much approval.

The Volta Centenary.—We have received from the committee who are organising the Como International Exhibition, which will open in a few weeks, a letter calling attention to the fact that at this exhibition there is to be shown a collection of portraits of gentlemen connected with the electrical profession. We are informed that authors, professors, inventors, and practical men are all to be represented. We may add that those of our English electricians who wish their portraits to be on view should send these with their signatures to the exhibition authorities at 11, Via Cusani, Milan.

Presentation.—On Saturday last the staff of the Bolton Corporation fittings department met at the Gas Offices, Hotel-street, to make the presentation of a gold albert and pendant to Mr. A. W. Crowter, on his leaving to take up the duties of electricity fittings superintendent to the Corporation of King's Lynn. The presentation was made by Mr. R. Baker, superintendent, and was supported by Messrs. J. Wood and R. E. Stringer on behalf of the electricians, and Mr. F. Ball on behalf of the gasfitters, all wishing him every success in his new appointment. Mr. Crowter suitably responded.

Electric Mail Vans.—We understand that the collecting van supplied by the Madelvic Motor Carriage Company, of Granton, under contract to her Majesty's Postmaster-General, has commenced running in Edinburgh for collecting mails from outlying boxes. The object of the design seems to be to get for a small weight fairly high speeds, and a good margin of power. The whole vehicle, complete with accumulators, weighs about 18cwt. only, and is guaranteed to carry half a ton of mails. Three of these vehicles are being supplied at present, but without doubt they will be multiplied if found serviceable.

Electro-Harmonic Society.—The annual meeting of this society, at which officers for the ensuing season will be elected, will take place on Wednesday, the 24th inst., at 4.30 p.m. By kind permission of the secretary of the Institution of Electrical Engineers, the meeting will be held at 28, Victoria-street, S.W. The annual report shows that 20 new members were elected during the past season, and that during the same period the society has lost two members by death and eleven by resignation. The total roll now includes 291 members. We gather from the balance-sheet that the concerts given in 1898-9 resulted in a small surplus.

Governmental Telephones.—The Sunderland Town Council has recently passed a resolution whereby it joins with the Liverpool City Council and the Liverpool Chamber of Commerce in recording its great dissatisfaction with the Government scheme for dealing with the telephones, and expressing the opinion that it is desirable, not only in the interest of trade and commerce, but of the whole community, that the telephone system of the country should be placed under the control of a Government department, so as to have it extended, developed, and cheapened with the least possible delay, and that the borough members be asked to give their support to the views expressed in the foregoing resolution.

Electric Lighting at Singapore.—Prof. A. B. W. Kennedy's advice has been sought with reference to electric lighting at Singapore. We gather from our contemporary *Indian Engineering* that in referring the matter to him the following points have been raised by the municipality: "Underground cables will be decidedly preferable to overhead wires, but whether or not the Commissioners will or can incur the extra cost must depend upon the amount and the probable difference in annual charges for maintenance; the estimates should therefore include figures for underground and overhead wiring. The facilities for repairs are not so great in Singapore as in European towns, especially for electric plant; the plant should therefore be of the highest class of workmanship and material so as to reduce the repairs and the probability of irregular service. The population being largely composed of most ignorant people, high-pressure current is undesirable."

Electric Lighting in the City.—There was evidence at the last meeting of the Court of Common Council for the City of London that the Board of Trade is putting pressure on the Corporation to make up their minds in one way or another as to what policy they intend to pursue with regard to electric lighting. It will be remembered that recently a request from the City of London Electric Lighting Company for a conference was not acceded to, and the matter was shelved for a month. The Court of Common Council last week reconsidered this decision, and decided to meet the representatives of the electric lighting company in conference. We gather from the debate that some of the members realise that a policy of confiscation is not possible, even if the original contracts should be proved void in a court of law. We trust that some arrangement which will either place the matter wholly in the hands of the Corporation or else assure the company of its position, will speedily be arrived at.

Lord Kelvin in Rome.—A complimentary dinner was recently given to Lord and Lady Kelvin in Rome by the Electro-Technical Society of Italy and the Ministry of Posts and Telegraphs. The toast of the evening was proposed in most warm and complimentary terms by no less than four speakers, and Lord Kelvin, in replying, spoke with great admiration of the extent to which electric works have been carried in Rome. He had been deeply impressed by the beauties of ancient Rome and the skill of her builders. Yet, he added, the old Romans, if they came back to life and saw 2,000 horse-power being transmitted 16 miles through four wires no bigger than his little finger (as is done to supply electricity to Rome from the waterfall at Tivoli) along nearly the same path as their magnificent aqueducts, they would think a feat had been accomplished even greater than those of old times. The

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menus were most ingeniously decorated with sketches of Lord Kelvin's inventions. Signor Mengarini, president of the Electrical Society, was in the chair, and other members of Roman scientific bodies were present.

Heat Combination of Alloys.—Dr. Alexander Galt, of Glasgow University, has communicated a paper to the Royal Society of Edinburgh on experiments showing that the heat of combination in the formation of alloys of zinc and copper is negative when the proportion of copper is less than about 30 per cent. Alloys of copper and silver were also tested, these showing practically no heat of combination, but the maximum effect of 52 gr. water heat unit Centigrade per gramme of alloy was obtained with an alloy of copper and zinc containing the metals in their ordinary chemical combining proportions, the metals being considered as bivalent elements. With percentages of copper less than this, the heat of combination rapidly fell, until at 30 per cent. copper no heat of combination was obtained. But when the percentages were lower than this, the negative value for the heat of combination was obtained for three of the alloys. Dr. Galt's conclusions are the continuation of a research, some results of which were communicated to the society about a year ago, and which are expected to be completed in the autumn.

Taping Armature Coils.—It is often necessary in electrical factories to insulate with tape certain parts of armature coils which are built up on formers of the Eickemeyer or other types. We notice in the columns of the *Street Railway Journal* an interesting device used by Mr. Sheldon, of Indianapolis, for taping such coils, which usually has to be done by hand. It consists of a circular rim, inside which a gear is cut. In this gearing a pinion, driven by a belt from the shafting, is arranged to run. The rim in question is mounted in an external bearing, out of which a segment corresponding to about 30deg. is cut. A spindle to carry the bobbin of tape is mounted on one side of this rim, with suitable arrangements for adjusting the tension of the tape. A diagonal slot is cut through the rim in such a way that a coil can be inserted through it, the grip not being sufficient to prevent the gear pinion continuing to drive the rim. The coil having been inserted and the tape made fast at one end of it, an even layer can be quickly run on and the tension can be maintained more evenly than with hand-winding. The author states that from 60 to 100 laps each minute can easily be made, and that the labour charges are in this way cut down to about one-third of those appertaining when the coils are wound by hand.

Energy of the Rontgen Rays.—We have just had an opportunity of reading a paper contributed by the Rev. Alexander Mowfat, M.A., B.Sc., to the Royal Society of Edinburgh, on the "Energy of the Röntgen Rays," which paper was read on Jan. 9 this year. The author commences by referring to the work of other experimenters in the same direction, and gives in careful detail the apparatus which was used in his work. To describe this fully would take up more space than we have at our disposal, but the conclusions are of great interest. The author assumes that the transformation coefficiency of radiant energy into luminiscence is not more than about 4 per cent., and that this ratio holds good in the case of the Röntgen rays. In this case, with the apparatus he used the Röntgen rays produced corresponded to about 73 watts. With this assumption, it would follow that they produced some 500 times the effect of the sun concentrated on a square centimetre. Thinking that this is too high, the author concludes that the coefficiency of the transformation of cathode rays into Röntgen rays must be very small. He considers it evident from the results he has obtained that the true average power of the Röntgen rays—*i.e.*, their energy divided by their duration as such—is much greater than is generally supposed, and that about 10 gramme-calories per second may be taken as the lower limit of its magnitude.

The Franklin Lamp.—At a meeting of the electrical section of the Franklin Institute on April 25 at Philadelphia, Prof. W. S. Franklin, of the Lehigh University, showed in operation, says the *Electrical World*, a Nernst lamp of his own construction. Prof. Franklin, who has experimented quite a little in this interesting field, has made many lamps and tried many materials. The lamp which he showed was said to take only about 0·8 ampere and 130 volts alternating current, and he estimated the candle-power to be about 150, which, however, he admitted was a mere estimate. The lamp had to be heated with a powerful blast lamp for nearly a minute, and was then started with about 1,000 volts. It could have been started with less, but then requires more heating. He referred chiefly to his own experience rather than the lamp as made by Nernst. He does not believe the preliminary heating will offer as great difficulties as the proper construction of the terminals, which latter he considers a very serious and difficult question. He believes that the material must contain something which begins to fuse before the conductivity is sufficient to carry an appreciable current. He seemed doubtful as to the probable future of the Nernst lamp. An interesting experiment which he showed was the fusing of a large glass tube through which the current was passed between two terminals after the tube had been brought to a red heat. The glass, of course, melted, but in doing so gave out considerable light.

Transformer Efficiency. — It seems that the Westinghouse Electric Manufacturing Company are supplying some transformers to the County of London and Brush Provincial Electric Lighting Company. We gather from the *Electrical World* that the orders were placed with the Westinghouse Company because they guaranteed very high efficiencies. As a proof of this, the following figures are given with respect to the efficiencies at various loads of the 100-kw. size. The transformer is required to increase a voltage of 2,100 up to 6,000 volts with a frequency of 50, and the variation of voltage on the secondary between no load and full load is guaranteed to be 1·3 per cent. The full load efficiency is to be 98·4 per cent., half load efficiency 98·5 per cent., quarter load 97·75 per cent., one-tenth load 94·9 per cent., and at one hundredth of its full load the transformer is to have an efficiency of 65 per cent. With these results the all-day efficiency, with 19 hours of no load and five hours at full load, works out at 96·5 per cent. As we gather from the context that the transformers are to be used in the stations for transforming up to large district feeders, even higher efficiencies will be obtained by cutting out certain transformers during the daytime. From the illustration given in our contemporary, we see that the transformer is of the design generally adopted by the Westinghouse Company, while the primary and secondary windings are wound in sections placed alternately so as to reduce the magnetic leakage.

Institution of Mechanical Engineers. — On Tuesday evening there was a house-warming at the new building at Storey's-gate, Westminster, which is to serve as the London home of the Institution of Mechanical Engineers. Sir William White (the president) and Lady White received the guests, of whom there were more than 1,000, in the Great Hall. The building is one of the finest possessed by any scientific society in the Metropolis, and was built from designs prepared by Mr

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Basil Slade. The entire structure was utilised for the entertainment of the guests. As was appropriate with the Director of Naval Construction filling the office of president, there were displayed in the large hall limelight pictures of typical ships of the navy. The guests included the Earl of Hopetoun, Lord Kelvin, Sir R. Webster, Q.C., M.P., the Ministers for Bolivia, Servia, Sweden, and Uruguay, the Lord Mayor of Belfast, the Mayors of Plymouth, Newcastle, Southampton, and Cardiff, members of the senates of the universities, leading representatives of scientific societies, the heads of Government departments, and other distinguished persons, including General Sir George White, Admiral Bedford, Admiral Moore, Mr. W. H. Preece, Sir Hugh Owen, Sir F. Marindin, Sir Thomas Sutherland, Sir J. Wolfe Barry, Sir Benjamin Baker, and Sir Frederick Bramwell. Music was furnished by the Meister Glee Singers and the London Concert Orchestra. On the following evening close upon 1,500 guests were to be entertained at a similar function, as even the palatial home of the engineers could not accommodate all their friends at one gathering.

Simple Steam-Engines.—We take from the columns of the *American Electrician* the following notes on a very simple steam-engine developed by Prof. Elihu Thomson for steam automobile work, which somewhat closely resembles one recently designed in France for the same purpose by Mr. Serpollet. The engine in question has four cylinders, each 2½in. in diameter with 3in. stroke. They are all single acting, and work with single expansion, thus being four small engines each with about 1 h.p. capacity; in fact, about 5 h.p. can be obtained from the four. The economy obtained from this small engine is wonderful, seeing that an effective horse-power is obtained with 20½lb. of water power per hour. The steam pressure was from 160lb. to 200lb., and superheating was used. The engine consists of a simple cylinder with an admission valve of the vertical cone type at the top, while the exhaust openings are made all round the sides of the cylinder; these are uncovered when the piston is at its lowest point. With this arrangement the exhaust line is not horizontal, as in the ordinary steam-engine, but from the time that the exhaust ports are re-covered by the piston the compression is continuous and adiabatic. As Prof. Thomson points out, the steam having once been admitted it goes steadily forward and out, and there is no retraversing of passages, causing condensation, as with an ordinary engine. The clearance allowed with this engine is ample, so that there should be no trouble with condensed water when starting. The engine is now being used on a steam automobile having a coil-pipe boiler heated by ordinary kerosene. The admission valve is very much of the same type as is used on gas-engine exhaust, and it does not suffer from the superheating of the steam, which at times is excessive.

The Nernst Lamp.—We have received from the Nernst Electric Light, Limited, a translation of an account which appeared in the *Boersen-Courier*, of Berlin, of a lecture by Prof. W. Nernst on the lamp with which his name is associated. Unfortunately, in making a translation, the reading of our German contemporary has been followed so closely that in many parts the translation is almost unintelligible. After making an attempt to correct obvious errors, we find it will be best to give a brief *résumé* only. Having explained that he had worked out his invention before he heard of the Jablochkoff lamp, Prof. Nernst went on to say that the object of his search was to find a substance which, when heated, turned more energy into light than was the case with the carbon-filament incandescent lamp. He then showed by a series of interesting experiments how oxide of magnesia loses its insulating properties when heated. Prof. Nernst treated his filaments as electrolytes, and showed that it was possible to work with a continuous current if the filament was exposed to the oxygen of the air. He held that the oxygen in the air, in consequence of its depolarising effect, neutralises the electrolysis produced by the current. In conclusion, he stated that after a number of experiments, he thought a practical lamp had now been arrived at. It was subsequently announced by the chief engineer of the Allgemeine Elektricitats-Gesellschaft that these lamps would be produced in the new factory now being erected, and which they expected to have in thorough working order during the course of the summer. He added that he attached great importance to the decision given last week by the claims department of the German Patent Office, by which all objections against the Nernst patents had been dismissed.

Limited Competition.—We regret to find that our prophecies as to the great disadvantages of inviting only a limited number of firms to tender for public electric lighting contracts has been so fully justified in the case of Fulham. We reported in our last issue the conclusions arrived at by the Vestry meeting which was held that week, and expressed a hope then that, the tender having been at length finally awarded, the matter could be allowed to rest. We have since, however, seen the reports in the local papers, and could not help noticing how much the success of the undertaking has been prejudiced by the course pursued. It will be remembered that in the first place some eight firms were asked to tender, and that these were so selected that they were all supposed to be capable of carrying out the whole of the work. With but one exception these firms did not alike make both cables and electrical machinery, and there was consequently bound to be a fair amount of sub-contracting. When two of the firms declined to send in tenders, the General Electric Company was selected by Mr. Medhurst to take part in the competition. This firm's offer was the lowest for the whole of the work, but was not recommended for acceptance. Out of this arose the whole of the trouble, as objections to the capabilities of the company were raised at a stage in which, in our opinion, these objections were quite inadmissible. The consulting engineer has a perfect right to object to a firm being awarded a contract if he considers that firm incapable of carrying out the work satisfactorily. But in this case it seems to us that such a right was debarred, from the very fact that the firms were selected for the purpose of fulfilling this very condition. In the local papers there is a publication in full of the correspondence which passed between Mr. Medhurst and the chairman of the Electric Lighting Committee, and we feel quite justified in saying that the publication of this has done no good. There is nothing in the early letters but what either party was quite entitled to write, and we are sure that the imputations made were equally unjustified. In fact, the whole matter, although raising a lot of personal feeling, was really traceable to the undesirable way in which tenders were invited. The proposal at the last meeting to readvertise the matter would have been quite futile, as no self-respecting firm would care to tender when its own price and that of its competitors were known. We trust that now the matter has been decided definitely, all will work together for the common weal.

Effete Water Powers.—We note from the columns of the *Electrical World* of New York that a number of water plants in America have recently been rendered inoperative by the exhaustion of the sources from which

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the water was derived. The first of these was at Austin, in Texas, but recently various installations on the Pacific slope have been equally troubled with deficient water supplies. In consequence of this our contemporary estimates that at least £200,000 worth of capital has been rendered idle as far as profit earning is concerned. There is no doubt that the failure to supply power, even if that failure only extends over a month in a number of years, seriously reduces the confidence of consumers in the power system in question. It is assumed, says our contemporary, that the engineers who planned the installations are to blame for the advice they gave as to the value of the water supply, and it goes on to quote the *National Geographical Magazine* to the effect "that the extension of explorations and observations in the region of country west of the Rocky Mountains tends in many ways to confirm the idea that a steadily progressive aridity is slowly replacing more humid climatic conditions. This change is manifest in various ways—most conspicuously in the decreasing volume of water in many of the lakes and streams throughout the region, as shown by the existence of former beach lines at higher levels, and in the profound disturbances and modifications taking place in the native flora. The phenomena which follow the advance of aridity are not limited by altitude, for while the desert conditions at low elevations exhibit them in their most intense aspect, they are also clearly traceable to the highest summits, where gradually dwindling glaciers and abnormally high extensions of certain lowland types of forest show the general trend of the climatic change." It is quite possible that such changes are taking place, but we are quite sure that they are not sufficiently rapid to absolve the engineers who design the schemes above mentioned from blame. In fact, in estimating the power derivable from a river, or, putting it more broadly, from a watershed, observations extending over one or two years are absolutely useless in determining the minimum flow. Unfortunately, it is just this minimum flow which causes trouble in power transmission schemes, unless extensive systems of water storage are added to retain storm water. It will be remembered that at the Falls of Foyers the British Aluminium Company have adopted this expedient, and that by making two small lakes into one large one with a higher water-level, they have succeeded in obtaining a regular supply for the summer.

Insulation.—An editorial article in the *Electrical World* of New York traces in a most interesting way the history of the development of insulation for electrical apparatus from the early days of electrical science down to the present. It is pointed out that at the commencement of the present century static electrical machinery producing only very high pressures were known. In consequence, the insulation could not readily be expressed in ohms, and materials such as dry glass, silk, or wax were so arranged as to provide sufficient long and narrow leakage surfaces. With the discovery of the Volta pile there came a revolution in the art of insulation, as very low pressures were then used. With the gradual growth in the use of dynamos and alternators, we have gone back into the earlier explored regions of high-pressure electricity, and with it have returned to the old and practically abandoned notions concerning high-pressure insulation. With these pressures the need for a dielectric which will resist disruptive discharges becomes more and more felt, while the need for large sections of conductors decreases. In this way the use of cotton as an insulator is rapidly going out, and mica coming in. Our contemporary prophesies that it will soon be a matter of absolute indifference to the high-pressure electrician what number of ohms is to be found in any part of his apparatus or system, while it becomes every day of more importance what factor of safety he possesses in dielectric strength in each and all parts of his plant. While it is necessary under the recently-developed *régime* to apply high-pressure tests to all kinds of electric apparatus, in order to insure the original existence of a sufficient margin of security or factor of safety in dielectric strength, yet there can be little doubt that it is unwise to continue the application of such a stress for an unduly great length of time. There seems to be in dielectrics, as in the mechanics of solids, an elastic limit beyond which applied stresses produce permanent displacements or strains. Such dielectric strains mean permanent weakening of the insulation just as permanent mechanical strains means permanent mechanical weakening. So far as we are at present able to judge, an electrically insulated system may be operated with safety for an indefinite period at pressures within the elastic limit. But once this elastic limit is passed, it is only a question of time when the dielectric strength of the apparatus will be destroyed and the apparatus itself will break down. It becomes, therefore, of increasing importance to develop methods of testing which shall be capable of indicating when the dielectric elastic limit is reached in an apparatus, or in samples of the insulating material of which such an apparatus may be constructed. A definite measurement of the dielectric elastic limit would be of great value to electrical engineers.

Electric Motor Vehicles.—Mr. Thomas B. Booth contributes to the *Electrical World* the first of a series of articles on the American types of electric motor vehicles. The article in question is devoted to the Columbia automobiles, which are manufactured at the company's works at Hartford. The company has taken over that part of the Pope Manufacturing Company's works which was organised to manufacture motor vehicles. It has devoted much attention to the accumulator system, and endeavoured to use such a construction of cell that a 25-mile run can be obtained with perfect safety with any of their vehicles. In the cell used the positive plates are of Planté formation, while the negatives have the active material assembled in masses. The positive plate is strong mechanically, and its Planté formation permits of a high rate of discharge. Its capacity is 3·5 ampere-hours per pound of complete cell at a discharge rate of 1·2 amperes per pound, or about ·91 horse-power hour per 100lb. This, the author thinks, may be perhaps taken at the present time as the limit beyond which increased capacity must involve a decreased life, although improvement in capacity per pound without sacrifice of durability is being effected at a more rapid rate than thought possible two years ago. He points out that several pasted cells have lately been developed which have yielded much higher capacities for a given weight, but that with this, short life and early renewals are inevitable. Mr. Booth gives an instance of one cell which, starting with a capacity of seven ampere-hours per pound, has been boomed, but which if a capacity curve be plotted for every successive discharge, a straight line is obtained which touches zero at about the twenty-fifth or thirtieth discharge. Coming to the vehicles themselves, one feature in their mechanical design is that the steering wheels are not mounted on a common axle which is rotated, but in steering the wheels individually are turned through an angle by means of a lever acting on a vertical axis. The hub of the wheel runs on a short spindle at right angles to this axis. We gather from the description that on the lighter vehicles pneumatic tyres are used, while on the heavier goods vans solid rubber tyres are employed. The pneumatic tyres are, of course, the more expensive, and the author con-

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siders that these are also somewhat less economical in the consumption of power. As an example of the proportion existing in these vehicles between the weight of a carriage and that of the accumulators, in one instance a hooded phaeton, weighing complete with batteries 2,400lb., contains a total weight of batteries of 1,100lb. The author concludes an interesting article by considering the great advantage the charging of such accumulators will be to central-station engineers in enabling them to provide a day load for their electrical machinery.

Royal Institution.—Last Friday evening Prof. T. Preston, M.A., D.Sc., F.R.S., delivered a lecture at the Royal Institution on "Magnetic Perturbations of the Spectral Lines." He commenced by saying that the subject about to be considered formed a connecting link between two of the most interesting branches of human knowledge—namely, that which treated of magnetism and that which treated of light. In order to understand the nature of the investigation which Faraday was the first to take in hand, and which had led up to the discourse of that evening, it was best to consider briefly some elementary facts concerning magnetism and light. He then proceeded to deal with the magnetic field. Faraday always pictured this as filled with lines of force—that is, lines, each representing the direction in which a north pole would be urged—and the importance of the conception could scarcely be over-rated, for it led us to view magnetic actions as being transmitted continuously through the intervention of some medium filling all space, rather than by the unintelligible process of direct action at a distance. This medium was called the ether, but as to what it was that was actually going on in the ether around the magnet we could not definitely say. In common light the vibrations took place indifferently in all directions around the ray, and followed no law or order as to their type. They possessed no permanent relation to any direction around the ray, so that if the magnetic action should happen to be a twisting of the vibrations round that ray it would be impossible to detect this twist in the case of ordinary light. As a matter of fact, a twist of this kind actually occurred, and this was what Faraday anticipated. In order to detect it, it was necessary to employ a beam of light in which the vibrations were restricted to a single plane passing through the ray. Such light was said to be plane polarised, and might be obtained by transmitting common light through a doubly refracting crystal. Faraday found that when a beam of this plane-polarised light was passed through the magnetic field in the direction of the lines of force a distinct effect took place, and that the effect was a twisting of the plane of polarisation of the light vibrations as they passed through the magnetic field, or, to be more precise, as the light passed through the matter occupying the field. The presence of matter in the field appeared to be necessary. The effect was not observed in a vacuum, but became greater as the field became filled with matter of greater density. It was therefore not a direct action of the magnetic field on the light vibrations, but rather an indirect action exerted through the intervention of the matter which occupied the magnetic field. Having explained what this action really was, he proceeded to refer to other experiments made by Faraday and Zeeman. Prof. Preston next referred to spectral lines from a source of light, which, having been photographed, were thrown on a screen, and which were found to be broadened when the light was produced in a strong magnetic field. Having alluded to the researches of Lorentz and Larmor, who examined the subject mathematically and came to the conclusion that each spectral line should be not merely broadened but actually split up into three lines, and that the constituent lines of this triplet must be each of them plane polarised, Prof. Preston employed a model in illustration of this action, and then dealt with types of other magnetic perturbations, which were obtained with a magnetic field of greater strength. While some of the spectral lines were split up into triplets, as indicated by theory, others became resolved into sixtets, or octets, or other complex types. Most of the remaining part of the lecture was occupied with theoretical considerations. In conclusion, Prof. Preston said there was, he thought, reasonable hope that the time was fast approaching when intimate relations, if not identities, would be seen to exist between properties of matter which had hitherto been considered as quite distinct.

The Black Art.—We have frequently had to refer to the catalogues and price lists of the various electrical firms in England, and it is surprising to see the amount of information which some of these firms crowd into their lists over and above the information given about the goods manufactured and supplied. Amongst such lists that of the General Electric Company takes a high place, but even then certain gentlemen are not satisfied. The following letter, which clearly expresses disappointment that the firm does not practice as family sorcerers, has been received. The letter was sent from South Birkenhead, and dated April 24 this year, and it reads as follows: "Dear Sir,—Many thanks for catalogues. I was under the impression that I could select from them a machine producing the effect hereinafter described. The object desired is to put a stop to an annoyance caused to a friend by persons living next door to him. They have made it a practice for a very long time to disturb and cause serious injury by passing currents and playing these upon the head and other parts of the body. On my friend's side of the bedroom wall the paint becomes of a lighter colour and is slightly illuminated, and there appear minute sparks, with an occasional small flash of light; the stuff passed through can be distinctly seen approaching. Sometimes the force is so great that the system is entirely shaken. The result of playing on the ear is that the head and face feel numbed as if standing for some time near a generator of great power; the sparks are identical. The tongue is affected by playing on, the mouth sometimes seriously agitated, the upper jaw feels as if something was continually dragging at it. Voices are distinctly heard, and remarks of the lowest character are continually manufactured. They often say that unless the ears are practised upon, they could not make themselves audible or hear anything from the other house. The direction of the sounds would lead one to believe that they have coadjutors in the immediate neighbourhood who are possessed of similar instruments. You will no doubt be able to determine the machines in use. Also whether any sound instrument is used in order to augment the sound. Can you supply any instrument that would enable us to detect these people at their operations? If you can you will certainly be a public benefactor, and will assist in bringing to justice a set of scoundrels who are continually perpetrating a most abominable crime. It is fearful that a man cannot sit in his own house without being continually annoyed by such ruffians. The kitchen under the bedroom is constantly annoyed. Their voices prove that they are constantly on espionage, and hear and see everything that passes in their neighbour's house. They often state that they can never be discovered, and on this sneaking behind a brick they rely for safety.—Signed, J. N. H." After the signature, of which we only give the initials, the correspondent adds a postscript to the following effect: "Most amusing, they suggest calling upon you or writing."

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THE POTTERIES ELECTRIC TRAMWAY.

On Tuesday last the electric service on a large part of the tramways of the Potteries Electric Tramways Company was officially commenced. In order that our readers may have some idea of the extensive system of tramways which this company will soon have completed and running in North Staffordshire we reproduce in Fig. 1 a general map of the district, drawn to a small scale. This map also shows the various interests which the British Electric Traction Company has succeeded in turning into a complete tramway, which will be of inestimable value to the inhabitants of the district. Commencing with the line indicated in black, this belonged to the North Staffordshire Tramways Company, which company has now been merged into the Potteries Electric Traction Company. Before this step was taken, the British Electric Traction Company had succeeded in obtaining light railway orders over those parts of the track which are shown dotted. The power station (marked No. 1 on the map), situated at Stoke-on-Trent, at present supplies the whole line, but a second station is being constructed at Wolstanton. The contracts for the conversion of these tramways into electric lines were let as long ago as December, 1896; the contract for the relaying of the permanent way was placed with Messrs. Dick, Kerr, and Co., while the electrical work was carried out by the Brush Electrical Engineering Company. Owing to various interruptions, over which the contractors had no control, the lines were not completed until recently. Thus the order for the Kidderminster trams, which was also placed with the Brush Company by the British Electric Traction Company at a later day, was completed first, hence our readers must not conclude from the fact that American machinery is used at Stoke that the Brush Company's practice of manufacturing all kinds of tramway plant has been discontinued.

Track.—The gauge of the lines used in connection with the Potteries Tramways is 4ft. throughout. The new rails laid by Messrs. Dick, Kerr, and Co. were supplied in

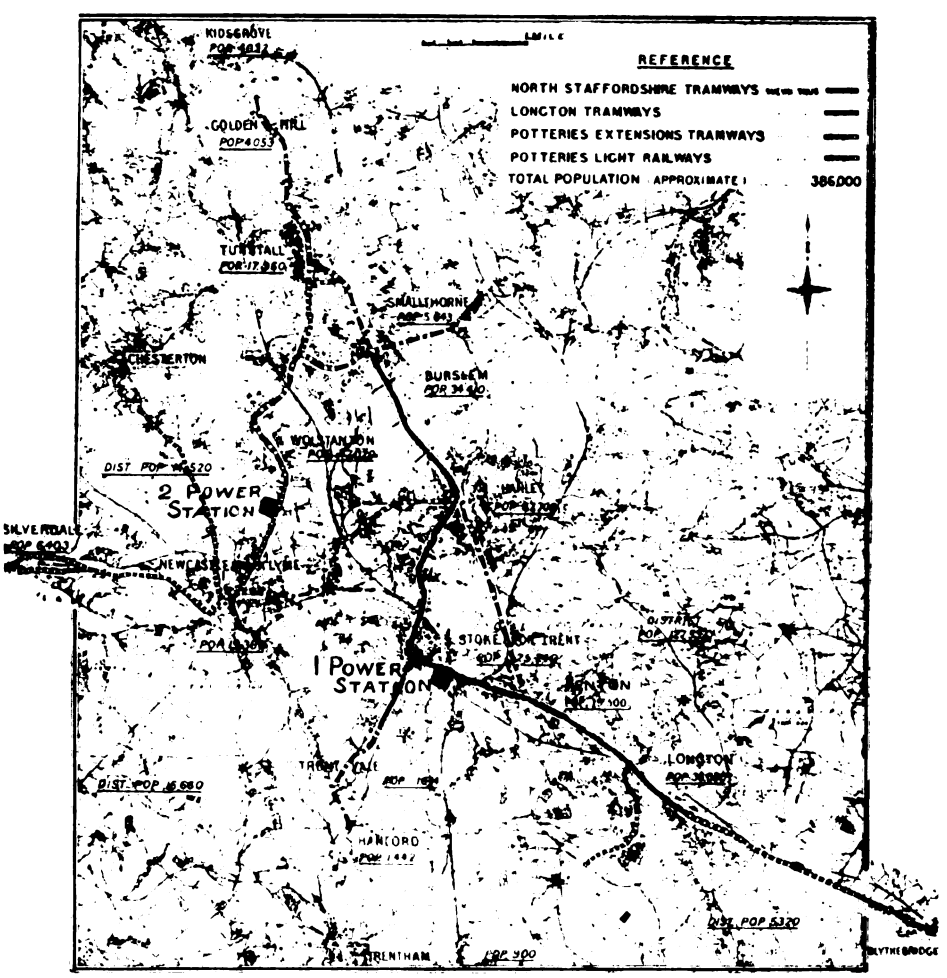

FIG. 1.—Map of the Potteries Tramways.

They also obtained the tramway orders shown by the dots and dashes in the map. The most interesting feature in connection with the line is connected with the two short lengths at Longton. These lines were constructed by the local authority some 20 years ago, but although this authority had powers to construct a tramway they had not powers to work it. Hence the line made so long ago has never been used. By connecting up the whole of these lines, and controlling them under one management, the Potteries Company will be able to give good through service and interconnections, which would be utterly impossible were the various parts of the line to be under different managements. Up to Tuesday last the North Staffordshire Tramways were worked by steam cars, which at 9.30 p.m. formed a melancholy procession into a siding near Hanley, never to be used again. Of the lines shown in the map, those between Longton and Burslem are now fully completed and working electrically. Other sections towards Golden Hill and Blythe Bridge are practically completed, and in some cases passed by the Board of Trade; while the work on other sections is being rapidly proceeded with.

lengths of 30ft. These rails, which are shown in Fig. 2, are of the girder type, and weigh 87lb. per yard. The speciality in the track is the arrangement of the joints with the patent fishplates, which give a continuous running surface for the car wheels. These fishplates, which are dove-tailed into the rail, as shown in the drawing, give a very smooth track and reduce very much the shocks which are usually felt when passing over joints. The fishplates are 20in. long, and secured with four $\frac{7}{8}$in. bolts and nuts. The rails are tied to gauge with tie-bars about 8ft. apart of 2in. by $\frac{3}{4}$in. flat bar, screwed one end and provided with nuts and washers, and the other end notched. These rails are laid on a bed of cement concrete 6in. thick, with the exception of where the ground is very soft, and are then laid on 12in. by 6in. longitudinal timbers placed on concrete foundation. Between the rails and 18in. on either side is paved with granite setts. A perspective view of this track is shown in Fig. 3. It is interesting, in passing, to note that great trouble has been found in the selection of these setts. No less than 15 different local authorities have had to be dealt with, and the surveyor of each of these had his own opinion, which in

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some cases was duplicated by the opinion of his committee. In this way a great number of different classes of setts were required, and in some cases it was found absolutely impossible to get exactly what was wanted. The track when laid does great credit to the contractors, and the smoothness of running on Tuesday last was remarkable.

The sub-contractors under the Brush Company for the overhead line and bonding were Messrs. R. W. Blackwell and Co., of Victoria-street, S.W. The span-wire type of overhead construction has been used with two trolley wires, one of which is used in either direction. These wires, which are supported on insulators from the span wires, are of No. 0 gauge, weighing about 1,700lb. per mile. The trolley wire is divided up into half-mile sections by

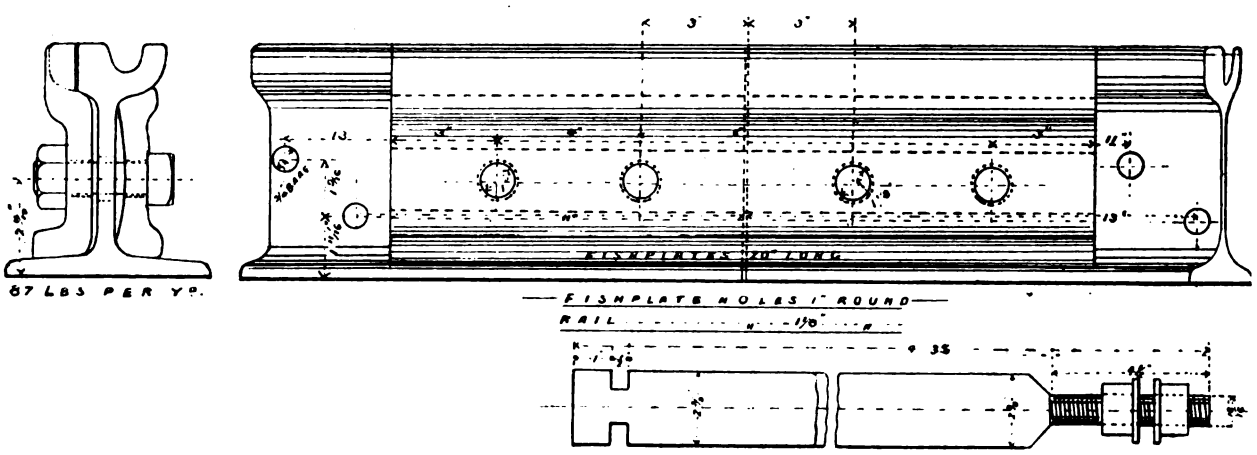

FIG. 2.—Details of the Rails and Fishplates used on the Potteries Tramways.

means of switch pillars placed by the roadside in order that interruption or fault may not disturb the whole road. Some four feeders run from the station to these section boxes, and from three to four boxes are connected to each feeder. Tubular steel posts are used to support the span wires in the great majority of cases, although sometimes permission has been obtained to affix one end to a building. We have seldom seen a more complicated system of guard lines than is used for these lines, owing to the fact that telephone and telegraph lines cross the road in all directions. This, coupled with the span-wire system of support, again emphasises the advantage of the side-running trolley and side-pole construction from an æsthetic point of view. The switch feeder pillars, which are manufactured by the Brush Company, are each provided with a telephone, so that a quick communication may be had from the central station. They are divided internally into two chambers, the upper one containing six-way plug switch block with the usual connections, while the lower compartment is arranged to contain the testing apparatus required by the Board of Trade, or connections for the same to the central station. All the rail joints are bonded by means of Chicago bonds, and the two lines of rails are also bridged every 100 yards. The insulated return feeder is also connected to these rails at very frequent intervals.

Feeders.—The feeders, of which there are at present four, were supplied and laid by the Callender's Cable and Construction Company, Limited. The cables are of this company's own make, lead sheathed, and laid on the solid system, with cast-iron connecting boxes between the various lengths. The sections of these cables are designed on a 5 per cent. drop when 20 motorcars and trailers are running on the line. In this way, where a feeder runs through three or four feeder boxes, its section is reduced proportionally from box to box.

The Power Station.—The power or generating station is situated on the site of the old tram depôt at Stoke, on the bank of the Trent. It consists of engine-room, boiler-house, and car-sheds, with the necessary repairing shops, test-rooms, etc. The old buildings have been utilised as far as possible, and the site has also tended to cramp the design. Steam is supplied by three Lancashire boilers, 7ft. by 30ft., with a working pressure of 120lb. per square inch giving 350 h.p., space being reserved for a fourth boiler should it be necessary. The boilers, which were supplied by Edwin Danks and Co., Limited, of Oldham, have the usual complement of fittings, including water gauges of the Hopkinson guarded type. A storage tank capable of holding 12,000 gallons of feed water is provided, from which water can be supplied to the boilers either direct or through a Green's economiser of 144 tubes. Two feed pumps of the three-throw type, made by Messrs. Hayward Tyler and Co., have been provided, each capable of delivering 12,000lb. of water per hour to the boilers. One of these pumps is driven by a small steam-engine, while the other is coupled by belting to an electric motor. This motor drives the pump at varying speeds, which can be obtained both by a controller and by the speed cones of the belt gear. The motor is of the General Electric Company's make, and is supplied at 110 volts off the station mains. The scrapers of the economiser are also electrically driven.

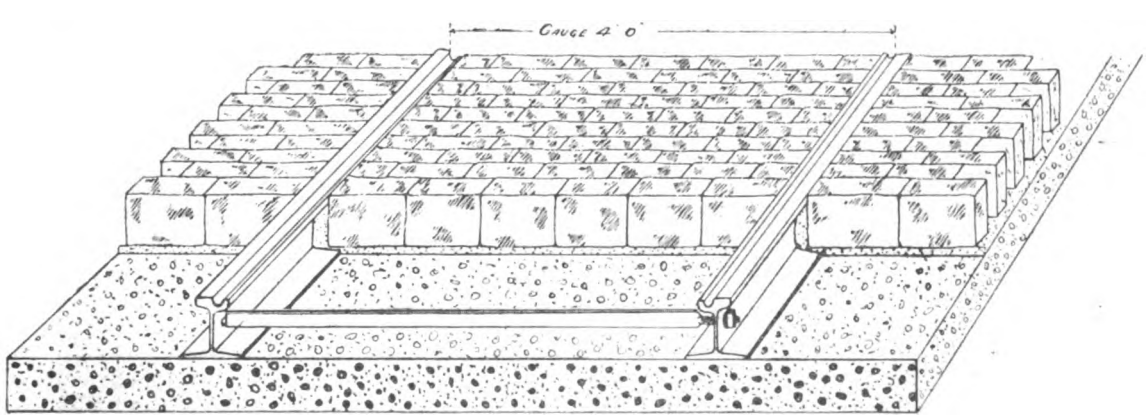

FIG. 3.—Perspective View of the Track.

The coal bunkers are situated at the side of the boiler-room parallel to the firing floor. An inclined roadway enables carts to deliver coal to manholes on a platform over the bunkers. The cramped state of these arrangements both for receiving coal and on the firing floor will hamper the firemen, and we shall not be surprised to hear that mechanical stokers are to be introduced.

The complete engine-room, which is exceedingly well

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lighted, is shown in Fig. 4, while Fig. 5 is a reproduction of a view taken in the opposite direction, so that the dynamo can be seen. There are at present installed two main engines of the Mackintosh and Seymour type, direct coupled to two six-pole dynamos. The capacity of 410 amperes at from 500 to 550 volts. They are over-compounded, so that the higher voltage can be easily obtained at full load.

In addition to these main engines there is a further smaller one used to drive the motor-generator. These latter machines

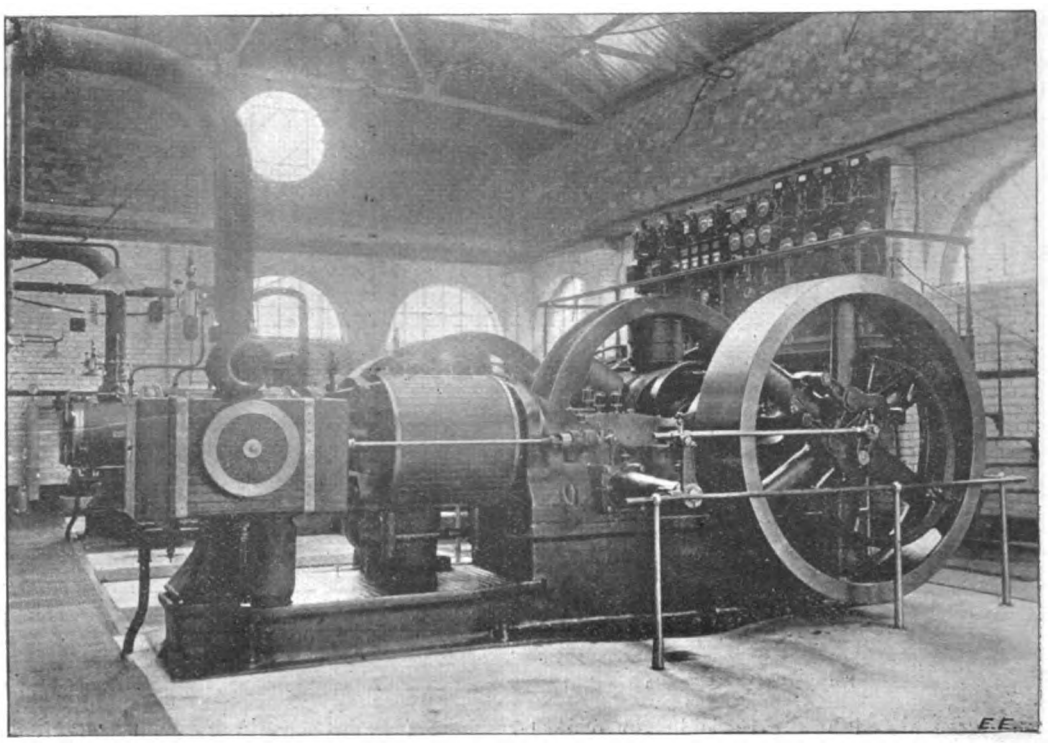

FIG. 4.—The Engine-Room at Stoke.

engines are capable of indicating continuously some 330 h.p. at 200 revolutions per minute. These are compound tandem condensing engines with flywheel governors. The necessary water for the ejector condensers is taken from the River Trent, for which purpose the electrically-

are shown in Fig. 6. The combination consists of one dynamo capable of giving 70 amperes at 500 volts, and one dynamo rated at 275 amperes at 110 volts, at a speed of 950 revolutions per minute. With the engine belted to this set it is possible to shut down the main engines and

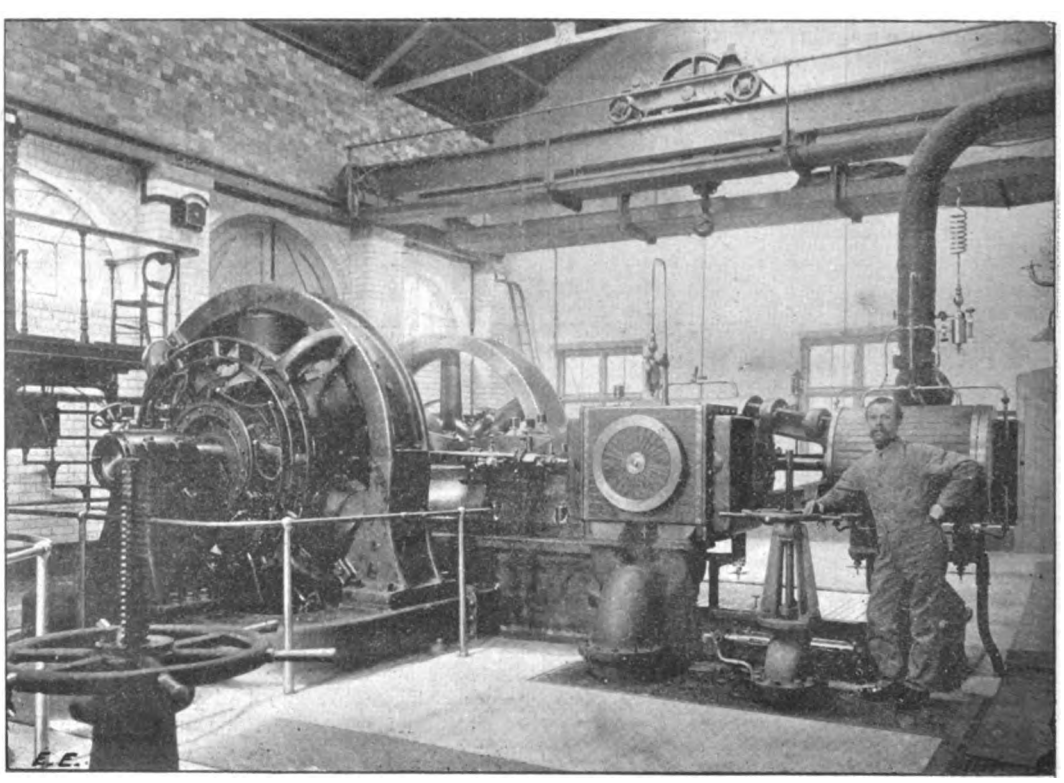

FIG. 5.—View of the 200-kw. General Electric Company's Dynamo and Mackintosh and Seymour Engine.

driven centrifugal pump (shown in Fig. 6) is used. The dynamos were supplied by the British Thomson-Houston Company, as sub-contractors, and are of the standard G.E. type. The details of these dynamos can be well seen in the illustrations Figs. 5 and 7. Each dynamo has a rated

still to have the current available for sending out single cars or for moving them about in the sheds. Again, the station power and lighting circuits, which are kept at 110 volts, can either be supplied by the small engine or can be fed by the motor-generator by transformation from

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the 500-volt circuit. The engine used to drive the set is one of the Universal type, manufactured by the Brush Company, who also made the dynamos.

The machines seen under the switch gallery both in Figs. 7 and 8 consist of two boosters of the Brush make

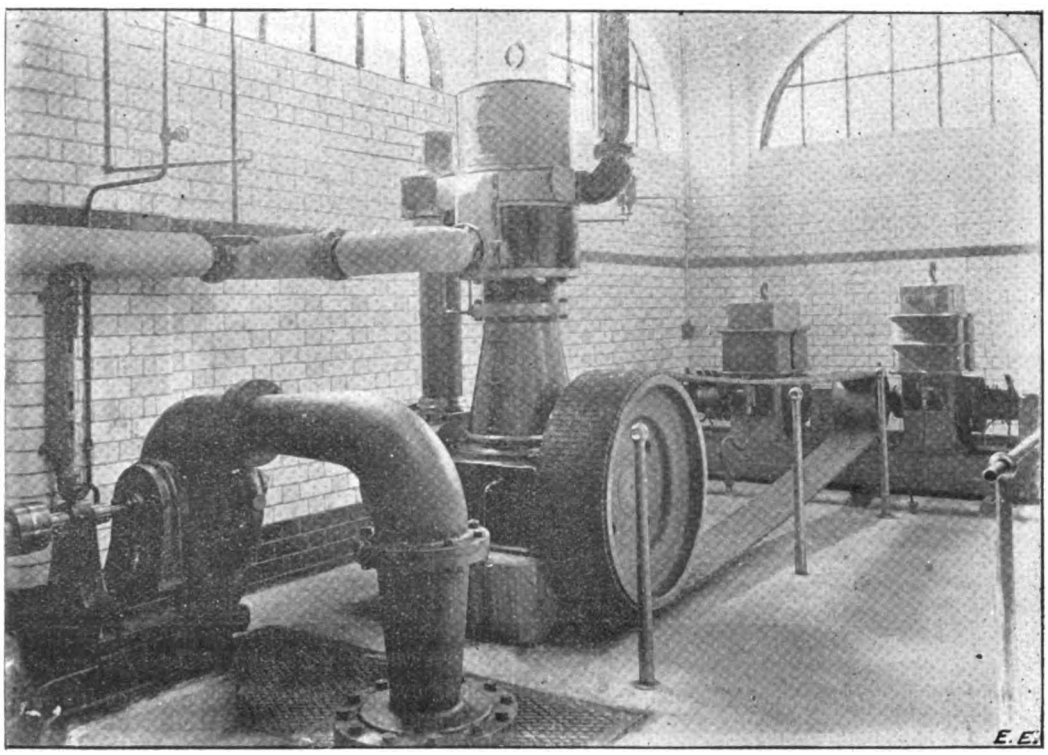

FIG. 6.—View of the Circulating Pump and of the Universal Engine driving the Motor-Generator.

for hitching up the voltage in the feeders at heavy loads. One of these boosters is used for feeders Nos. 1 and 2, and the other for feeders Nos. 3 and 4. The dynamos and motors are of the ordinary inverted two-pole type, with the Mordey chord-wound armatures.

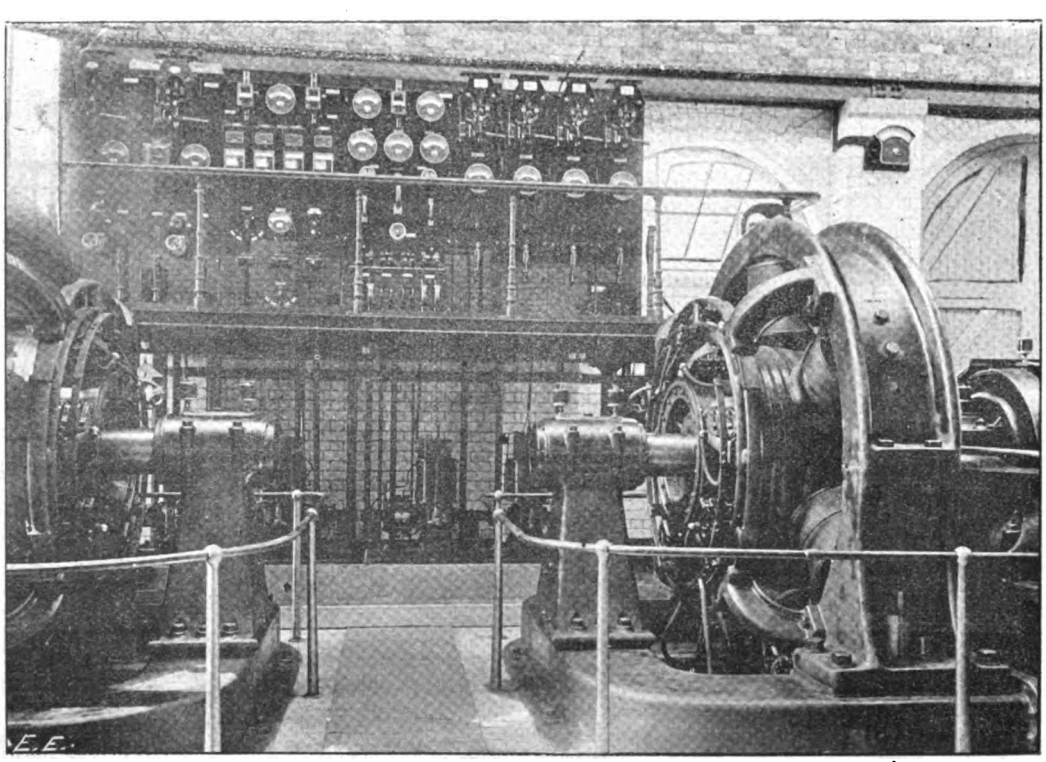

FIG. 7.—Front View of the Switchboard, with the Dynamos in the Foreground.

The switchboard, which appears in several of the illustrations, and of which we give a detailed plan and elevation in Figs. 9 and 10, was made by the Brush Company. It is of fireproof construction throughout, and no wood whatever is used on or about it. The details of the supports can be seen in these illustrations, but Fig. 8 shows the general appearance of the board and platform somewhat better. It will be seen that separate panels are provided for each generator and feeder, and that the instruments connected with the lighting of the station are also kept on one panel. The panel, marked "Board of Trade and main reading," contains all the pilot wire instruments. In the illustration the letters indicate as follows: (A) Thomson-Houston circuit breakers; (B) Weston ammeters; (D) Kelvin voltmeters; (K) feeder switches; (N) main recording voltmeters; (O) Board of Trade recording voltmeter; (P) Board of Trade recording ammeter; (Q) main recording ammeter, etc.

The electric cars used on the Potteries line are shown in Fig. 11. The car bodies were manufactured by the Brush

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Electrical Engineering Company at the Falcon Works, Loughborough, while the trucks are of the Peckham type. The motors are G.E.-800 type motor, and the controllers

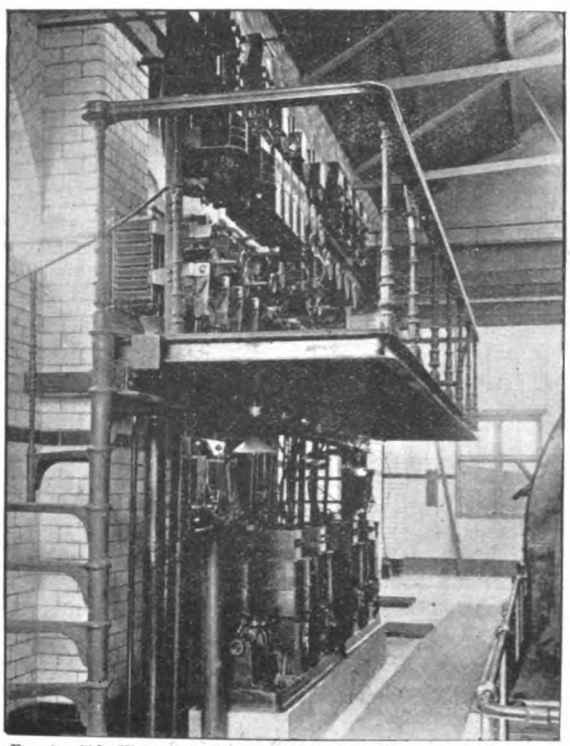


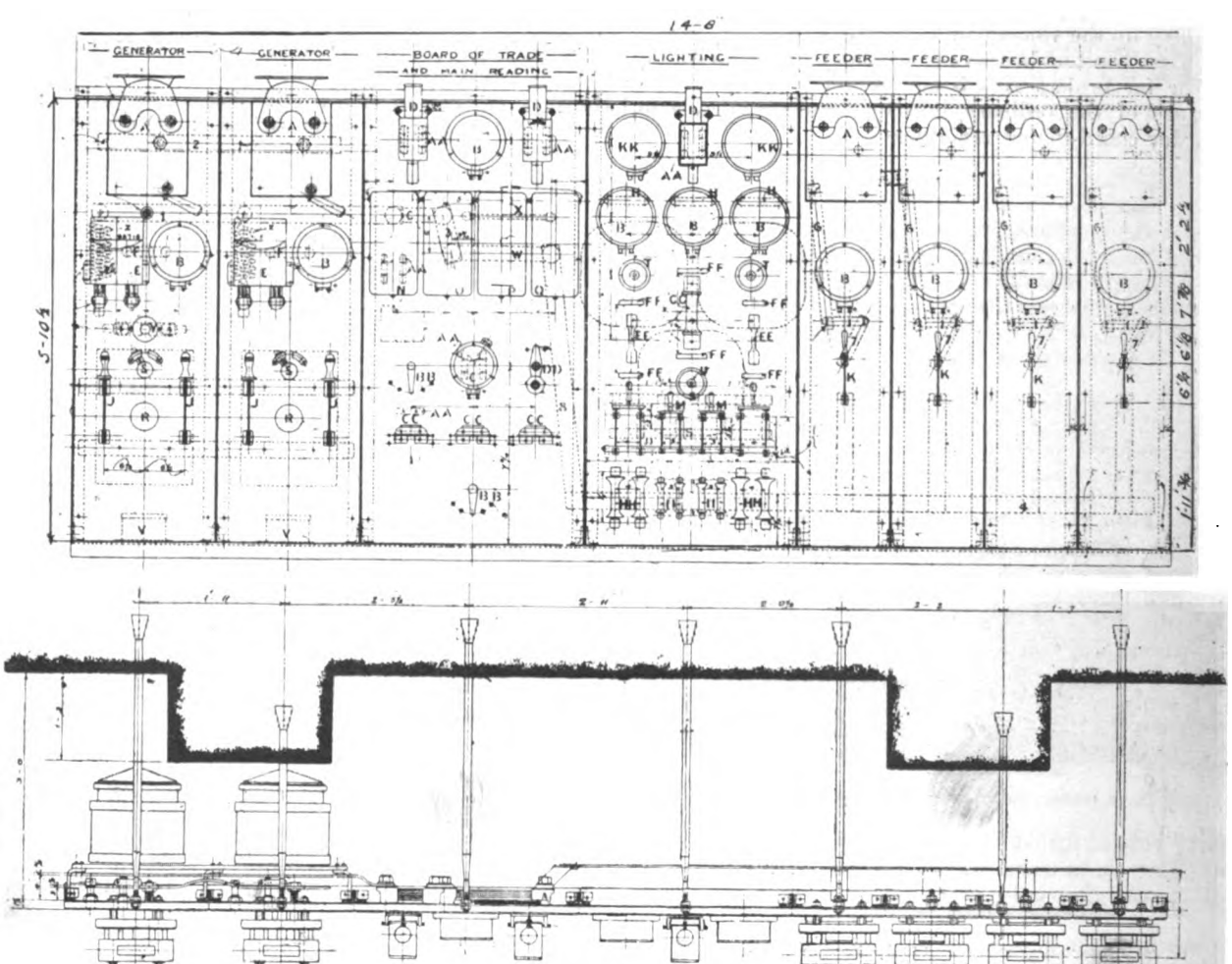
FIG. 8.—Side View of the Switch Gallery, with Boosters Underneath.

were also made by the General Electric Company, and supplied through the British Thomson-Houston Company. All the cars and trailers are arranged to take some 24 passengers inside. The low bridges along the route prevent the use of top seats, and no provision is made for platform passengers.

The opening ceremony on Tuesday last was commenced by the guests assembling at the power-house, where Sir Charles Freemantle, K.C.B., switched on the current to the line. After a short speech, which, owing to the noise of the machinery, it was very difficult to follow, the guests were invited to take seats in the six electric cars which were the first to run over the line. As already mentioned, the steam service had been previously stopped, and after the cars containing the guests had started, a regular five minutes' service was instituted at the usual rate of fares. To reserve motorcars for this, trailers behind three motorcars were used for the guests. Owing to the exceedingly greasy state of the rails and to the heavy town councillors in the first trailer, the leading cars had some difficulty in negotiating the first grades. A supply of sand soon, however, put matters right, and the worst grades subsequently encountered were accomplished without any difficulty whatever. The party proceeded first in the direction of Longton, after which the whole length of the line to Burslem was negotiated. A few photographs having been taken with a prominent councillor as driver of the first car, the party returned to Hanley for the inaugural lunch. This was admirably served and highly appreciated after the long ride. Mr. Emile Garcke was in the chair, and after the usual loyal toasts,

Sir CHARLES FREEMANTLE, K.C.B., proposed "The Success of the Potteries Electric Traction Company." He alluded to the successful opening of this the first line of communication through a district which contained nearly half a million inhabitants in an area of something like 40 square miles, and to the service the electric trams would be to the population.

Mr. EMILE GARCKE, in replying as chairman of the board of directors of the company, referred to the great difficulties which had been overcome, and to the fact that no less than 15 local authorities had to be dealt with in the matter. He expressed his great pleasure at seeing so many of the local authorities represented at the luncheon, and took that as a mark of confidence they had in the



FIGS. 9 AND 10.—Elevation and Plan of the Switchboard at Stoke.

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service the electric tramways would be to the community. He thought that the present case was one in which it was easily seen that the municipalisation of tramways could not be carried into effect, and pointed out that all the authorities would gain was from the fact that the tramways were under one control. He concluded by congratulating the engineers and the contractors on the good quality of the work they had inspected that day.

The next toast was that of "The Engineer," proposed by the CHAIRMAN, coupled with the name of Mr. Stephen Sellon, who has been responsible for the engineering work

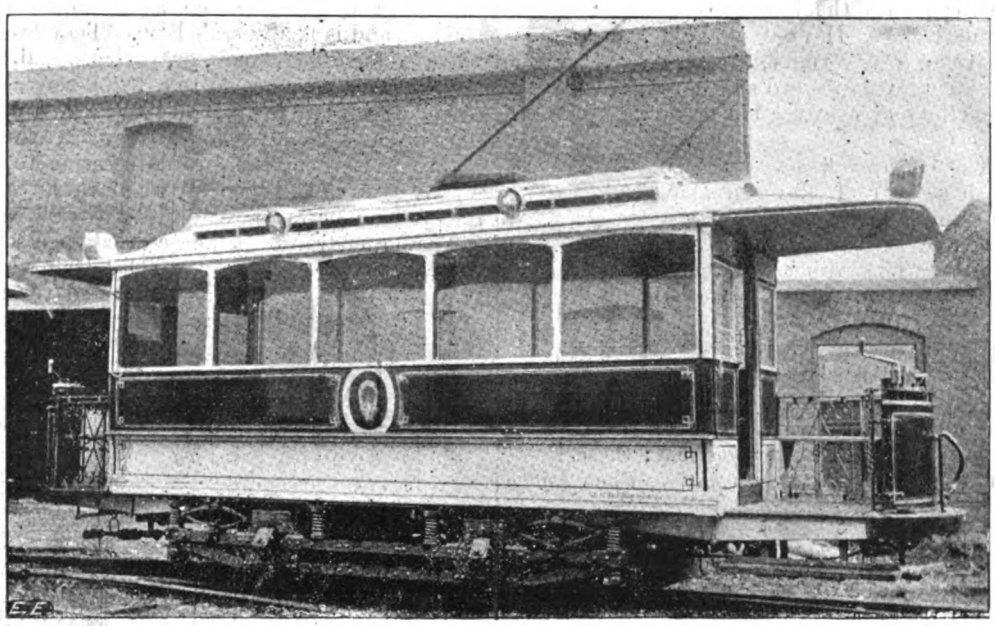

FIG. 11.—One of the Motor Cars of the Potteries Electric Traction Company.

in converting the tramways. Here, again, the difficulties this gentleman had had to contend with in having so many authorities to please and so many contractors to look after was mentioned.

Mr. STEPHEN SELLON acknowledged the toast in a laughable speech, in which he attributed the delay in opening the tramways to the pleasant intercourse he had enjoyed with the municipal authorities. He was naturally afraid that a too early completion would put a discontinuation to these happy relations.

The remaining toast was that of "The Local Authorities," proposed by Mr. J. S. RAWORTH, and responded to by the MAYOR OF HANLEY, after which,

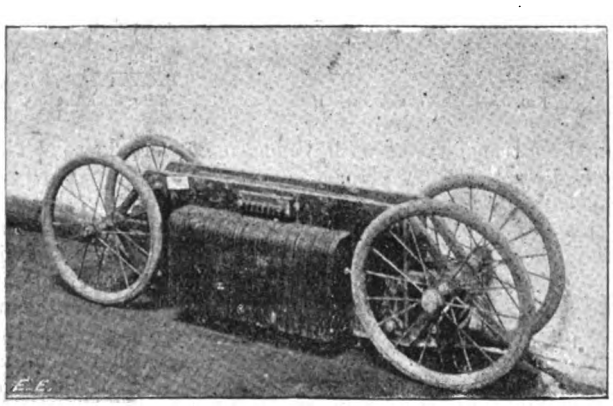

FIG. 12.—A Leakage Tester used to locate Cable Faults.

A hearty vote of thanks was proposed to the chairman, Mr. Emile Garcke, to whom was duly accredited the energy and tact of carrying out the negotiations attending the work.

After luncheon the guests had an opportunity of seeing the tramway in full working order, and of noting that the five minutes' interval was well maintained. The engineer in charge of the line, and who has also been responsible for the superintendence of the work in question, is Mr. W. Slade Olver, to whom we are indebted for much of our information.

MISCELLANEOUS NOTES ON THE CHELTENHAM MAINS.*

BY HAMILTON KILGOUR, MEMBER.

(*Concluded from page 599.*)

The town network of distributors is broken up into sections by the sub-stations, and a fault on any section (or service on it) merely cuts out that section by the fuses blowing at each end of it, and does not affect supply to other sections. Where a branch to supply a side street is taken off a distributor, a switch tee box with a testing socket (Fig. 6)—connected to the branch—is used, and for convenience in connecting new customers without disturbing supply to those previously connected to more than a minimum extent, we are breaking up the distributors in the principal streets by straight switchboxes, which are also

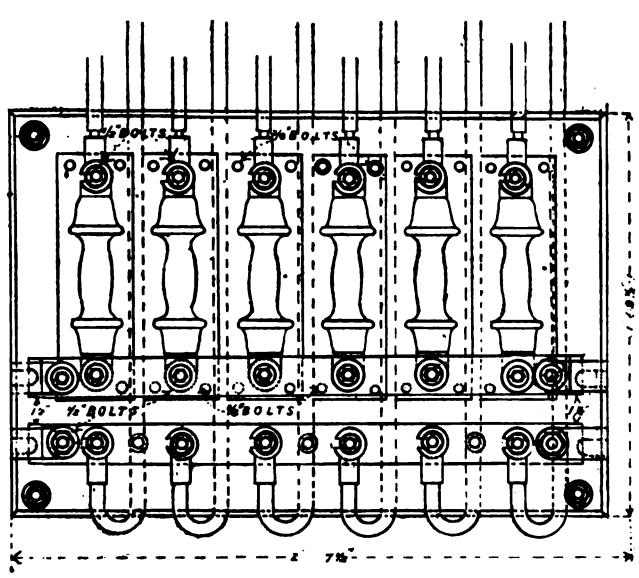

FIG. 6.—Sub-Station Low-Tension Circuit-Board.

provided with testing sockets. The average distance between sub-stations in the town is about 330 yards, so that the use of one or two switchboxes breaks up a section into either two or three sub-sections of 168 and 110 yards lengths respectively. In the cases, which are few, where high-pressure feeders and low-pressure distributors pass through the same conduit boxes, the cables are provided with distinctive labels. Practically all distributors are, however, armoured cables laid direct in the ground, and

* Paper read before the Northern Society of Electrical Engineers.

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protected, where necessary, with wood troughs and bitumen from the action of the soil.

All the sub-stations, except the principal sub-station, are underground brick chambers with a backing of concrete outside the brick walls, and in the town they average about 10ft. by 7ft. by 7ft. high; where possible they are placed under footways, but in some cases it has been necessary to construct them under roadway, with the result that a much greater thickness of roof has had to be given. In the older sub-stations, sewer manhole covers have been fixed centrally in their roofs, and movable iron ladders afford the means of descent into the low-pressure parts; in the more recent sub-stations, Hayward's lights, which are movable for lowering transformers, etc., are fixed in the roofs, and side stairs provide the ordinary means of entrance for men—this method of construction produces a lighter and cleaner sub-station and does away with the central iron ladder. The concrete floors of the sub-stations are floated over with a layer of bitumen about 2in. thick; upon the bitumen floor are placed wooden gratings similar to those used in boats, and in the high-pressure parts of the sub-stations rubber mats rest upon the wooden gratings, and are kept clear of any water which may have accumulated between the days for cleaning. Ventilating pillars with pipes to the tops and bottoms of the sub-stations are provided, and where necessary and possible a sub-station has been drained through a trap to the sewers. The older sub-stations are not so drained, but have small sumps in them; these, however, are not much needed, as a sub-station, when fairly

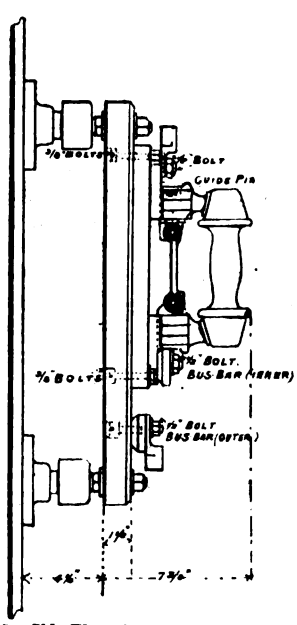

FIG. 5.—Side Elevation of L.-T. Circuit-Board.

loaded, keeps perfectly dry. The walls and roofs of the sub-stations are painted with Blundell, Spence, and Co.'s white petrifying paint, which gives a very good surface and one which can be washed without injury. The dividing boxes, switchboards, etc., are fixed on iron battens supported by irons built into the walls. All high-pressure cables and work are painted red, and all low-pressure cables and work are painted black.

Almost all the transformers used have been manufactured by the Brush Electrical Engineering Company, Limited, and out of a very large number comparatively few have broken down. With one or two exceptions the transformers, which have given trouble, have been small—almost all of the 650-watt size used for the arc lighting and placed in the bases of the arc lamp-posts. I think I may say that in practically every case the cause of breakdown has been damp; in any case breakdowns have been entirely stopped by heating the transformers as now described:

First, short lead-covered cables are passed through the glands and connected to the primary and secondary terminals, and these glands and all openings into the transformer case, except the door to the fuses, are sealed up. The transformers are then taken in batches of six at a time into the principal sub-station, which is a hot dry room, where the primaries are connected in parallel to a 100-volt circuit and the secondaries in series to a low resistance, by which the secondary current can be varied from about eight to fifteen amperes as desired. Pots of calcium chloride are inserted through the fuse doors and then these doors are sealed up. The transformers are run in this way continuously for about a week, the calcium chloride being changed frequently at first and the fuse door resealed after each change. Towards the end of the week very little water is found to remain in the transformers, and at the end of this preliminary run each transformer is given a new quantum of calcium chloride and is finally sealed up. They are then run individually for some hours, or, perhaps, a day or two, with their primaries connected to a 2,000-volt circuit and their secondaries to arc lamps, and they are also flashed—primary to case—with 2,000 volts. As they have short leads already connected to them, there is no occasion to open the transformer cases in the open air when they are being fixed in the arc lamp-posts.

The larger transformers are dried in a somewhat similar way, except that they are usually dealt with individually, and have their secondaries connected through resistances to a low-pressure circuit and their primaries to lamp loads. In sub-stations we usually, and in very dry ones invariably,

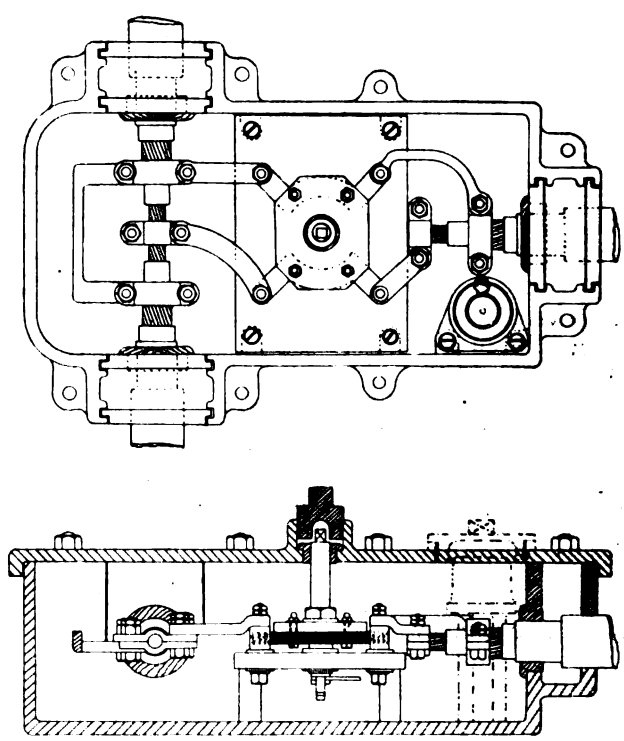

FIG. 6.—High-Tension Switch Tee Box, with Testing Socket.

run these transformers with their top covers loose. This we find a satisfactory plan.

The desire that the occurrence of a fault, or the connection of a new customer, should disturb as little as possible supply to existing customers has resulted—as will have been clear from the foregoing brief account of our mains—in an extensive sectionising of both the high and low pressure mains. It will also be obvious that this dividing of the mains into comparatively short sections immediately localises a fault to within a small distance, and reduces the work of finding its precise position to merely—in general—testing a single length of cable.

I think that there is one point in connection with the finding of faults which deserves more attention than has been usually given it, and I consider that to localise the responsibility for the fault is almost as important as to localise its position.

Faults on our mains have been due in several cases to external damage, in a good many to defects in manufacture, in two or three to water getting into boxes with oil insulation, and in one case to a badly made joint. I think it fair to add that most of the faults due to defects in manufacture occurred on a 200-yard length of cable, which was not made by Callender's Cable Company, and

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which I tried for high-pressure services to house transformers. Cases of external damage done to cable are now happily rare, since all road openings, for whatever purpose, are now made by either the highways or the waterworks department of the Corporation, who give us, as a rule, adequate notice to enable us to send a man to look after our work where necessary. Up till a few months ago, however, any building contractor or plumber would make road openings at his discretion without giving the notice required by our by-laws, at any rate, till it was too late to send a man to supervise the work on our behalf, and the result of this was a number of faults.

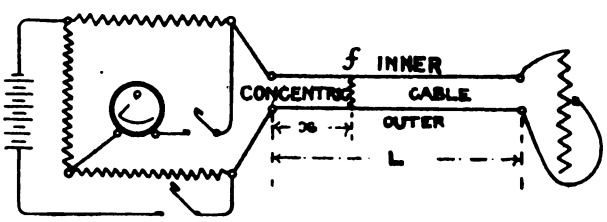

FIG. 7.—Loop Test.

Now the effect of burning up a fault in order to get a "dead short" between inner and outer, for the purpose of the ordinary loop test, is often to obliterate entirely all traces of the cause of the fault, and so to make it impossible to secure sufficient evidence to support a claim for compensation from the presumptive culprit. Further, as is well known, the ordinary loop test gives by no means accurate results in such cases: its application assumes the existence of two generally incompatible conditions—viz., that the resistance of the fault is very small, and that neither the inner nor the outer is much damaged at the fault. By a very slight modification of this test (Fig. 7) we have obtained very accurate results, without burning up the fault or reducing its resistance to less than about a 1,000 ohms. The change we have made consists simply in joining the inner and outer, in the second stage of the test, together at the far end of the cable through a known resistance, variable at will.

If A = resistance of fault plus resistance of inner and outer up to the fault;
B = parallel resistance of fault and circuit formed by inner and outer beyond the fault and the variable resistance, plus the resistance of inner and outer up to the fault;
C = resistance of inner and outer of whole length of cable in series—this is assumed known in advance;
r = value of the variable resistance;
x = distance in yards to the fault;
L = length of cable in yards;

then
$$x = \frac{B - \sqrt{[(A-B)\{(C+r)-B\}]}}{C} . L$$

and, after a preliminary trial, it is not difficult to assign a value to r which will give accurate results if care has been taken in making connections, allowing for the testing leads, etc.

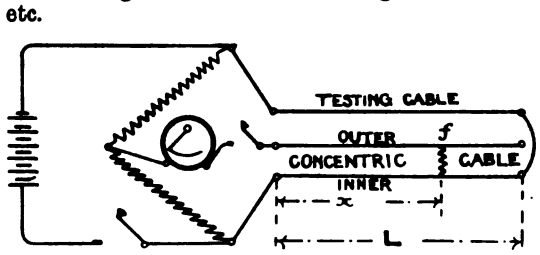

FIG. 8.—Murray's Loop Test.

I much prefer, however, the Murray's loop test (Fig. 8), which we have almost invariably used, and by which we have found it possible to localise faults with great accuracy. This method of testing has the great advantage that a resistance of a few thousand ohms at the fault does not matter, so that no attempt at reducing the resistance of the fault is necessary, and the cause of the fault can usually be found with a fair degree of certainty. By this test we have more than once localised a fault which, on being dissected, has shown merely a single parted wire in the outer, the solder being still visible, and a tiny pinhole through the inner insulation immediately below one of the free ends of the broken wire; the cable was otherwise quite uninjured and showed scarcely any sign of a current from inner to outer.

In Murray's test either the inner or the outer, preferably the inner, as it is more likely to be intact, of the cable up to the fault forms one arm of the bridge, the remaining part of the same conductor and the return lead, which may be the inner or outer of another cable or a special cable laid along the road surface for the purpose of the test, from the far end of the faulty cable forms the second arm; one set of the proportional coils and the variable bridge resistance form the other two arms of the bridge; whichever of the two conductors of the faulty cable which is not used as above described, is employed as the galvanometer lead to the junction of the two arms of the bridge at the fault.

If A = ratio of the resistance of the faulty cable conductor (used as one bridge arm) up to the fault to the resistance of the remainder of this conductor and of the return lead in series;
B = ratio of the resistance of the return lead to the resistance of the whole length of the conductor used as part of the bridge;
L = length of cable in yards;
x = distance in yards to the fault;

then
$$x = \frac{A\,(1+B)}{1+A} . L;$$

or if
$$A' = A,$$
$$B' = 1/B,$$
$$x = \frac{A'\,(1+B')}{B'\,(1+A')} . L;$$

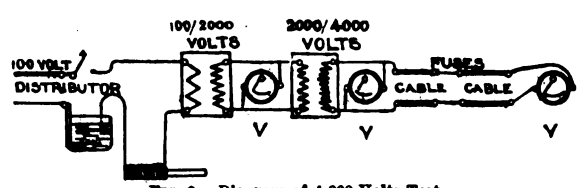

FIG. 9.—Diagram of 4,000-Volts Test.

With our arc lighting circuits, where we have the all-night and the half-night cables laid side by side, we have usually used one of these as the return lead for the other; in other cases we have used a $^{37}/_{20}$ rubber-insulated, wire-armoured single cable, of which we keep a 350-yard length specially for testing purposes. In addition to the two before-mentioned loop tests, we have used Heaviside's telephone method, sometimes with and sometimes without success. One drawback to the general use of this method is that the noise of the traffic in the daytime makes it almost necessary to work at night; another is that unless the fault is not merely from inner to outer, but also to earth, which generally means a badly burnt up fault, the method is useless with concentric cables. With heavily-taped armoured concentric cables, laid either in dry soil of a sandy character or in wooden troughs and bitumen, a fault to the lead sheath or armour means that most of the leakage current traverses the armour in both directions along the cable until it gets to earth at the earthed joint-boxes; this makes it very difficult to accurately localise a fault in many cases, and sometimes even to form a rough idea where the fault is.

In conclusion of these miscellaneous notes one point (of minor importance) in the designing of mains upon which further information is, I think, desirable may be mentioned. I allude to the temperature rise in a cable carrying current. Few experiments, as far as I am aware, have been made to determine—even to but a rough degree of approximation—the rise of temperature in an underground cable, and certainly there are no data generally available upon which a judgment can be formed with respect to different cables laid under different conditions and carrying currents varying according to different load diagrams. The Board of Trade has enacted by No. 4 of their regulations that "the maximum working current shall not be sufficient to raise the temperature of any con-

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ductor . . . to a greater extent than 30deg. of Fahrenheit's thermometer," but it is very doubtful whether any station engineer can say whether his mains comply with this regulation, and if so, with what margin of safety. A few general conclusions can of course be readily arrived at *a priori—e.g.*, under similar conditions the current densities in concentric cables should be less than in pairs of single cables; the current densities in similar cables, laid under similar conditions, should be less when the current is for street-lighting than when for private supply; the current density should be less the larger cable—and so forth. Precise information with respect to a few well-defined and characteristic cases is wanted—may it soon be rendered available.

THE MUNICIPAL ELECTRICAL ASSOCIATION.

We have received an advance copy of the programme for the Bristol Conference of this association. The conference will open on Wednesday, June 14, when a general meeting for discussion of papers will take place at the Museum Lecture Theatre, Museum-road, at 9.45 a.m. After the address of welcome by the Mayor of Bristol, Mr. H. Faraday Proctor (city electrical engineer, Bristol) will deliver the presidential address. The following papers will then be put forward for discussion: "Municipal Trading," by Councillor Geo. Pearson, chairman of the Electricity Committee of the Bristol Corporation; "Appropriation of Profits," by Bailie Maclay, convener of the Electricity Committee of the Glasgow Corporation. A luncheon will take place at 1.15 p.m. at the Royal Hotel, by special invitation of Mr. G. Pearson, after which, on the invitation of the Mayor of Cheltenham (Alderman Norman), a visit will be paid to the electricity and dust destructor works of the Cheltenham Corparation. The train for Cheltenham will leave Bristol at 3.15 p.m.

On Thursday, June 15, a general meeting for discussion of papers will be held at the Museum Lecture Theatre at 10 a.m., at which the following papers will be read: "Combined Lighting and Traction Works," by Mr. J. H. Rider, borough electrical engineer, Plymouth; "The Municipalisation of Telephones," by Mr. A. B. Mountain, borough electrical engineer, Huddersfield; and "House-to-House Distribution of Electricity," by Mr. C. D. Taite, borough electrical engineer, Southport. After the adjournment, by permission of the Bath Electricity Committee, the Bath electricity works will be visited, the trains leaving Bristol at 1.58, 2.35, and 3 p.m. As an alternative to the Bath trip, by permission of the directors of the Bristol Tramways and Carriage Company, Limited, a visit may be paid to the generating works of the electric tramways at 3 p.m., when special electric cars will convey the visitors from the old Market-street terminus. In the evening the association dinner will be held at the Grand Hotel, College Green, at 7 p.m. for 7.30 p.m. The tickets will be 7s. 6d. each until June 1, after which date 10s. will be charged.

On Friday, June 16, another general meeting for the discussion of papers will take place at the Museum Lecture Theatre, at 10 a.m. Papers on: "Condensing Appliances," by Mr. J. F. C. Snell, borough electrical engineer, Sunderland; and "Steam Pipes, Fittings, and their Arrangement," by Mr. J. E. Edgcome, borough electrical engineer, Kingston-on-Thames, will then be read; from 3 to 6 p.m., a garden party will be held at Cook's Folly, Sneyd Park, by special invitation of the Mayor of Bristol.

On Saturday, June 17, a business meeting will be held at the Museum Lecture Hall Theatre at 10 a.m. The agenda for this meeting contains the following items: election of president; place of meeting for next convention; election of officers; report of council; treasurer's statement; and secretary's report. On Saturday afternoon a visit will be organised to Tintern Abbey if a sufficient number desire such an excursion

During the convention the Bristol electricity works will be open for the inspection of visitors and members at all hours throughout the convention, and also, by kind permission of the various companies and firms, the following works will be open during the convention to visitors and members of the association on presentation of card: the Great Western Railway Works, Swindon; the Bristol Wagon and Carriage Company's Works, Lawrence Hill; Messrs. Peckett and Sons' Locomotive Works, St. George; Messrs. Humpage, Jacques, and Pedersen, machine tools and helical gearing, Ashton Gate. We are asked to state that visitors are cordially invited, and that tickets for the various entertainments and visits may be obtained on application either to the president, Mr. H. Faraday Proctor, Bristol, or to Mr. E. T. Ruthven-Murray, hon. secretary, 21, Acton-lane, Harlesden, N.W.

THE GARNESDON ELECTROPATHIC CURE.

BY J. H. C. B.

It was not altogether a fortunate thing for the peace of mind of the responsible staff of the Garnesdon Electric Light Works when the local cabinet factory applied for connection to their mains, because the manager of the factory made it understood that he would require his nephew to be transformed into an electrical engineer as a set-off. As it happened, the switchboard attendant has just then suddenly discovered a distaste for the high-tension side of the profession, on account of personally short-circuiting the 'bus bars while dusting behind the panels, wherefore a heaven-sent opportunity presented itself to the company for catching one who would pay a premium instead of being paid wages for the privilege of watching the voltmeters, turning the rheostat handles, and flicking the dust off the switchboard.

In due time, terms having been arranged and a cheque honoured, the new pupil presented himself. He was a happy-go-lucky young man of about 18 summers, who had just left school, and whose chief educational efforts appeared to have been directed towards a study of the art of practical jocularity. In addition, the school had taught a course of electricity and magnetism to such purpose that the new pupil at first refused to credit the fact that there were no pith balls in the works or gold-leaf electroscopes either.

However, after a few drillings as to the object of keeping the voltmeter needles steady on their red lines, and a graphic description of what the late attendant looked like after his little turn up with 1,000 volts without the gloves, the pupil took kindly to his work and gave the rheostat no rest. It used to be a source of amusement to the engine driver to monkey with his throttle valve during light-load hours, and watch the eager activity of the pupil as he scrupulously adjusted his resistances to meet the fluctuations of the needles. Other time-honoured tricks were played upon him, until he grew to believe that an electricity supply works was but a continuation course of his principal subject of school study, and that man's highest aim in life was the playful torture of his friend and neighbour. This having been made fully and painfully obvious, young Leonard Foster started in with a cheerful spirit to even up accounts. There were three men in particular whom he favoured with his attentions. One was the storekeeper, another the engine driver, and the other the arc trimmer, and they had all basked themselves in the sunshine of his ignorance. The storekeeper was wont to take afternoon naps on his counter, to atone for the labours of the day, and it happened sometimes that a cat would crawl upon his collar and die from contact with his breath; at least, that was the popular reason adduced when he mentioned the finding of dead animals in such places. Sometimes, too, a beetle would meet its fate in his mouth, which was left conveniently open for it to crawl into. These were possibilities that even his best friends acknowledged might be due to accident, but when one day the hose pipe arose and trained itself over the door so that its nozzle was in a line with the storekeeper's mouth, it was tacitly acknowledged that neither psychology nor chance had to with that action, nor with the subsequent opening of the hydrant valve to which the other end was connected. It was generally believed, however, that the storekeeper swallowed more water during that few seconds of time than he had done during several years previously.

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The engine driver suffered in spirits as well as in flesh. It did not seem natural that wire should be sometimes left trailing from the low-tension 'bus bars to his spanner bracket, so that when he wished to tighten up a bolt he was wont to execute a Highland fling on reaching down a spanner for the purpose. And he grew wary of using his vice, before inspecting its environs for a wire that would lead to the nearest switch plug, by reason of bitter experience in the capacity of an animated earth. It was also aggravating to find how keys and nuts would come undone on loose pulley clutches when a machine had to be run up on the countershaft, or perhaps after carefully uncrewing the throttle valve of an auxiliary engine to its full gape, the tachometer would register 20 revolutions, instead of the few thousand that should have resulted in the absence of load. A partly-closed branch stop valve would account for this, but nothing short of miracles or Foster could account for the closing of the stop valve, and the engineer took neither into account in his denunciation of delayed paralleling.

The arc trimmer's hair was frequently on the verge of turning white while replacing carbons, sudden shocks sometimes passing through him, making him imagine for a brief second per shock that the arc circuit was switched on and he was about to die. Then he would clamber down the post and cut the lamp off, and curse the name of Foster for using the Evershed testing set at unholy times.

Little incidents like this served but to whet young Foster's appetite for amusement, and, failing other sources of legitimate game, he forsook the paths of honest endeavour and brought his energies to bear upon the task of converting the engineer to a sense of his own responsibility by meddling with the switchboard connections and changing the main fuses. This sort of thing was not to be borne, and Foster was sent to help the service jointer outside, but the latter begged to be excused the infliction after a day or two of distraction. So it ended in a cancelling of the indentures, and Foster retired from his scientific labours to go into the office of the furniture factory, and help to propagate the doctrines of Schopenhauer in a new sphere.

The works settled down to rest again. The storekeeper slept the sleep of the just, and woke in a natural manner, dry and uncontaminated. The engine-man handled his tools and machines with trustfulness, and the arc trimmer did not trouble to short-circuit the local switch when at work. All was peace.

One day, just as the engineer was explaining to a deputation from another town how perfectly satisfactory the A. C. system was, and how particularly free from fault was his own plant, there came a sudden groaning to the day-load set, which slowed down, and the voltmeter needle tried to stand on its head. Presently came the revulsion, and the engine started racing heedless of automatic contrivances to the contrary. The deputation had watched the engineer with bated breath as he rushed to the throttle, and they now listened to him with similar feelings as he expressed his views about things outside the works, and hurried the mains super. off to the sub-station indicated by ammeter where the fuse had blown. It was clearly a short-circuit that had done the mischief, and a short of a particularly sustained and malignant character.

"If that infernal Foster had been about, I could have understood it," spoke the engineer. "As it is, it must be a burn-up on the mains. That diatrine must be as rotten as bitumen for high pressures." But the circuit tested out all right, rather better, in fact, than usual, so the engineer satisfied himself that the short had burnt itself out and would be heard of no more, and the circuit was connected to the 'bus bars again.

The next day this happened again, and about the same hour. Before putting on again the whole circuit was tested in sections, and a portion of low insulation resistance was disconnected. This faulty bit had several services connected (one of which was the furniture factory), and they all made vigorous complaints and threatened legal proceedings and gas companies, the furniture people especially. A test with the main fuses of the services disconnected showed good insulation on both mains, so it was obvious that there was something wrong on a consumer's circuit. The mains engineer went carefully over each installation, but they had deteriorated very slightly in insulation resistance since the taking over test. Their fuses were all intact, though, of course, of much smaller section than the transformer fuse that had gone. It was a mystery, the aggravation of which increased as time went on, for the blowing of the transformer fuse became of constant occurrence. In the engineer's opinion it was a case more for the Psychological Society than a test.

The consumers were much affected by the continual cutting off of the light, both from the unknown cause, and for consequent (but futile) testing reasons, and, led by the furniture factory owner, they made known their resolve to be disconnected from the mains and set up an installation among themselves if another stoppage took place. This made the supply people desperate, and they arranged elaborate preparations to burn out the trouble at all risks. All boilers were kept under steam, the engines were kept turning, and a fuse of equal conductivity to the section of the afflicted main was put in at the sub-station. A loud ringing bell circuit was also connected to the ammeter of the circuit, so that when the needle went over the ringing of the bell would at once indicate it.

Day after day of breathless anxiety went by, and at last the bell rang. Instantly the furnaces were being fed with tarred waste, kerosened wood, and other inflammables of a Guy Fawkes bonfire nature; the machines were run up to speed and switched in, and the other circuits were cut out so as to concentrate the station upon the fault. Outside, black smoke poured from the chimney, and soot descended in showers; inside, the staff stood with hands upon valve-wheels and switch-levers watching the prostrate ammeter finger. The main fuses began to change colour, and the engineer seized a reel of binding wire and wound its contents over the terminals with fevered haste. A smell of shellac rent the air, and the sickening odour of heated rubber. The rattle of shovels and bang of furnace doors told of the stokers' activity, and the words "inquest" and "parboiled" delicately suggested themselves to some men's minds as they noticed the steam-pipes slide along the expansion rollers.

At last, the ammeter needle jumped up from the pin at the limit mark, and with a shake or two fell over to zero, and simultaneously the throttle valves were closed and by-passes to exhaust were opened. A chuckle of relief went around, and the outdoor men flew for the affected district and started opening the street boxes. The mains were almost red hot, but until they neared the furniture factory not a trace could be found of the break. The factory was on fire, and flames were likewise issuing from the street service box near the yard entrance. A youth who bore a certain structural resemblance to the once-time pupil was being helped into a cab, with his fingers burnt off. His features were too contorted for facial recognition.

The furniture manufacturer stood cursing impotently all things connected with electricity, the dilatory fire brigade, and the ineffectiveness of his own men's efforts to get the flames under with buckets. The mains engineer at considerable risk went inside to the main fuse and found it intact. The cause of the fire was clearly between the service joint and the house fuse, and it turned out that the ex-pupil had made a couple of T joints in the cellar where the service entered the premises, and had amused himself by short-circuiting the ends with copper rods till the transformer fuse went. This last time, however, the cables smouldered and stank so that the lad became frightened and endeavoured to pull the bar off, which resulted in his fingers being held by muscular contraction to the red-hot metal until they were burnt off, while the cable gave way at the bar contact and opened the circuit.

As a cure for practical jocularity the operation was a complete success, and the whole of the station got drunk to celebrate the event, and lived happily ever afterwards.

Bermondsey Electric Lighting Bill.—The Bill confirming an electric lighting provisional order for Bermondsey was further considered by the Select Committee of the House of Commons on Tuesday, and the preamble was held to have been proved.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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PEACE, RETRENCHMENT, AND REFORM.

It does not pay municipal authorities to be too niggardly in the salaries they pay to responsible officials, and especially is this true as regards officials in what may be termed the spending departments. Although we are strong advocates for the employment of consulting engineers, we are fully aware that the resident engineer, whether he be the borough, electrical, water, or tramway, must necessarily be responsible for the outlay of large sums of money. The old political war cry placed at the head of this article applies very strongly to the local politics of to-day. One party always opposes a suggestion from the opposite side, no matter how good or how bad it may be. Hence peace is seldom known. As for retrenchment, the efforts are generally in a wrong direction. The success of a cheap-jack in the selling of his goods is wonderful. There always seems to be an attraction to "buy" if a thing is said to be cheap. Few people consider that the purchase of an article generally involves two things, not only its purchase, but also its subsequent use. If in the use the article is found wanting it cannot be termed cheap, whatever the money paid originally for it. Now, an engineer is not a show article. He is not intended to stand on a pedestal or within a glass case, but to do work. The work he undertakes is varied in character and costly in execution. There are many ways of doing the work, only one of which is the best and hence the most economical. An incompetent official will soon lose from incompetent design or organisation far larger sums of money than would serve to employ a competent man. That is the case in a nutshell. Knowledge and experience are saleable commodities, and the better the article the higher the price it will fetch. Some of our municipal authorities hold an entirely different view, and imagine that the value of an electrical engineer is something between that of a prize pug dog and a railway foreman. That view may be, and no doubt is, the correct one in some cases—indeed, we would go further and say that the value is a negative quantity; but ordinarily the salaries offered and paid to these gentlemen are altogether too small. It must ever be remembered that the gentlemen now designing and organising electrical central stations are working upon their own initiative. They have little or no history to fall back upon, and when we consider that the majority of the workers are young men, it is amazing to find so few mistakes. They have energy, they have ability and tact to a high degree, and they deserve to obtain a fair remuneration for services rendered. A few authorities are fully alive to the value of the work done, and show their appreciation of its value by giving adequate salaries. In other, and unfortunately these are the majority of cases, the view taken is to starve the engineer. Blackburn is the latest case in point. Some of the councillors do not appreciate the value of brains, with the result that a suggestion to raise the electrical engineer's salary to a sum that would only be moderately adequate as a remuneration for his services has been referred back for further consideration. It is sincerely

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to be hoped that the discussion will hereafter be carried out in private, and that the result will show Blackburn to be as considerate of the welfare or satisfaction of its officials as other Lancashire towns are known to be.

TELEPHONY.

The evolution of the Government scheme is gradual, but another step has been taken in the issue of the Treasury minute, reprinted in another part of this issue. The minute, so to speak, consolidates the Government scheme. It shows that legislative sanction is to be given for the use of public money in competition with private capital. This is essentially a new departure, and one which cannot fail to have important results. We think it absolutely wrong, and cannot understand the reasoning which brings about the result. However, the one point upon which the proposed scheme seems illogical is the one which assume that the Government ought to take over the telephones after Dec. 31, 1911, but not before. If the Government take control then, why not now? or if not till then, why at all? The work has to be done under the direction or approval of the Postmaster-General; why not directly by him? Is the Government less able to borrow money than local authorities? The simple question is, Do we want perfection in telegraphy or not? If we do, then the whole system would be best under the control of one authority. As suggested, the local authorities are contractors to establish and work lines for eleven years, when they will cease to exist and the real owners come to their own. It would be easy to put a worse construction upon it and say that the local authorities have eleven years to waste, or otherwise, the ratepayers' money, to kill private enterprise, and then the Government takes over the concern at cost price.

INSTITUTION OF CIVIL ENGINEERS.

THE 1899 CONFERENCE.

The programme of arrangements in connection with the second conference of the Institution of Civil Engineers, which is to be held on June 7, 8, and 9, has been issued, and from it we gather that the proceedings will be opened with an address by the president in the theatre of the institution. Accommodation has been placed at the disposal of the council by the Institution of Mechanical Engineers, the Surveyors' Institution, and the Middlesex County Council. The reading and writing room of the Institution of Mechanical Engineers, Storey's-gate, will be open to members attending the conference, and the hon. secretaries' office, for enquiries, etc., will be at the Surveyors' Institution. Advance proofs of the notes introducing subjects for discussion at the meetings may be obtained on application to the institution after June 1, and the hon. secretaries of the various sections will be glad to receive the names of those who may wish to take part in the discussions. The cards of admittance to the visits will be posted on June 1, and it is requested that those intending to take part in these visits should indicate by numerals which they most desire to participate in on the schedule. This should then be returned to the secretary marked "Conference." The following will be visited: on Wednesday, June 7—Staines Reservoir Works, East London Waterworks, Woolwich Arsenal, Thames Ironworks, Messrs. Fraser and Chalmer's Works (Erith); Thursday, June 8—Crewe Works and back (L. and N.W.R.), Messrs. Thornycroft and Co.'s Works, Messrs. Wm. Cory and Son's Works, Hydraulic Power Company's Pumping Station and Westminster Electric Supply Corporation's Station (Millbank), Vauxhall Bridge Works, Victoria and Albert Docks and Surrey Commercial Docks; Friday, June 9—Dover Harbour Works, Metropolitan Sewage-Disposal Works (Barking) and Gaslight and Coke Company's Works (Beckton), Central London Railway Works, Messrs. Siemens Bros. and Co.'s Works.

The conference will be divided into seven sections, which will be as follows: (1) railways; (2) harbours, docks, and canals; (3) machinery; (4) mining and metallurgy; (5) shipbuilding; (6) waterworks, sewerage, and gasworks; (7) applications of electricity. Discussions will take place on the following subjects, most of which will be of interest to our readers:

WEDNESDAY, JUNE 7.

Section I.—Railways.

"What is a Light Railway, and what Circumstances should govern the Gauge?" Introduced by Mr. A. C. Pain.

"Mountain Railways." Introduced by Mr. C. A. W. Pownall.

"The Advantages or Disadvantages of Uniting the Lock and Block Signalling Appliances of Railways." Introduced by Mr. A. Ross.

"The Various Systems of Fog Signalling." Introduced by Mr. Wilfrid S. Boult.

Section II.—Harbours, Docks, and Canals.

"Recent Improvements in Facilitating the Discharge and Loading of Large Steamers, and the Best Form of Warehouses." Introduced by Mr. W. Henry Hunter.

"The Length, Width, and Depth, and Shape and Mode of Construction of Locks, Entrances, and Graving Docks, having regard to the Increasing Sizes and the Shapes of Vessels." Introduced by Mr. R. C. H. Davison.

Section III.—Machinery.

"Recent Advances in Locomotive Practice." Introduced by Mr. F. W. Webb.

"The Relative Advantages of Different Kinds of Power for Tramways, Light Railways, and Motorcar Traffic, both Heavy and Light." Introduced by Mr. Thomas Parker.

"Forgings and the Machines used in producing them." Introduced by Mr. E. S. Brett.

Section V.—Shipbuilding.

"Swift Passenger Steamers of Moderate Size."

"On the Practicability of so constructing Merchant Steamers as to render them readily available for War Purposes." Introduced by Mr. J. H. Biles.

"Recent Developments in Cargo Steamers." Introduced by Mr. E. W. De Rusett.

Section VII.—Applications of Electricity.

"Methods of Electrical Transformation." Introduced by Mr. James Swinburne.

"Some Non-Integrating Electric Meters." Introduced by Prof. W. E. Ayrton.

THURSDAY, JUNE 8.

Section II.—Harbours, Docks, and Canals.

"Sand Pump Dredgers." Introduced by Mr. A. G. Lyster.

"Effect of Waves on Breakwaters in Different Depths of Water." Introduced by Mr. William Shield.

"The Design of Breakwaters." Introduced by Mr. J. Watt Sandeman.

Section IV.—Mining and Metallurgy.

"Modern Improvements in Coal Mining: Winding from Deep Mines." Introduced by Mr. H. W. Martin.

"Modern Practice in Gold Mining." Introduced by Mr. Fearnside Irvine.

"Comparative Advantages of Electricity, Compressed Air and Steam for Mining and Manufacturing Purposes Generally. Introduced by Mr. J. C. Howell.

Section VI.—Waterworks, Sewerage, and Gasworks.

"The Use of Filtered Flood-Water." Introduced by Mr. M. W. Hervey.

"The Rate per Head of Supply in Different Towns, with a Consideration of the Causes which Increase or Diminish it in Particular Instances." Introduced by Mr. James Watson.

"Sewage Sludge Disposal by Natural Agencies, including the Purification of Sewage by means of Artificial Filters." Introduced by Dr. G. Sims Woodhead.

Section VII.—Applications of Electricity.

"Mechanical Traction by Electricity." Introduced by Mr. G. C. Cuningham.

"Economical Transmission and Distribution of Electricity from a Distance." Introduced by Mr. H. F. Parshall.

FRIDAY, JUNE 9.

Section I.—Railways.

"The Most Expeditious Method of Relaying the Railways of this Country, involving least interruption of traffic, having regard to safety and economy. Introduced by Mr. Harry Footner.

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"Causes of Earth-Slips in the Slopes of Cuttings and Embankments of Railways, and how to prevent or remedy." Introduced by Mr. R. Elliott Cooper.

"Economy in Handling and Transport of Minerals." Introduced by Mr. Charles Forman.

Section III.—Machinery.

"Machine Tools; with special reference to American and German Practice as compared with English." Introduced by Mr. Arthur Greenwood.

"Separate Condensing Plants for Factory Purposes." Introduced by Sir A. Seale Haslam.

"Cranes, and the Power to be used with them." Introduced by Mr. Walter Pitt.

Section IV.—Mining and Metallurgy.

"By-Product Coke Ovens." Introduced by Mr. Evence Coppée.

"The Influence of Casting Temperature on Steel." Introduced by Mr. R. A. Hadfield.

Section V.—Shipbuilding.

"Dock-Blocks and Docking Appliances." Introduced by Mr. A. J. Maginnis.

"The Application of Mechanical Appliances to the Riveting and Caulking of Ships, and the Materials of Ships Rivets." Introduced by Mr. Robert T. Napier.

Section VI.—Waterworks, Sewerage, and Gasworks.

"The Purification of Gas and the Conversion of Chemical Residuals therefrom, including the Preparation of Cyanogen." Introduced by Mr. W. Foulis.

"Labour-Saving Machinery applicable to Operations in Gasworks." Introduced by Mr. C. C. Carpenter.

THE TELEPHONE QUESTION.

The following Treasury minute, dated May 8, 1899, upon the proposals for the development of the telephone system in the United Kingdom has been issued:

1. My Lords have before them the Treasury minute of May 23, 1892, the several agreements made between the Postmaster-General and the National Telephone Company, and the report of the Select Committee of the House of Commons appointed last session to consider the condition of the telephone service.

2. The committee find (i.) that the existing exchange service is not of general benefit to the country, and that it is not likely to become of general benefit so long as the present practical monopoly in the hands of a private company shall continue; (ii.) that competition by either the Post Office or the local authority is necessary in the public interest, and that the Post Office is not prevented, either by legal agreement or by good faith, from competing in any areas either by itself or by means of licensees.

3. My Lords agree generally in this conclusion, and approve of the proposals of the Postmaster-General: (i) that licenses should be granted to certain local authorities to transact telephone business within appropriate areas; and (ii.) that the Post Office should itself open telephone exchanges in London as soon as Parliament has provided the necessary funds.

4. Local authorities cannot, without the sanction of Parliament, borrow on the security of their rates or use their funds to establish a telephone service. My Lords are of opinion that this sanction may be most conveniently given by a general enabling Act, and a Bill containing the necessary provision on the subject has been introduced.

5. The licenses to local authorities will be of the same general character as that held by the National Telephone Company and will contain a provision that the local authorities licensed by the Postmaster-General shall connect their exchanges with post offices in order that persons using their telephones may, on payment of the usual charges: (*a*) speak over the trunk lines of the Postmaster-General; (*b*) speak messages to a post office for delivery as telegrams, express letters, or ordinary letters; and (*c*) call for the services of express messengers. My Lords propose that messages which are to be delivered as express letters should be spoken for that purpose, not only as at present to a post office in the same town, but to any post office connected with an exchange. Thus, any person using a call office will be able to secure the delivery of his message in any part of the country where an exchange is established.

6. In order to ensure that telephonic communication shall be open as far as possible to persons who do not rent a telephone, the Postmaster-General will require licensed local authorities to open call offices at post offices, and will confine the charges at such offices within reasonable limits; while the restriction hitherto imposed upon renters of telephones, that they shall not allow their telephones to be used by persons outside their own households, will be removed in all cases where messages are paid for on the "toll" system, whether the telephones are rented from the local authority or from the National Telephone Company. Thus it is anticipated that some classes of subscribers will be ready to offer to the public the use of their telephones either gratuitously or for a small fee.

7. It will be a condition of the licenses granted to local authorities that no terminal charge shall be levied by the licensee upon trunk-wire messages originating in an exchange of the Post Office, or of any other local authority, or of the National Telephone Company, if (in the latter case) the company cease to levy such charges on trunk-wire messages originating in the exchange of the local authority.

8. The following conditions will also be attached to a license to a local authority: (*a*) that the plant shall be of such character and so constructed as the Postmaster-General may from time to time direct or approve; (*b*) that there shall be no preferential treatment as between one subscriber and another; (*c*) that the system of charge and the maximum and minimum sums to be charged shall be subject to the Postmaster-General's approval and (if necessary) revision, and that yearly accounts shall be submitted to him of the revenue and expenditure of the service; (*d*) that neither the license nor any of the powers conferred by it shall be assigned or sub-let, and that no plant shall be sold to, and no working agreement made with, another licensee without the sanction of the Postmaster-General; (*e*) that the license shall be subject to determination if the local authority does not *bonâ fide* establish a telephone exchange system within a reasonable time and maintain such system in effective working.

9. The royalties payable to the State will be the same as those specified in the National Telephone Company's license.

10. All licenses will be terminable on Dec. 31, 1911.

11. With respect to the purchase of plant whether of the local authority or of the company, my Lords agree with the conclusion of the Select Committee "that the Postmaster-General should in no case undertake to buy useless or antiquated plant." Single-wire circuits, for example, fall into this category. Subject to this consideration, it will be a condition of the license to a local authority, that on the termination by the Postmaster-General of such license the local authority shall sell, and the Postmaster-General shall purchase, all plant then in use in the telephone service of the local authority which is suitable for the actual requirements at the time of the local service of the Post Office. The question of suitability will be left, if the parties differ, to the decision of an arbitrator, subject to the provision that no plant shall in any case be considered suitable which has been brought into use without the sanction of the Postmaster-General. The plant will be taken at its fair market value at the time of the purchase without any addition in respect of compulsory purchase or goodwill or profits, the value to be ascertained by arbitration if necessary.

12. My Lords propose that where, within a reasonable period, *bonâ fide* competition between the National Telephone Company and any local authority is established in any area where the company are now working, similar treatment should be applied to so much of the plant of the company in such area as existed at the time when the competition was inaugurated. Further, if the company within a reasonable period give intercommunication in such area between their exchanges and the exchanges of the local authority, on conditions approved by the Postmaster-General, the purchase will extend (on the same terms) to the plant of the company constructed (with the sanction of the Postmaster-General) after the commencement of the competition.

13. The Postmaster-General will consider all applications for licenses by local authorities with reference to the circumstances of each case, and will exercise a discretion both as to the grant of the license and as to any modifications of its terms (not inconsistent with the principles indicated in this minute) which he may think desirable.

14. The right of the Post Office to establish telephone exchanges, and to license persons, companies, and other bodies to establish such exchanges—a right explicitly reserved in every license and agreement with the National Telephone Company—will remain intact; and should her Majesty's Government at any time see fit to exercise this right in a manner different from that indicated in this minute, neither the company nor any local authority will have any ground to complain of breach of contract or want of good faith on the part of the Postmaster-General.

INSTITUTION OF ELECTRICAL ENGINEERS, MAY 18.

The following candidates were balloted for last night:

Member.—W. E. Goldsborough, Purdue University, La Fayette, Ind., U.S.A.

Associate Members.—F. J. Howitt, chief electrician, Messrs. P. R. Jackson and Co., Limited, Salford Rolling Mills, Manchester; E. B. Thornhill, Corporation Electricity Works, Taunton.

Associates.—C. G. M. Bennett, 21, Elsham-road, Kensington, W.; W. A. Harris, Suburban Telephone Company, Port of Spain, Trinidad; W. J. Higley, Controller of Orange Free State Railway Telegraphs, Bloemfontein; J. N. C. Holroyde, Stapleford Vicarage, Notts; N. Hosgood, 34, Osbaldestan-road, N.

Students.—A. G. Elliott, 12, Beulah-hill, London; R. W. Martin, 20, Avenue-road, Grantham.

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MAGNETISM.*

BY PROF. JAMES ALFRED EWING, F.R.S., M.I.C.E.

(Continued from page 606.)

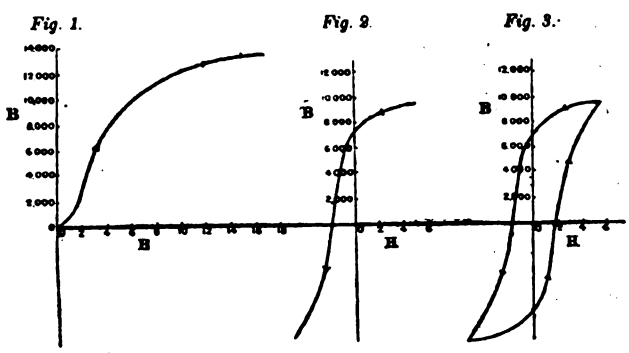
Alternating currents in the primary circuit produce reversals of magnetism in the core, and thereby induce corresponding alternating currents in the secondary circuit, the ratio of electric pressure between the two depending on the number of turns in the winding of the two coils. It is to the induction coil that we owe the high-pressure currents required for Hertzian telegraphy and for the Röntgen rays. The transformer—an induction coil with a core closed upon itself to form a complete magnetic circuit in iron—gives the engineer means of economically conveying electric energy over long distances, by first raising it to a pressure which may be transmitted with but little loss in a long conducting wire of moderate size, and then lowering it to a pressure at which it may be utilised without inconvenience or danger. The principle found its earliest engineering embodiment in the crudely-designed "secondary generators" of Gaulard and Gibbs. Here we have another notable application of magnetism, and it may be added that it is by applying magnetic theory and magnetic experiment that the conditions are practically arrived at which allow the conversion of electricity by the transformer to be performed efficiently. Here, too, a study of the magnetic qualities of iron is all-important to the electrical engineer.

A few incidental applications of magnetism to engineering purposes remain to be briefly mentioned. The attraction across a surface of division between two parts of a magnetic circuit, originally investigated by Joule in 1838, is made use of in the workshops in a variety of ways. Magnetic crane hooks are employed to lay hold of and lift heavy plates. Drills and other tools are attached by magnetic attraction to the piece on which they are to work. Magnetic clutches serve to connect and disconnect lines of shafting. Magnetic brakes have been applied to the wheels of vehicles. In all these cases the force which is taken advantage of is due to magnetisation; it comes and goes with the making and breaking of the magnetising current; and it may readily be made to amount to nearly 200lb. per square inch.

Thermo-magnetic engines have been devised to perform directly the conversion of heat into work. A piece of iron heated to bright redness (say 780deg. C.) loses nearly all its capacity for magnetic induction and ceases to be attracted by a magnet. It may therefore be withdrawn from the neighbourhood of a magnet pole without expenditure of work; but once the iron is cooled the magnet resumes its attraction. Hence, by heating the iron when it is in a strong field, then removing it while hot to a place where the field is weaker, then cooling it till the magnetic action reasserts itself and then allowing it to return, we take it through a cycle in which mechanical work is done by it, work which may be applied to a useful purpose by appropriate means. The energy to do the work comes from heat, more heat being absorbed in the heating of the iron than is given out in the cooling. But though it is easy to make a working model which will illustrate the principle of this action, the task of making an engine which will carry it out efficiently on a practical scale has not been accomplished, nor is it in the least likely of accomplishment. A model is shown on the table in which the working substance is nickel, which loses its magnetic quality at a lower temperature than does iron, and by alternately heating and cooling the piece as it swings in pendulum fashion towards and from the pole of a magnet, enough heat is converted into work to keep up the swing.

Yet another application of magnetism, and one with a more promising future, is the use of the magnetic field in separating magnetic from non-magnetic substances. A familiar instance is the workshop process of separating iron filings and turnings from brass. Edison has lately turned this idea to practical account by employing magnets in the concentration of iron ore. One of the most widely-diffused ores of iron is the magnetic oxide—the material of the loadstone—which is susceptible to magnetic induction, and is therefore attracted by the magnet. In most cases it is so much intermixed with foreign matter that to smelt the mixture would not be remunerative. Edison's process renders it possible to work such low-grade ore economically. He first grinds it, and for the operation of grinding he has devised machinery remarkable for its boldness in conception and its ingenuity in detail. He then causes the ground mass to fall in a stream before the face of a magnet which deflects the particles that are capable of attraction; so that, while the earthy matter continues to fall vertically, the concentrated ore falls to one side and is separated out. In practice, the crushing and magnetic separation proceed in a long series of stages. Through this process of concentrating low-grade iron ore by magnetic winnowing, as one may call it, Edison hopes, and apparently not without reason, to unlock vast natural stores of iron which have hitherto been unavailable, and he has shown the courage of his convictions by spending great sums on the plant by which the process is now being tested on a commercial scale. His crushing and separating machinery at the town of Edison, New Jersey, is able to deal with 5,000 tons of ore a day, and it is said to produce a concentrate containing 67 per cent. of iron from crude ore containing only 20 per cent. An English syndicate has taken up this matter, and, though the prospectus is not yet brought to the birth, the prospector is already at work searching in the Scottish highlands for beds of mixed magnetic ore. In this search he is guided in the first place by the magnetic survey of Rücker and Thorpe, expecting, *primâ facie*, to find deposits of ore where they have detected local perturbations of the terrestrial magnetic field. Here we have an example of what occurs over and over again in the history of scientific discovery. A utilitarian application unexpectedly follows a piece of scientific research which at the time it was made seemed to have none but the most abstract interest. In the evolution of engineering few things are more conspicuous than the ultimate usefulness of "useless" knowledge.

The electrical engineer requires special iron to derive the best results in his dynamos and transformers, and the supply of it has become an important industry. The carbon and manganese which are essential in steel that is intended to be strong are prejudicial in steel that is intended to be magnetic. Special steel castings, consisting of almost pure iron, now supply the dynamo builder with a material that is excellent in magnetic quality, and, being cast, they are readily supplied in appropriate shapes for the field magnets. Special iron and steel is rolled into sheets and stamped into the forms which are wanted for the armatures of dynamos and the cores of transformers, and the magnetic quality which it possesses is immensely superior to that of any iron which could be obtained a few years ago. The testing of iron for magnetic quality, which within my own experience was a matter of original research, is now an everyday operation in the workshop, and iron is ordered to specification of its magnetic properties, just as in other departments of engineering it is ordered to specification of its strength.



Magnetisation of Iron.

In the magnetisation of iron we are concerned mainly with two properties—one is permeability, or the readiness with which the metal takes up magnetic induction, the other is a property to which some 18 years ago I gave the name of "hysteresis," after an investigation that was undertaken without any idea that the property in question would come to be commercially important. To understand what happens when iron is magnetised, consider again a ring of iron forming the core on which a magnetising coil is wound. A current passing through the coil subjects the ring to magnetising force, which increases in simple proportion as the current is increased. But the magnetic induction within the core does not increase proportionately to the magnetising force. Let the magnetising force be gradually raised. At first the increase of induction is slow, then very rapid, then slow again. You observe three more or less clearly marked stages in the process (Fig. 1), and in special cases you may see the three very sharply distinguished from one another (as in Fig. 4), which exhibits the magnetisation of a piece of nickel under certain conditions as to stress. Thus the permeability of iron is a variable quantity, comparatively small for small magnetising forces, very large for forces of medium intensity, and then comparatively small again when the force is strong. In all three stages, however, the induction increases faster than the magnetising force increases. But by using exceedingly strong forces we find that a fourth stage is reached, in which the increase of induction is only equal to the increase of magnetising force. When that happens the iron is said to be saturated. After that it has no greater power of taking additional induction than a piece of brass or wood. Engineers have nothing to do with that extreme condition of magnetisation. In the transformer and the dynamo we are concerned only with what I have here called the second and the third stages of the process.

Next, suppose that after the magnetising force (H) has been raised to any value, it is reduced, say, to zero (Fig. 2). We find that the magnetic induction (B) also becomes reduced, but by no means

* The "James Forrest" lecture, delivered before the Institution of Civil Engineers, April 20, 1899.

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so much as you might expect. It tends in great measure to persist, and a good part of it survives the complete withdrawal of the magnetising force. Let the process be continued by applying magnetising force in the opposite direction to the first, and then let the force be again removed and reversed. We thereby get the cyclic process of change illustrated in Fig. 3. Throughout this process the changes of induction lag behind the changes of magnetising force, and it is this lagging behind that is called hysteresis.

Residual magnetisation is one of the consequences of hysteresis, and when steel is wanted for permanent magnets the maker has to aim at getting as much hysteresis as possible,

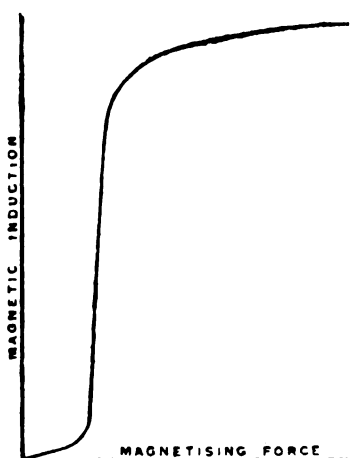

FIG. 4.—Magnetisation of Nickel in a State of Torsion (Nagasaka).

which he generally does by putting in some tungsten. But in most of the magnetic uses of iron it is desirable to reduce hysteresis to the uttermost. This is notably true of dynamo armatures and the cores of transformers. In the core of a transformer the magnetism goes through repeated cycles of reversal, such as the cycle shown in Fig. 3, often as frequently as 100 times a second. Now every such cycle means an expenditure of energy, which is greater the greater the hysteresis. It is easy to prove (as was first done by Warburg) that the area enclosed by the two curves which make up the cyclic process is a measure of the work that is spent upon the iron. That work is wasted; it is simply dissipated as heat. The efficiency of a transformer consequently depends on this, more than on anything else, whether the core is made of iron having little hysteresis. Various specimens of iron differ very widely in hysteresis as well as in permeability, and hence the practical importance of magnetic tests.

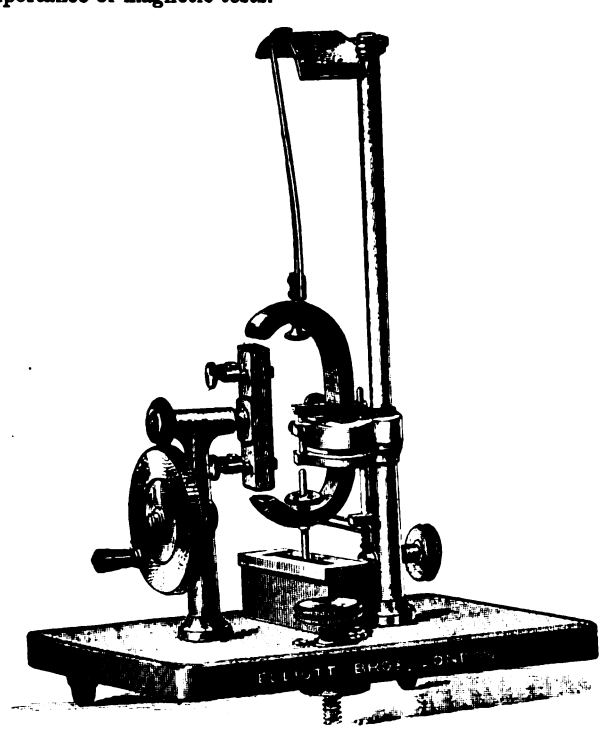

FIG. 5.—Hysteresis Tester.

The methods by which the permeability and the hysteresis of iron were at first investigated were laborious, even in the hands of people used to physical research. Several inventors have applied themselves to the task of providing simpler means of making such measurements. Having some personal experience—which began earlier than most people's—in this matter of magnetic testing, I have endeavoured to provide apparatus suitable for workshop use. Three of the instruments devised with this object are before you. The first is a hysteresis tester (Fig. 5), which has come into extensive use for measuring directly the hysteresis of sheet iron, such as is employed in the cores of transformers and dynamo armatures. The specimen is a little bundle of strips, and it is made to revolve between the poles of a permanent magnet which is free to swing upon a

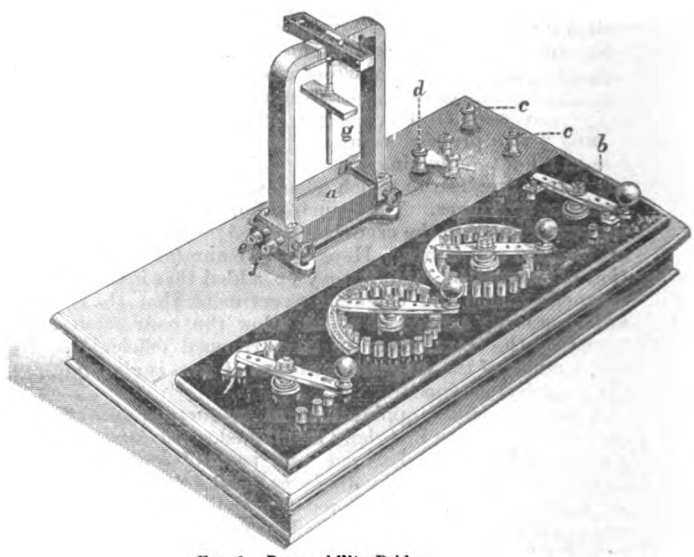

FIG. 6.—Permeability Bridge.

knife-edge. At each half-turn the magnetism in the specimen induced by the permanent magnet is reversed, and this reversal involves hysteresis, which shows itself by making the magnet become deflected over more or less. The amount of the definition is read off by a pointer on a scale above, and gives a very simple measure of the hysteresis. The second instrument (Fig. 6) I call a permeability bridge. It allows tests to be made of the permeability of forged iron or cast steel in a way that is analogous to the measurement of resistance by Wheatstone's bridge.

(To be continued.)

QUESTIONS AND ANSWERS.

QUESTIONS.

167. What is the best arrangement for ensuring that a large motor connected to supply mains cannot be put in or out of circuit so rapidly as to affect the adjacent lamps?—LESLIE.

168. The two mains from an alternating-current system of supply are carried into a house through two separate steel conduits. When many lamps are turned on, the drop in pressure is so great as to be altogether inadmissible. The same mains are then put together in a single steel conduit, when no such drop occurs. Explain this.—J. C. R.

ANSWERS.

Question No. 161.—What is the best practical method of calculating the resistance and size of coils required for a motor-starting switch, giving due attention to accuracy and economy?

Best Answer to No. 161 *(awarded* 10*s.)*.—The calculation of the resistance and size of coils required for a starting switch involves two distinct operations: (1) the determination of the resistance necessary in the various sections to give the required result upon the motor; (2) the determination of the diameter and length of wire necessary to give the required resistance and carry the current without dangerous overheating, and with due regard to the time such wires are likely to be in use.

The conditions to be complied with in the first part are frequently of the following form: the current passing with switch on first stud must not exceed, say, 20 amperes, and when any one section of resistance is cut out the current must not increase by more than that amount. Number of contact studs must not be less than ——. (This, it will be seen, has a minimum fixed by the first condition, but it is frequently specified separately.) Up to the point where the motor starts to run, the calculation of the necessary resistance is merely a matter of Ohm's law.

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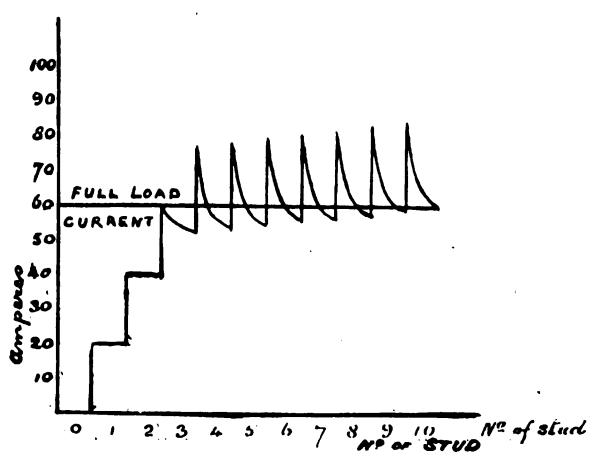
$$\text{Resistance in circuit} = \frac{\text{volts of supply}}{\text{current allowed with switch on stud in question.}}$$

Unless there is specific information to the contrary, it is advisable to assume that the motor may have to start with full load, in which case it will not start until it receives it full load current through the armature. When the armature begins to move it generates a back E.M.F., which tends to cut down the current driving it, but as soon as the switch-arm touches the next stud there is a sudden rise of current, owing to a section of resistance having been short-circuited. The speed of the armature increases and the back E.M.F. reduces the current once more to about its former value. The whole process is usually as represented on the diagram (Fig. 1). The spaces on the line of abscissæ are taken to represent the studs of the switch.



Amperes are plotted vertically. The sharp peaks of the curves are in reality no doubt somewhat reduced and rounded off by the effect of self-induction in the circuit. The sections of resistance should evidently be so proportioned that the rise and fall of current value shall take place over the same range for every stud during the speeding up. Of course the assumption must be made that the switch is allowed to remain on each stud sufficiently long for the armature to have reached its full speed for that stud. This can be insured either by compulsory slow gear or by intelligence on the part of the operator.

To fulfil the above condition, the values of the resistances from any stud onwards must be in a descending geometrical progression, as shown by the following proof, where for the sake of simplicity the current is assumed to fluctuate between a fixed maximum and minimum, which is quite near enough for all practical purposes.

Let the full current be on and motor start running on stud S;
Current on touching stud $S = C_1$, and let it fall to C_s;
Current on touching stud $(S+1) = C_2$, and let it fall to C_s;
Current on touching stud $(S+2) = C_3$, and let it fall to C_s;
Volts at terminals of mains $= V$;
Final back E.M.F. on stud $S = e_1$;
Final back E.M.F. on stud $S+1 = e_2$;
Resistance in circuit from stud $S = r_1$ (including armature);
Resistance in circuit from stud $S+1 = n r_1$;
Resistance in circuit from stud $S+2 = m r_1$ (n and m being fractional).

With motor still when switch touches S, $C_1 = \frac{V}{r_1}$.

With motors started when switch remains on S, $C_s = \frac{V - e_1}{r_1}$.

When switch touches stud $(S+1)$ $C_2 = \frac{V - e_1}{n r_1}$.

When switch remains on stud $(S+1)$ current $= C_s = \frac{V - e_2}{n r_1}$.

When switch touches stud $(S+2)$ $C_3 = \frac{V - e_2}{m r_1}$.

But it is intended to make $C_3 = C_2$.

$$\therefore \frac{V - e_2}{m r_1} = \frac{V - e_1}{n r_1}.$$

$$\therefore \frac{V - e_2}{V - e_1} = \frac{m r_1}{n r_1} = \frac{m}{n}.$$

Also $$\frac{V - e_1}{r_1} = C_s = \frac{V - e_2}{n r_1}.$$

$$\therefore \frac{V - e_2}{V - e_1} = \frac{n r_1}{r_1} = n.$$

$$\therefore \frac{m}{n} = n, \text{ or } m = n^2.$$

∴ The resistances are of values r_1, $r_1 n$, $r_1 n^2$, etc., which is a geometrical progression. The value of resistance from the point where the motor starts is already known, and the resistance in circuit from the last stud is that of the armature only. It is therefore required to insert between these two extremes a number of geometrical means corresponding to the number of studs lying between them on the switch. Undoubtedly the simplest method of doing this is that advocated by Mr. E. A. N. Pochin, B.A.—viz., find the two extreme values on the scale of a slide rule and on a strip of paper, divide the length between them into a number of equal parts, one more than the required number of means, and read off the values of the means from the points so obtained. The length between two adjacent points being the log. of the constant factor of the geometrical progression as represented on the slide rule.

MOTOR STARTER.—15 AMPERES, 20 VOLTS.

Stud No.	1	2	3	4	5	6	7
Resistance in circuit, including armature	22	14·6	7 6	4·2	2·3	1·3	·7
Current	10	15	—	—	—	—	—

Resistance between studs	290	7 4	7	3·4	1 9	1·0	·6
Material			Spe	cial	all	oy	
S.W.G.	34	18	16	16	16	16	16
Turns per inch	20	12	10	10	10	10	10
Resistance per foot of wire	3·5	·05	·03	·03	·03	·03	·03
Feet of wire	83	148	233	113	63	33	20

* This column refers to resistance used for closing the shunt before cutting off supply.

Fig. 2 represents a form which the writer has found convenient for recording the various results and furnishing instructions to the shop. It is filled in with figures for a case in which the maximum current allowed on first stud was 10 amperes.

"Resistance in circuit," No. 2 to No. 7, is the geometrical series.

"Resistance between studs" are simply the differences of the successive terms of the series.

"Turns per inch" refers to the number of turns of bare wire wound on an insulating former per inch length of such former.

To find the diameter and length of wire required, we must first consider the connection between diameter and current carried for a given rise of temperature in the wire.

This is evidently $C = K d^{\frac{3}{2}}$;
where C = current;
d = diameter of wire;
and K is a constant depending on the material and on the temperature allowable.

This is similar to the law of Preece's fuse table, the constant only being changed. The reason for it is briefly thus: for the temperature of the wire to remain steady the rate of production of heat must be equal to its rate of radiation.

Rate of production of heat in watts $= C^2 r = C^2 \frac{\rho l}{\frac{\pi}{4} d^2}$

Rate of radiation of heat $= T m l \pi d$;
ρ = specific resistance of material;
l = length of wire;

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d = diameter of wire;
T = excess temperature above surroundings;
m = constant depending on character of radiating surface.

$$C^2 \frac{\rho l}{\frac{\pi}{4} d^2} = T\, m\, l\, \pi\, d.$$

$$\therefore C^2 = \left(\frac{T\, m\, \pi^2}{4\rho}\right) d^3.$$

(Quantity in brackets is a constant for a given temperature.)

$$\therefore C = (K)\, d^{\frac{3}{2}}.$$

A table of values of $d^{\frac{3}{2}}$ for the gauges to be used is easily prepared by the use of logarithms. The value of K having been ascertained for any material, the current allowable in any size of wire can immediately be found. The value of K depends to a large extent upon the perfection of the ventilation of the containing box, and, of course, any variation of this condition must be allowed for. A list of approximate values is appended:

Material.	Values of K for starting purposes only.
German silver	From 1,000 to 1,500
Platinoid	,, 800 ,, 1,300
Eureka	,, 700 ,, 1,100
Iron (tinned)*	,, 1,100 ,, 2,000

* Common iron wire varies very considerably in its resistance properties.

Several makers of high-resistance wires provide tables of temperature rise and current carried by their wires.—F. O. HUNT.

Answer to No. 161 (*awarded* 5*s.*).—In calculating the resistance required for a motor-starting switch, it must be kept in view that the essential function of such a resistance is to prevent an unduly large current from passing through the motor armature. The resistance of the latter, except in very small sizes of motors (such as small fan motors, etc.) is a fraction of one ohm, which would allow a sufficiently large current to pass through the armature to burn out the coils, unless a resistance is placed in series with it. In calculating the value of this resistance, it is usual to assume that when the full resistance is placed directly across the mains upon which the motor is to work, a current equal to the full-load current required by the motor will pass. The resistance of the armature coils is so small as to be negligible in this calculation. From this we have the formula

$$R = \frac{E}{C} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where R is the required resistance in ohms, E is the working voltage, and C the maximum working current in amperes.

Now,
$$C = \frac{H.P. \times 746}{E} \quad . \quad . \quad . \quad . \quad (2)$$

where H.P. is the maximum working horse-power (brake) which the motor is able to exert. Substituting the above value of C in equation (1), we have

$$R = \frac{E^2}{H.P. \times 746}.$$

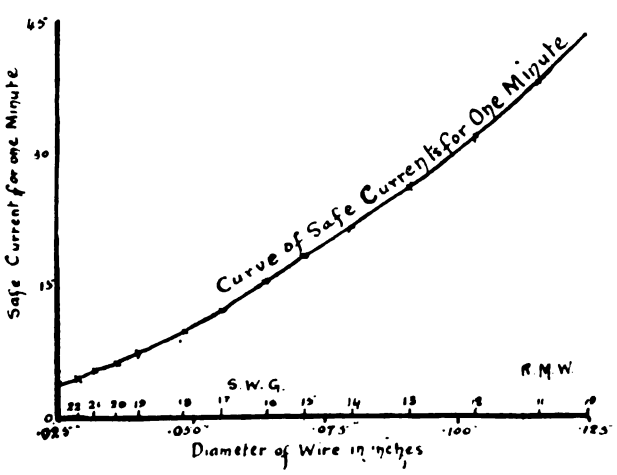
It is usual to assume 10 per cent. for losses in the motor, so that in practice the equation used is

$$R = \frac{E^2 \times 10}{H.P. \times 746 \times 11}, \text{ or } R = \frac{E^2}{H.P.} \times \cdot 001218.$$

This last equation gives at once the required resistance in ohms. To calculate the size of wire required it is first necessary to determine the material which is to be used for the resistance. Iron wire (annealed and tinned) and German-silver wire are both largely used in the manufacture of rheostats. The relation between the diameter of a conductor and the current it can safely carry without overheating is given by the following formula by W. H. Snell:

$$C^2 = D^3\, t\, \frac{\pi^2 H}{4 R \times \cdot 24},$$

where C is the current in amperes; D is the diameter of the wire in centimetres; t is the excess of temperature (in degrees Centigrade) of wire over the surrounding air; H is the coefficient of radiation and convection (= ·0003); and R is the specific resistance of the material at the maximum temperature. This, however, as a practical working formula is somewhat unwieldy, and the table and curve given below will be found much more useful. The data for the table and curve are given by Mr. P. M. Heldt



Annealed Iron Wire

in the *American Electrician*, and are from actual practice. The curve has been plotted from the table. For tinned iron wire the following values may be taken:

1 Size of wire, S.W.G.	2 Safe current for one minute.	3 Feet per ohm.
10	46·6	245
11	38·0	196·2
12	31·6	137·5
13	25·9	107·4
14	21·5	86·4
15	18·0	68·5
16	15·0	54·0
17	12·0	42·5
18	10·0	32·6
19	7·5	24·3
20	6·1	16·5
21	4·9	13·5
22	4·4	10·7

The specific resistance and conductivity of German silver varies considerably, as it is an alloy, but the most common quality of German silver has a specific resistance about 2·2 times that of copper, so that with the same rise of temperature a German-silver wire would carry about two-thirds the current carried by an iron wire of the same section. The feet per ohm for German-silver wire would be to the feet per ohm for iron wire of the same size as 6·46 is to 13·92, being in the inverse ratio of their relative resistances. To find the resistance and size of coils for a motor of a given horse-power, starting with the equation given previously, and finding the resistance in ohms, next find the size of wire necessary from Tables 2 and 1, and from Table 3 the length of wire required is at once found. Any currents greater than the maximum tabulated can easily be arranged for by combining two or more lengths, or two or more sizes in parallel.—R. M. W.

Question No. 162.—Discuss the advantages and disadvantages of earthing the neutral in a three-wire system of distribution (*a*) at the station only, (*b*) at various points in the supply area.

Best Answer to No. 162 (*awarded* 10*s.*).—In order to discuss this question we must find the formulæ which show how the potentials of the mains depend on their insulation resistances. In the figure let A, B, and C be the three mains, and x, y, z their insulation resistance respectively. Let V be the potential difference between A and B and between B and C, and let V_1, V_2, and V_3 be the potentials of the three mains.

Then $V_1 - V_2 = V$, and $V_2 - V_3 = V$ . . . (1)

Also since the *algebraical* sum of the currents meeting at 0 is zero,

$$\therefore \frac{V_1}{x} + \frac{V_2}{y} + \frac{V_3}{z} = 0.$$

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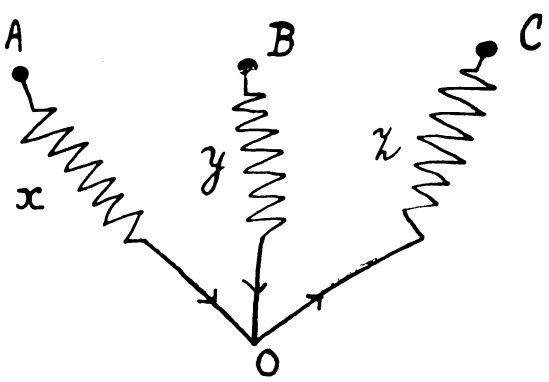
Hence from (1) $V_2 = \dfrac{\frac{1}{z} - \frac{1}{x}}{\frac{1}{x} + \frac{1}{y} + \frac{1}{z}} V$ . . . . . (2)

And $V_1 = V_2 + V$, and $V_3 = V_2 - V$ . . . (3)

Hence we have found the potential differences of the three mains in terms of their insulation resistances and the applied voltage.



The advantages and disadvantages of earthing the neutral wire will be best understood by considering a numerical example. Suppose that the insulation resistance of the main A and of the network in metallic connection with it be 100 ohms, of B 200 ohms, and of C 10 ohms, and that the potential difference between adjacent mains is 200 volts; then, applying formulæ (2) and (3), we find that

$$V_1 = 357,\ V_2 = 157,\ \text{and}\ V_3 = -43.$$

The power lost in leakage is $\frac{V_1^2}{x} + \frac{V_2^2}{y} + \frac{V_3^2}{z}$, and this is 1,583 watts. The maximum leakage current is from the negative main, and equals 4·3 amperes.

(*a*) Supposing now that we earthed the neutral at the station; then $V_1 = 200$, $V_2 = 0$, and $V_3 = -200$. The power lost in leakage is now 4,400 watts, and the maximum leakage current is 20 amperes. Hence in this case the immediate effect of earthing the neutral would be to nearly treble the power lost in the leakage paths, and nearly quintuple one of the leakage currents. The advantages in this case would be the reducing of the pressure between one of the outers and earth from 357 to 200, and thus greatly reducing the danger from shock and the risk of fire from accidental earth contacts on that main. The disadvantages in this case would be the losing of the good insulation resistance of the middle main, and thus trebling the power lost. The increased value of the leakage currents is also bad, as it might lead to disastrous electrolytic action in the gas and water mains, and hence make the supply company liable to heavy damages for compensation.

(*b*) In this case, $V_1 = 200$, $V_3 = -200$, and $V_2 = 0$, as before. In our solution we have neglected the copper resistance of the mains, and hence these values for the potentials are only approximate; the potential will obviously be higher near the station than further off. If we earth the middle wire at various points, then, as Mr. Wordingham has pointed out, we may have very large leakage currents from one earthed point to another, especially if the two sides of the three-wire system are not well balanced, and this ought to be avoided at all costs, owing to the dangers of electrolysis among the gas and water pipes.

The conclusion arrived at is therefore that (*b*) is always inadvisable, but that (*a*) is sometimes advisable if the potential of one of the outers is much higher than that of the other. It is interesting to note that if $x = z$ (see figure), then $V_2 = 0$, and hence earthing the middle wire at the station does not affect the working of the system in the slightest degree.—J. C. R.

Answer to No. 162 *(awarded* 5*s.).*—The insulation resistance of his distributing network is always a constant source of anxiety to the station engineer. No matter how much care has been taken in laying down the conductors, the end is inevitably the same sooner or later—a fault more or less serious will develop on one main. So long as the pressure between the outers did not materially exceed 200 volts, this fault on one or other of the mains was of little consequence to the consumer, who, even if the faulty main happened to be an outer, at the worst only received a somewhat disagreeable shock on inadvertently touching some part of the circuit connected to the main not in contact with earth, while he would probably be standing on a damp floor. Since, however, the Board of Trade raised the permissible pressure of supply to a consumer from 100 to 200 volts, and in some cases 250 volts, the consequences of a shock from the full pressure of the outers have assumed very grave proportions. Though it is quite impossible to definitely state what is the maximum voltage to which the human body may be subjected without fatal results, there cannot be the slightest doubt that under certain conditions this voltage is considerably below 500.

The question then arises, how to avoid the possibility of a consumer receiving the full pressure of the outers from an earth shock. Obviously the way to do this is to permanently connect the middle or neutral conductor of the system to earth, and thereby make it impossible for the difference of potential between any conductor and earth to exceed half that of the two outer mains. Though not included in the "revised regulations" lately issued, the writer believes that on more than one occasion this method of procedure has been strongly recommended by the Board of Trade, and there can be little doubt that before very long it will become compulsory. Having thus shown that for the safety of the consumer it is almost imperative that the middle wire be earthed, we will now consider the best method of doing this. There are practically two courses open. The first is to earth at the station only, and keep the middle wire insulated like the others; and the second is to earth the middle wire at various points in the network either by connecting to efficient earth-plates or else using an entirely uninsulated conductor. The first method has the following great advantages not possessed by the second: firstly, an ammeter included in the station earthing circuit affords a permanent indication of the condition of the insulation of the two outer mains; and secondly, if a suitably proportioned fuse is also included, then in the event of a serious earth developing on either of the other mains this fuse will blow and thereby avoid the disastrous consequences of a dead short on the mains which would inevitably follow if earthing plates were used all round the area or an uninsulated middle wire was used.

The second method has, however, advantages peculiar to itself, inasmuch as by earthing the middle wire at various points in the supply area, its potential is maintained practically at zero, and hence the tendency is to preserve a better balance on the three-wire system by eliminating the drop in the middle wire. This is, however, in itself likely to cause most serious trouble by the electrolysis of pipes, etc., owing to stray currents flowing from one earthing point to another, a result which obviously cannot obtain if the main is only earthed at one point. If to this trouble is added the fact that no check whatever can be kept on the current flowing to earth, the advantages to be gained by the second method are, in the writer's opinion, far outweighed by the disadvantages which necessarily accrue. It would, of course, be far better not to earth the mains at all, but to keep the insulation of all three as perfect as possible were it not for reasons pointed out at the commencement. The mere fact of earthing one main permanently throws a far greater strain on the insulation of the other two, but if the first method is adopted of earthing through an ammeter and fuse, the disadvantages are reduced to a minimum.—A. A.

Answer to No. 162 (*awarded* 5*s.*).—The general objection to earthing the neutral in a three-wire system, whether within a station or without, is that the first step towards a direct short to earth has been purposely made. Looked at in one way, an earth connection is a fault in the insulation, and if a second fault occur, whether in another wire, or at another point in the same wire at different potential from the first, a current will flow, and the least that can happen is a loss of energy. For this reason it has been usual to insulate dynamo and motor, frames included, as completely

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as possible from earth. On the other hand, earthing any part of a system limits the potential to which every other part may rise above earth to the maximum potential which can be developed by the generator. Before earthing, the only limit was the greatest electrical strain to which the weakest part of the insulation could be subjected without giving way. Hence, in the first case there is hardly any possibility of the potential above earth rising to such an extent as to break down the insulation if the workmanship is good. The only probable cause of a second earth would be due to accident or deterioration. For this reason it is now becoming customary to earth one conductor in high-tension work, in order to fix the maximum strain to be put on insulation in the machines, switchboard, etc. Suppose the neutral to be earthed at the station. It does not necessarily follow that every part of the neutral wire is at earth potential, for owing to the resistance of the copper and the load on the conductor there may be a 2 or 3 per cent. voltage drop from its further end to the station. Hence, if the further end were also earthed, there would be an earth current between the two points due to a potential difference of, say, five volts, with the attendant evils of corrosion and complaints from the gas and water people. The same holds good with the proposal of earthing at various points in the supply area, only that with a network the resistance between any two points, and the consequent maximum potential difference, can only be predetermined with great difficulty. The only way to make system (*b*) successful is to carry it to excess—*i.e.*, to peg the volts down to earth, so to speak, at such frequent intervals that the whole line is at earth potential. The expense of this method would be out of proportion to the result obtained. The best way to earth the neutral is to do so at the station, and to so keep up the standard of insulation of feeders and installation that nothing short of an accident will cause a second earth. A maximum current indicator fixed between the wire and earth at the station will, in addition to limiting the maximum potential above earth at any part of the line, indicate the maximum leakage that has taken place during any period, and show at once when any important loss of energy takes place.—J. A. S.

HAMMERSMITH ELECTRIC LIGHTING ACCOUNTS.

From the above accounts it appears that the total expenditure on capital account up to March 25, 1899, has been £72,425. 11s. 6d., of which £32,811. 3s. 9d. has been expended during the past year. The report of Mr. G. G. Bell, the engineer, on the year's working of the electricity department appeared in our last issue. We give herewith the general balance-sheet, revenue account, and statement of electricity generated, sold, etc. :

BALANCE SHEET.

Liabilities.	£	s.	d.
Capital account—London County Council mortgages	64 759	0	0
Temporary advance from loan account	5,764	11	6
Revenue account—Sundry creditors:			
Interest and repayment of principal on mortgage debt, balance £1 718 18 6			
Creditors on open accounts 1 116 14 3			
Deposits re installations 23 4 0			
	2,858	16	9
Net revenue—balance as per preceding account 720 15 1			
Add surplus on capital account, being the amount of loans paid off out of revenue 1,902 0 0			
	2,622	15	1
	£76,005	3	4

Assets.	£	s.	d.
Capital account—amount expended for works	72,425	11	6
Revenue account—Sundry debtors for current supplied: Private lighting 2,416 5 0			
Public lighting 489 7 6			
2,905 12 6			
Ditto on open accounts 227 14 10			
	3,133	7	4
Stores in hand	123	19	9
Cash at bankers—on revenue account	322	4	9
	£76,005	3	4

REVENUE ACCOUNT.

Dr. Generation of Electricity.				£	s.	d.
Coal, including carriage	£2,206	15	11			
Oil, waste, water, and engine-room stores	431	3	1			
Wages at generating station	959	12	0			
Repairs and maintenance—viz.: buildings, £4. 6s. 1d.; engines, boilers, etc., £98. 13s. 6d.; dynamos, exciters, etc., £27. 13s.; other machinery, instruments, tools, etc., £7. 11s. 8d.	138	4	3			
	3,735	15	3			
Less penalties deducted under contract	215	3	0			
				3,520	12	3
Distribution of Electricity.						
Wages to linesmen, fitters, etc.	242	5	11			
Repairs, renewals etc., of mains	31	16	3			
Repairs of meters, switches, etc., on consumers' premises	40	5	9			
Repairs of apparatus at distributing stations	24	6	11			
				338	14	10
Public Lamps.						
Wages	197	0	4			
Carbons, arc lamps, etc.	190	4	8			
				387	5	0
Rates and taxes				499	7	11
Management Expenses.						
Engineer's salary	250	0	0			
Clerk's and office cleaner's ditto	109	16	3			
Stationery and printing	62	19	4			
Advertisements	14	4	7			
General establishment charges	111	4	10			
				548	5	0
Special charges—insurance				189	15	0
				5,484	0	0
Balance forward to net revenue account				3,749	5	3
				£9,233	5	3

Cr. Private Lighting.	£	s.	d.
Sale of current	7,174	14	5
Sales by contract	6	15	0
Charges for attending private lamps	39	6	8
Public lighting	1,957	10	0
Work done and sale of apparatus, £33. 2s. 11d.; damages to lamps, etc., recovered, £21. 16s. 3d.	54	19	2
	£9,233	5	3

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated (in Board of Trade units)		723,354
Quantity sold: Public lamps	145,438	517,629
Quantity sold: Private consumers (by meter)	372,191	
Quantity used on works		37,834
Total quantity accounted for		555 412
Quantity not accounted for		167,942
Number of public lamps		87
Total maximum supply demanded (kilowatts)		501

LEGAL INTELLIGENCE.

ELECTRIC BARGES ON THE MERSEY.

In the Queen's Bench Division before Mr. Justice Mathew, sitting without a jury, Messrs. Tudors, Mash, and Co. brought an action against Headland's Patent Electric Storage Battery Company, Limited (Walkers, Parker, and Co., third parties), to recover £75. 5s. 6d. for goods sold and delivered.

Mr. Fletcher Moulton, Q.C., M.P., and Mr Peile were for the plaintiffs; and Mr. Arthur O'Connor, Q.C., M.P., and Mr. Eldridge were for the defendants; and Mr. Robson, Q.C., and Mr. Haldenstein were for Messrs. Walkers, Parker, and Co.

The plaintiffs' claim was admitted, but defendants counterclaimed for damages. Their case was that plaintiffs had supplied eight casks of red lead and ten casks of powdered litharge. The latter was required for the electric storage batteries for electric barges, and therefore should be of the best quality. An experimental trial of the barges proved unsatisfactory, and this, it was alleged, was due to the inferior quality of the litharge. A large number of plates for the electric storage batteries which had been packed with the litharge and red lead had been spoiled and rendered useless. Defendants counterclaimed special damage to the amount of £500. Plaintiffs denied that they had any knowledge of the purpose for which the litharge was required, or that it was of inferior quality, and in this they were confirmed by Messrs. Walker, the third parties.

His Lordship reserved judgment.

THEFT AT AN ELECTRIC LIGHT WORKS.

At the Portsmouth Police-court on Wednesday, before Messrs. A. W. White and B. Bramble, Ed. Sly, 33, a labourer, employed in the borough electric light station, Gunwharf-road, was charged

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with stealing 63ft. of British Insulated twin cable and 56lb. of scrap metal, of the value together of £1. 1s. 6d.

Mr. G. Hall King prosecuted, and Mr. A. Wallis White appeared for the defence.

Evidence was given to the effect that the property was found in a shed at the back of prisoner's house.

Mr. Price, the superintendent of the electric light works, said that the prisoner was a good workman, and they had had no other cause of complaint against him.

The **Chairman** said that the prisoner had lost his billet and his character, and that was in itself a considerable punishment. It being a first offence, he would be fined 10s. only. The fine was paid.

ELECTRIC INCUBATOR'S COUNTY COURT ACTION.

At the St. Helens County Court last week, before his Honour Judge Collie, an action was brought by Peter Tickle, builder, St. Helens, against Robert Pownall, watchmaker, St. Helens and Widnes, for £4. 0s. 10d., balance due for work done.

Mr. W. Webster, for plaintiff, said that when defendant went to live at Sutton he was struck with the idea that he could make money out of electric chicken incubators. Plaintiff performed certain work in regard to these, and had received £3 on account.

For the defence **Mr. Riley** contended that the plaintiff contracted to do the work for £3, and therefore was of the opinion that he had discharged his liability.

His **Honour** gave judgment for the amount claimed, with costs. *Liverpool Courier.*

COMPANIES' MEETINGS AND REPORTS.

CALCUTTA ELECTRIC SUPPLY CORPORATION, LIMITED.

The annual general meeting was held at the Cannon-street Hotel on the 12th inst.

Colonel A J. Filgate, who presided, said that the central station was nearly completed by the end of December, and it was reported that all the machinery had arrived in good order, and that its erection had been carried out satisfactorily. When the works were started on the 17th ult. there were 3½ miles of underground mains and 10 miles of overhead mains in operation. The total length of sanctioned mains at the present time was about 7⅛ miles underground and 17 miles overhead. There were still two 360-i.h.p. steam sets under construction in England; one of these would be ready for shipment very shortly. Although the Company would probably be able to meet all demands on their system in the immediate future, judging from the probable extensive use of fans in place of punkahs, an extension of the plant might be necessary at an early date. They were still negotiating with the Calcutta Municipality for lighting certain streets, and their tender to the Government for lighting Fort William was under consideration. An equivalent of 2,000 lamps had been applied for for private lighting and power, and many residents were only waiting to see the light in use before adopting it. The Company's consulting engineer, Mr. Crompton, had been to Calcutta, and had returned greatly impressed with the prospects of the undertaking and the manner in which the works had been carried out. Mr. Crompton had gone into the question of the promise made by the Government to renew the license at the expiration of the first 21 years with the Viceroy and the Lieutenant Governor of Bengal, and he (the chairman) had every hope that this question was in fair train for satisfactory disposal at no distant date.

Sir G. L. Molesworth seconded the motion, which was carried unanimously.

GIFFRE ELECTRO-CHEMICAL AND POWER COMPANY, LIMITED.

The first general statutory meeting of this Company was held on Wednesday at the offices of the Company.

Mr. E. E. Sawyer, chairman of the Company, who presided, said that last Saturday he saw the four turbines and four dynamos, representing 4,000 e.h.p., and seven furnaces at work (one of the latter being of 1,000 e.h.p.), and they could now reckon upon turning out not less than 50 tons of carbide a week. In August another 2,000 e.h.p. and in January next year a further 2 000 e.h.p. would be added, thus doubling the present output

A vote of thanks to the chairman concluded the meeting.

LONDON PLATINO-BRAZILIAN TELEGRAPH COMPANY, LIMITED.

At the twenty-first ordinary general meeting, Mr. W. S. Andrews presiding, the total earnings for the year 1898 were stated as £36,288, showing an increase of £11,104 as compared with the previous year. The total expenses had been £8,312, an increase of £1,405. Including the sum brought forward from 1897 and after providing for income tax, the balance to the credit of revenue account was £28,540. From this had been deducted £6 000 for debenture interest and £10,325 for an interim dividend of 5s. 6d. per share in respect of the half-year ended June 30 last. After placing £6,539 to the reserve fund, there remained £6,675. The directors recommended a final dividend of 1s. 6d. per share, making 3½ per cent. for the year, and leaving £2,859 to be carried forward. The report was unanimously adopted.

REUTER'S TELEGRAM COMPANY, LIMITED.

The report of this Company for the past year states that the net profits for the year ended Dec. 31, after payment of current charges and deducting rebate on unexpired subscriptions, amount to £6 624, including £411 brought forward. The directors propose a dividend of 8s. per share, equal to 5 per cent., tax free, for the year. This will absorb £4,994, and after adding £1,000 to reserve there will remain a balance of £29 to be carried forward. - *The Times.*

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Taunton—The Corporation invite tenders for various plant by June 1.

Dudley.—Tenders are required for boilers, dynamos, cables, and lamps by June 17.

Madrid—The Public Works Department invite tenders for electric tramways for Madrid. Tenders by June 14.

Sappemeer (Holland).—The Municipality invite tenders for the erection of central electric lighting station by June 1

Madrid.—The Post and Telegraph Department require 26,000 2in. cylinders for electric batteries. Tenders by June 13.

Paris.—The Post and Telegraph Department, Rue de Grenelle, 103, invite tenders for 240,000 porcelain insulators by May 25.

Lisbon.—The Mozambique Company will receive at their offices in Lisbon tenders for the erection of electricity works by July 10.

Southampton—The Corporation invite tenders for motorcars and equipment and electrical equipment of lines. Tenders before noon on June 5.

Birkenhead.—The Corporation invite tenders for 100 electricity meters by 26th inst; also a 225-kw. direct-current high-speed steam dynamo by June 9.

Medina Sidonia (Province of Cadiz, Spain).—The Municipal Authorities invite tenders for an electric light installation for public lighting by June 2.

Beira (East Africa).—The Colonial Office at Lisbon invites tenders for construction and working of electric lighting and telephones in Beira by July 8.

Carlisle.—The Town Council invite tenders for rewiring, etc., the public library, art gallery, etc., buildings for the purpose of lighting the same with electricity.

Hackney.—The Electric Lighting Committee of the Vestry invite tenders for trenching, troughing, cables, joint-boxes and jointing, and house services, by June 13.

St. Pancras.—The Vestry are prepared to receive tenders for supplying about 22 miles of lead-covered armoured cables of various sizes. Tenders by 12 noon on 23rd inst.

Darlington.—The Corporation invite tenders for the supply and delivery of various plant, together with the fixing of the same at their electric generating station. Tenders by May 30.

Madrid.—The Post and Telegraph Department invite tenders for 16 tons of copper vitriol, estimated at 820 pesetas per ton (about £30 to £32) A deposit of 5 per cent. is required. Tenders by June 3.

London.—The Asylums Committee of the London County Council invite tenders for the installation of telephones, fire-alarms, tell-tale clocks and call bells at the Heath Asylum, Bexley, Kent, by May 31.

Wimbledon.—The Urban District Council invite tenders for 425 yards of 2ft. gauge tramlines and six tip wagons. Copy of plans can be had on application to Mr. H. C. Cooper, M.I.C.E., Council Offices, Wimbledon. Tenders by noon on 29th inst.

Tarifa (Spain).—Tenders are invited for public electric light installation, and working of the same for 20 years. The deposit required is 5 per cent. of the tender. Specifications, etc., are to be obtained from, and tenders addressed to, the Syndaco, Tarifa, Spain.

Brighton—The Town Council invite tenders for the supply of auxiliary switchboards and switchboard gallery at the Corporation electricity works. Specifications, etc., may be obtained from Mr. Francis J. Tillstone, Town Hall, Brighton. Tenders by 10 a.m. on 29th inst.

Russia—The Secretary of State for Foreign Affairs has received a dispatch from her Majesty's Consul at Taganrog, stating that tenders are invited by the Municipality of Kertch for the supply of materials for the construction of electric lighting plant and tramways in that town.

Teneriffe.—Tenders are invited for the erection and working of an electric tramway between Santa Cruz and San Cristobal. The deposit required is about 776 214 pesetas (about £350). Specifications, etc., are to be obtained from, and tenders addressed to, Public Works Department, Madrid, by 1 p.m. on June 14.

Halifax.—The Guardians invite tenders for the electric lighting of the workhouse and union offices from the Corporation mains. Plans and specifications may be obtained from Messrs. Shepherd

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and Watney, Greek-street-chambers, Leeds, on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders by noon on June 8.

Plymouth.—Tenders are invited for coal-conveying plant at the electricity works, Prince Rock, Plymouth, capable of conveying small steam coal from vessels lying at wharf into stores about 190ft. distant. Particulars of requirements may be obtained from Mr. John H. Rider, borough electrical engineer, East street, Plymouth. Tenders by 24th inst.

Islington.—The Guardians invite tenders for the installation of the electric light at the new infirmary for the parish at Highgate-hill, Upper Holloway. Particulars may be obtained from Mr. William Smith, architect, 65, Chancery-lane, W.C., up to May 20 upon depositing £5, which will be returned on receipt of a bona fide tender. Tenders by June 1.

Patricroft.—The Guardians of Barton-upon-Irwell Union invite tenders for the wiring, with lamps and fittings, of their new infirmary buildings, Green-lane, Patricroft. Specifications, etc, can be obtained from Mr. G. R. Peers, A.I.E.E., 96, Deansgate, Manchester, upon deposit of a cheque for £3. 3s., which will be returned on receipt of a bona fide tender. Tenders by June 6.

Darlington.—The Corporation invite tenders for the various works required to be executed in the erection of buildings to be used as an electric lighting station in the borough. Specifications, etc., may be obtained on payment of £2 2s. (which sum will be returned on receipt of a bona fide tender), from the Borough Surveyor, Town Hall, Darlington, on and after 15th inst. Tenders by 30th inst.

London.—The Guardians of St. Mary, Islington, invite tenders for works of installation of the electric light at the new infirmary for the parish at Highgate-hill, Upper Holloway. Specifications, etc., may be obtained from Mr. William Smith, architect, 65, Chancery-lane, W.C., up to 20th inst. upon depositing £5, which will be returned upon receipt of a bona fide tender. Tenders by 11 a.m. on June 1.

Enniskillen.—The Urban District Council invite tenders for supplying and fitting up gas-engine, dynamo, and complete electric light installation for lighting New Town Hall, Enniskillen. Specifications can be seen at the office of Messrs. Anthony Scott. M.S.A., and Wm. A. Scott, A.R.I B.A., architects, 16, William-street, Drogheda. or at the Town Clerk's Office, Enniskillen. Tenders by 12 noon on 22nd inst.

Sheffield.—The Health Committee invite tenders for the supply and erection of engines, electric lighting plant, pumps shafting, pulleys, and other engineering work required at the destructor, Lumley-street, Attercliffe, Sheffield. Specifications, etc., may be obtained at the office of Mr. Charles F. Wike, C.E , city surveyor, Town Hall, Sheffield, on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders by June 5.

Crewe.—The Corporation invite tenders for supply of boilers and economisers, engines and dynamos, centrifugal pump and motor, mains, battery, switchboard, travelling crane. Specifications, etc., may be obtained from the Borough Engineer, Crewe, or from the engineers, Messrs Hopkinson and Talbot, 26, Victoria-street, London, S.W., and 29, Princess-street, Manchester, on payment of £2. 2s., which will be returned on receipt of a bona fide tender. Tenders by June 1.

Prestwich.—The Committee of Visitors of the Prestwich County Lunatic Asylum invite tenders for steam-pipes, condensers and cooling tower, steam dynamos for 274 kw., mains, switchboards, storage batteries, and wiring for an electric light installation. Firms desiring to tender are directed to send their names, with a statement of the parts of the work they desire to quote for, to Mr. Charles Hopkinson, M.I.C.E., 29, Princess-street, Manchester: or to Messrs. Hopkinsons and Talbot, 26, Victoria-street, London, S.W. They will then be informed when the specifications are ready for issue.

London S.W.—The Vestry of St. Mary, Battersea, invite tenders for the supply and erection and the carrying out of work in connection with the electric lighting of the parish to specifications as follows: (Specification No. 1) feeders, distributing mains, and arc light leads, including laying and jointing; (2) water-tube boilers; (3) steam dynamos and engines. Specifications, etc., may be obtained from the Vestry Clerk, at the Municipal Buildings, Lavender hill, S.W., on payment of £3. 3s. for each specification, etc., which sum will be returned after the receipt of the specification, etc., accompanied by a bona fide tender. Specifications and drawings can also be seen at (but not obtained from) the office of Prof. Alex. B. W. Kennedy, 17, Victoria-street, Westminster. Tenders by 12 noon on June 7.

RESULTS OF TENDERS.

Carlisle.—The Town Council have accepted the tender of the British Illuminating Company for wiring the electric lighting station for £118.

Wimbledon.—The Urban District Council have accepted the tender of Messrs. Gerald Berners and Co. for lighting the sewage farm and pumping station.

Bradford.—The Corporation have accepted the tender of the Electrical Power Storage Company, Limited, for a storage battery similar to the one supplied by that company to the Liverpool Corporation for their trams.

Bootle.—The tender of Messrs. Thomas Parker, Limited, Wolverhampton, has been accepted for supplying and fitting a gantry, with handrailing on both sides, across the boilers at the electric light station, for the sum of £39. 15s.

Huddersfield.—The Corporation have accepted the following tenders for steel tramway rails (girder section), fishplates, soleplates, tie-bars, and bolts: Leeds Steelworks, Limited, Leeds, rails. fishplates, and soleplates; Askham Bros. and Wilson, Limited, Sheffield, bolts and tie-rods.

Harrogate.—The Council have ordered from Mr. James Pitkin Clerkenwell, a recording voltmeter to register the variation of pressure in any district for £14. 14s., less 10 per cent., and have accepted the tender of Mr. J. Ritchie, Middlesbrough, for 60 tons of 3in. piping for trunk mains at £5. 11s. 9d. per ton.

Derby.—The Town Council have accepted the tender of Mr. Hy. Vernon (£2 030. 8s. 8d.) for excavating and building the foundations of extensions to the engine-house, boiler-house, and retaining wall at the electric lighting station, and the contract for transformers has been awarded on a schedule of prices for one year to the Electric Construction Company, Limited.

London, S.W.—The following tenders have been received for decorative, sanitary, and electric light works at 38, Nevern-square, Earl's Court, South Kensington:

Heath	£256
Holdstock	239
Whitaker (accepted)	231

London, S.W.—The following tenders have been received for decorations and electric light at 24, Nevern-square, and decorations at 25, Nevern-square, Earl's Court, South Kensington:

Rugg	£612
Holdstock	556
Whitaker	537
Oldrey, North Kensington (accepted)	501

Southampton.—The Corporation have received the following tenders for electric lighting, wiring, and fittings for the Municipal Lodging House:

F. Shalders (recommended for acceptance)	£286 0 0
W. J. Fryer and Co., Limited, London	287 15 0
McAulay, Clark, and McLaren, Glasgow	310 0 0
McAulay, Clark, and McLaren	340 7 6
Roger Dawson, London	331 10 0
E. T. Fiford and Sons	339 0 0

Burton.—The Town Council have accepted the tender of Messrs. John Fowler and Co. (Leeds), Limited, for the alterations and additions required for the switchboard to accommodate the new machinery at the sum of £163, exclusive of fixing, and the tender of Messrs. E. Green and Son, of Wakefield, for economisers for heating the feed water of the electric light new boilers, at the sum of £224, including fixing. They have also agreed that the Manchester Steam Users' Association be instructed to examine and test the three new boilers for the electric light works upon the terms specified in their scale of charges.

Southampton.—The Corporation have received the following tenders for the reconstruction of about 1¾ miles of tramway on the Shirley route:

Krauss and Son, Lawrence-hill, Bristol (accepted)	£8,352 0 0
W. Meredith, Gloucester	8 356 8 11
F. Osman, Southampton	8,992 0 0
W. Griffiths, London	9,976 10 1
H. W. Bull, Southampton	10,870 0 0
J. Fell, Leamington	11,369 5 0
Dick, Kerr, and Co., London	14,568 5 8

West Ham.—The County Borough Council have received the following tenders for two 1,500 i.h.p. engines, two 800-kw. alternators and exciters, or two 800 kw. 1,500-i.h.p. steam alternators and exciters:

Engines and alternators.	
C. A. Parsons and Co., turbo alternators	£12,844 0 0
S. Z de Ferranti, own engines and alternators (1,500 i.h.p. and 800 kw.)	15,900 0 0
Brush Electrical Engineering Company, Limited, own engines and alternators	17,000 0 0
British Schuckert Company, Belliss engines and own alternators	17,664 0 0
British Schuckert Company, McLaren engines and own alternators	18,357 0 0
Siemens Bros. and Co., Belliss engines and own alternators	18,740 0 0
S. Z. de Ferranti, Limited, own engines and alternators (2,000 i.h.p. and 1,200 kw. (accepted)	19,000 0 0
Thames Ironworks, Limited, own engines and alternators	21,000 0 0
Siemens Bros. and Co., McLaren engines and own alternators	21,320 0 0
J. Fowler and Co., Belliss engines and own alternators	23,148 0 0
Engines only.	
W. H. Allen, Son, and Co	8 600 0 0
Bever, Dorling, and Co	9,880 0 0
Blackwell and Co.	10,706 1 0
E. Chester and Co.	10,273 0 0
J. and H. McLaren	11,300 0 0
F. Nell	12,240 0 0
E. Chester and Co	13,000 0 0
T. Adamson and Co.	13,900 0 0
Alternators only.	
Fuller Wenstrom Electrical Manufacturing Company	5,480 0 0
Helios Elektricitäts Aktiengesellschaft	6,800 0 0
T. Richardson and Co.	8,400 0 0

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London, W.—The following tenders for erection of the buildings upon land adjoining the present electric lighting station have been referred to the Electricity and Lighting Committee for report:

Spencer and Co., Earl-street, Westminster, S W....	£10,740	0	0
Nightingale, Albert Works, Albert-embankment, S.E.	10 375	0	0
G. Lyford, 266, Uxbridge-road, W.	11,927	13	4
Hockley and Son, Grantham and Kensington.....	10,750	0	0
Chessum and Sons, Crown Works, 283, Kingsland-road	10,614	0	0
Minter, Ferry Works, Johnson-street, Westminster	11,958	0	0
Martin, Wells, and Co., 25, Auckland-street, Vauxhall, S.E.	10,199	0	0
Marney, Progress-walk Wharf, Notting Hill, W. ...	10.670	0	0
R. M. Heywood, 44, Bridge-road, Hammersmith ..	9,351	0	0

BUSINESS NOTES.

Walsall.—The total number of consumers supplied on April 30 last was 141.

Ayr.—The Town Council have agreed to borrow an additional sum of £1,750 for electric lighting.

Ilkeston.—The Bill confirming the Ilkeston electric lighting order has passed the examiners of private Bills in the House of Commons.

Chatham.—Local tradesmen are to be given the opportunity of giving estimates and designs for electrical fittings for the town hall buildings.

Kensington.—The Board of Trade have now definitely decided not to proceed with the Kensington Vestry's electric lighting provisional order.

Chester.—The Town Council on Wednesday authorised the extension of the electric light mains to Hough Green and Curzon-park, at a cost of £3 500.

South Shields.—At a meeting of the Town Improvements Committee it was decided to substitute the electric light for gas in the lighting of a number of streets.

Tewkesbury.—At Monday's meeting of the Urban District Council notice was given of an intended application for a provisional order relating to electric lighting.

Birkenhead.—At the meeting of the Town Council on Wednesday it was stated that the electric lighting estate was no longer a burden on the rates of the borough.

Cheaper Telephones.—The National Telephone Company are about to establish a uniform rate of £10 per instrument per annum for the whole of the county of London.

North Metropolitan Electrical Power Distribution Company, Limited.—This Company has been registered with a capital of £50,000 in £10 shares (2,500 preference).

Halifax.—The Board of Trade have intimated that the inspection of the completed line of tramways running up the side of Savile Park will be made on Thursday next.

Blackpool.—The number of electric tramcars running between Blackpool and Fleetwood is to be increased during the ensuing summer to 36. Last year there were only 10 cars in use.

Heckmondwike.—At a ratepayers' meeting in Heckmondwike the District Council's electric lighting scheme, prepared by Mr. Hawtayne, consulting electrical engineer, was approved.

Bootle.—The Corporation have decided not to incur any further expenditure in electric lighting until a report on the comparative cost of electric, gas, and incandescent lighting has been procured.

Stretford.—The chairman of the District Council has been appointed chairman, and Mr. Philip Estcourt deputy-chairman, of the Electric Lighting and Tramways Committee for the ensuing year.

Teddington.—In consequence of the joint opposition of Teddington and Twickenham, the application for a provisional order to light Teddington by electricity will not be proceeded with.

Dublin.—With reference to the application of the Corporation for loans for electric lighting purposes, amounting to £20,000 and £7,000, the Local Government Board have sanctioned a loan of £24,000.

Brighton.—The expense of the Continental tour of the Tramways Committee of the Town Council for the purpose of inspecting foreign systems of tramways is officially stated at £154. 18s. 10d.

Burton.—The Town Council have resolved that the electric mains be for the present extended from the Borough-road along Derby-street as far as the premises of Truman, Hanbury, Buxton, and Co., Limited.

Crewe.—The Town Council have received official intimation from the Local Government Board that the order, after enquiry by the Light Railway Commissioners, for the construction of light railways or tramways at Crewe has been withdrawn.

Lytham.—It is reported with regard to the lighting of Lytham by electricity that so far the necessary particulars have not yet been ascertained. Tenders are to be invited for the erection of a destructor on the principle of one inspected at Rochdale.

Whitefield.—Mr C. Bleakley has been appointed chairman of the Electricity Committee. A committee is to confer with the Bury Corporation upon their offer to sell or lease the Whitefield section of their tramways order after the same has been granted.

County of Surrey Electrical Power Distribution Company, Limited.—This Company has been registered with a capital of £50,000 in £10 shares (2,500 preference).

Colwyn Bay.—Mr. S. V. Clirehugh has been instructed to complete the drawings and estimates for the Local Government Board for the erection of a temporary building adjoining the generating station, having an iron chimney 80ft. high and a diameter of 4ft. 6in.

Blackpool Improvement Bill.—The Police and Sanitary Committee of the House of Commons have adjourned until June 1 the consideration of the Blackpool Improvement Bill, the object of which is the construction of further parade works, tramways, etc.

Buenos Ayres Electric Tramway, Limited.—This Company has been registered, with a capital of £300,000 in £5 shares (35,000 6 per cent. cumulative preference), to adopt an agreement with Mr. C. Bright, and to carry on business as carriers, tramway and light railway proprietors, electricians, etc.

Maidenhead.—At the poll taken on the electric lighting question on Friday last, 440 votes were recorded. Of these 310 were in favour of the Corporation undertaking the electric lighting, and 118 were in favour of its being undertaken by a private trading company, and there were 12 spoilt papers.

Southwark.—At a meeting of the St. Saviour's Board of Works on Wednesday last, it was agreed to inform the London County Council that the Board approved an extension of the tramways from Stamford-street over Blackfriars Bridge, but did not approve a proposed extension of the tramlines along Borough High-street.

Lowestoft.—The residents in South Lowestoft strongly object to the route which the proposed electric railway is to take as laid down by the draft order. The Council are conferring with the Drake and Gorham Electric Power and Traction Company, Limited, with reference to the plan of the Upper High-street widening.

Batley.—At a recent meeting of the Tradesmen's Association it was resolved that the Corporation should be approached, and urged that while they were putting down an electric plant, they should provide sufficient power to run electric trams, so as to provide communication between the outside districts and the centre of the town.

Plymouth.—The Chairman of the Tramways Committee said at the last meeting of the Borough Council that he hoped to recommence the summer service to West Hoe almost immediately. Attention was drawn to the deficient lighting of Athenæum-street, and the Chairman of the Electric Lighting Committee promised to give the matter attention.

Limerick.—A special meeting of the Town Council will be called, at which a memorial of the Limerick Electric Tramways Company will be fully discussed and a conclusion arrived at. On the request of the Telephone Company of Ireland, the Corporation have passed a resolution asking the postal authorities to extend the telephone trunk system.

Westgate and Birchington.—The Board of Trade have issued a provisional order to the Isle of Thanet Light Railways (Electric) Company, Limited, of 7, Poultry, London, E.C., authorising them to supply electrical energy for public and private purposes within the parishes of Westgate-on-Sea and Birchington-on-Sea, in the rural district of the Isle of Thanet.

Messrs. P. R. Jackson and Co's Catalogue.—We regret to see that when reviewing this excellent catalogue we omitted to state that the electrical portion was compiled and written by Mr. Walter F. Jones, A.M.I.E.E., M.I.M.E. We are sure that the firm in question could not have selected a more qualified collaborator in the preparation of their catalogue.

Kingswinford.—It is reported that the British Electric Traction Company hope to start their Kinver tramways within the next few weeks. This line will connect Kingswinford with Dudley and Stourbridge by junctions with the existing tramway between those two towns. The Board of Trade have only just given their final approval to the Kingswinford scheme.

Portrush.—At a special meeting of the Urban Council last week the following resolution was adopted: "That the Portrush, Giant's Causeway, and Bush Valley Railway and Tramway Company, within 14 days from service of notice, be required to have removed all the poles erected for the purpose of overhead electric traction between the tramway depôt and the railway station."

Wolverhampton.—The annual report of the Wolverhampton Chamber of Commerce, laid before the members on Wednesday, contains the following paragraph: The electrical trades in Wolverhampton are still employing their full complement of men, and have a plentiful supply of orders in hand. There is great activity in the application of electricity to tramway and railway work.

Maxim Electrical and Engineering Export Company, Limited. This Company has been registered with a capital of £100,000 in £1 shares, and the object is to act as agents for the sale in Australia, Africa, Asia, or elsewhere of all goods manufactured by the Hiram S. Maxim Electrical Corporation, Limited, or by J. F. Peace and Co., Limited, and to carry on the business of electricians, etc.

Leatherhead.—The draft circular to the ratepayers on the subject of the electric lighting was read at the last meeting of the Council, and it was resolved that, previous to any circular being sent out, a canvass of the persons living in North-street, Church-street, Bridge-street, and High-street be taken to ascertain whether they would use the electric light if the Council carried out the work.

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Liversedge.—A resolution supporting (under certain conditions) the tramway scheme of the British Electric Traction Company has been rescinded. The District Council intend to join in the combination of the Dewsbury Corporation and the Cleckheaton and Heckmondwike District Councils, which has in view the providing of a tramway from Dewsbury through the Spen Valley.

Fire.—The London firemen were called recently to the property of the London Electric Supply Corporation, Limited, in a railway arch under the South-Eastern Railway in Southwark Park-road. It was found that a short-circuit of electric wires had resulted in the ignition of a switch-box and a quantity of fittings, and the blaze was for a short time alarming, but it was fortunately soon overcome.

Canterbury.—The gas contract for lighting the portion of the city included in the present electric lighting area will terminate on June 25. On that date the standards for the incandescent electric light, numbering about 170, are expected to be in position, and these lamps will then be brought into use. The lamps are 16 c.p., or equal to those of the gas lamps displaced, but they will be placed closer to each other.

Bury.—The Electric Lighting Committee have resolved to support the Municipal Electrical Association in their application to the Board of Trade to insert a clause in the regulations relieving undertakers of their obligations to supply under certain conditions except on the terms mentioned. The engineer is to present a report to the next meeting in reference to the lighting of the Whitefield district with electricity.

Personal.—Mr. A. A. Campbell Swinton has joined the Board of the Cambridge Electric Supply Company, Limited.—We are informed that Mr. H. W. Clayden has resigned his post as electrical engineer at Morley, having accepted an appointment on the staff of Mr Robert Hammond in London.—The Vestry of Hampstead have appointed Mr. Leadbeater, the senior assistant engineer, to the post of chief indoor assistant.

Shrewsbury.—At the last quarterly meeting of the Town Council the Town Clerk read a letter from the secretary of the gas company stating that, as the Corporation had undertaken the public and private lighting of the town by electricity, the company were desirous of terminating their present agreement with the Council, and entering into a new arrangement. The matter was referred to the Lighting Committee.

Eccles.—At the last meeting of the Town Council it was asked in connection with the minutes of the Town Hall and Electric Lighting Committee what likelihood there was of the whole scheme of electrical installation being carried out in the borough. The Chairman of the committee said he believed the works would very soon be in the hands of the Corporation. When that was the case they might see their way to go in for a larger scheme, as suggested.

Walker.—The Bill to confirm a provisional order with respect to the lighting of Walker by electricity was before the Court of Referees on the 11th inst., the point for decision being whether the Walker and Wallsend Union Gas Company, and manufacturers and others in the urban district of Walker, had a *locus standi* entitling them to be heard against the Bill in committee. The Court decided to allow a *locus* so far as the first-named was concerned only.

Army and Navy Co-operative Society, Limited.—The new extensions erected on the site of Hooper's depôt are being carried out by Messrs. Laing, Warton, and Down for 90 arc lamps and 470 incandescent lamps. We are informed that as the society's plant is taxed to the utmost, and there is no available space for extensions, the current will be taken from the Westminster Supply Company. The work is being carried out to the specification of Mr. Bernard Drake.

Edinburgh.—The Electric Lighting Committee of the Town Council decided on Wednesday to recommend the extension of the electric lighting subway from Picardy-place to Little King-street, at a probable cost of £1,500. They also recommended the acceptance of several estimates, among which were one for the supply of feeders, amounting to over £18,090, and another for work in connection with the erection of water-tanks at Dewar-place station, amounting to over £500.

Broadstairs and St. Peters.—A copy of the Broadstairs provisional order issued by the Board of Trade to the Isle of Thanet Light Railways Company, Limited, was received by the Urban District Council last week, and the Council were asked if they wished to make any observations. The order was approved subject to the addition of a schedule of a number of streets which the Council has decided were to have the distributing main laid within a period of two years.

Portsmouth.—Application is to be made to the Board of Trade for the appointment of an arbitrator with reference to the claim by the tramway company of £306,450. 18s 6d. for the purchase of the tramways, exclusive of harness used in connection with the omnibuses and carriages, consumable stores, stable equipment, machinery, plant, tools, furniture, fittings, and sundries, which it was suggested should be taken at a valuation. The claim is considered to be excessive.

Chelsea Hospital for Women.—At the annual meeting of this hospital, held on Thursday week, Lord Glenesk said a great work had been done for the nursing staff in the provision of an admirable nurses' home, at a cost of £2,000. It was now of the utmost importance to make some greatly-needed improvements in the hospital, the enlargement of the operating theatre, new lift, new hot-water service, and the installation of electric light, which, with minor work, would cost nearly £3,000.

Carlisle.—On Thursday evening last week, the Mayoress of Carlisle (Mrs. White) formally switched on the electric current at the central electric lighting station in James-street. Invitations had been issued by Mr. Scott (the chairman) and the members of the General Purposes Committee of the Town Council to the whole of the members of the Council, with their wives, the city officials, and their friends, who responded in large numbers. The customary speeches and light refreshment concluded the proceedings.

Ealing.—The Electric Lighting Committee's report, which was adopted at the last meeting of the Urban District Council, stated that Councillors Jordan, Cowley, and the chairman of the committee had been appointed a sub-committee to visit the electricity works from time to time. The committee recommended that Mr. Jordan be nominated as representative of the Council on the Municipal Electrical Association, without the power to vote. Since the last meeting of the committee 443 8-c.p. lamps had been applied for, making a total of 22,443, of which number 22,117 were connected to the mains.

Leeds.—The Tramways Committee are endeavouring to complete the equipment for the electrical tramway to Headingley by June 29 so as to be able to temporarily run a service of electrical cars between Boar-lane and the Oak during the England *v.* Australia cricket match. At present only the trolley wire remains to be fixed in order to permit of the electric current now produced at the generating station being switched on. As the new 1,300-h.p. engines will not be ready for some months, both the present 800-h.p. engines will be worked. It is proposed to have a five minutes' service.

Colne.—The refuse destructor and health depôt will be in full working order in the course of a few days, fires having already been put in. The main building is fitted with a two-cell destructor of Messrs. Beaman and Deas's most improved type, each cell being calculated to destroy 24 tons of refuse per 24 hours. The chimney is round in section, and 211ft. high above ground. A block of offices will serve as the headquarters of the sanitary department. The whole scheme, which will be lighted with electricity derived from the burning of the refuse, with weighbridge, approach roads, and boundary walls, is estimated to cost £12,500.

West Ham.—At the last meeting of the Town Council the Tramways and Electric Lighting Committee reported that they had considered the various tenders for the plant for the extension of the electric lighting installation, and had selected the tenders of the Brush Company and Messrs. Ferranti for special report by the electrical engineer. The committee had directed the electrical engineer, in connection with his report on the two tenders before mentioned, to bring up a tabulated list of the whole of the tenders, with notes as to any special features respecting the labour clause therein, for the consideration of the committee at a further meeting.

Harrogate.—The electrical engineer's special report, which has been adopted, proposes a reduction in the charges for electric supply (to come into operation from Christmas next) as follows: 6d. per unit for the average daily demand, for an hour and a half per day, to 3d. per unit afterwards; for heating, cooking, and power, 6d. and 2d., rebates to be allowed every half-year—namely, at the end of December and June quarters—based on the previous six months' readings. It has also been resolved that the salary of the electrical engineer be increased £50 per annum, and that in all cases of expenditure over £5 the electrical engineer invite tenders for the work.

Chatham and Gillingham Light Railway.—Sir Courtenay Boyle, accompanied by Mr. F. J. J. Hopwood, Sir T. Blomefield, and Mr. Taring, held an enquiry on the 12th inst. at the Board of Trade, Whitehall, to hear objections to the confirmation of the order authorising the construction of a light railway to be worked by electric traction between Chatham and Gillingham. The Gillingham Council wanted power to license the drivers and conductors of the trams, but Sir Courtenay Boyle declined to agree to the proposal. The Chatham Corporation obtained insertion of a clause requiring the company to run two workmen's cars each way daily at cheap fares from the dockyard to each terminus.

Appointments Vacant.—The Corporation of Morley require the services of a competent engineer; the St. Pancras Vestry require an inspector of works who has had previous experience with an electric supply company as assistant distributing engineer; the Pemberton Urban District Council require an electrical engineer to examine and report upon electric lighting schemes. Particulars of the above vacancies, and of a foreman wireman, canvasser, etc., will be found in another column.—The Hampstead Vestry have decided to appoint an assistant electrical engineer in place of Mr. Leadbeater (promoted).—The Whitehaven Town Council have decided to appoint an electrical engineer, who is to have full control and responsibility.

Quarry Bank.—At the last meeting of the District Council a letter was read from the Board of Trade enclosing a copy of an order proposed to be issued to the Midland Electric Corporation, asking if the Council had any observations to make thereon. Mr. Shaw asked if it were necessary that the particulars and conditions agreed upon with the representatives of the Midland Electric Corporation should be sent to the Board of Trade? He thought the members should be perfectly clear on that point, because the Council laid down some stringent regulations. Mr. Thorneycroft said the order provided that distributing mains should be laid down from High-street, at the junction of Thorns-road, to the Rowley Regis boundary within a period of three years.

Glasgow.—A report has been submitted to the Watching and Lighting Committee of the Corporation stating that common stairs, where the service mains are laid into the building from the

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street mains for the purpose of supplying private consumers within the building, could be lighted by electricity at the rate of 25s. for a 6 c.p. lamp, 27s. 6d. for 8-c.p., and 37s. 6d. for 16-c.p., subject to the following conditions: (1) that the owner provide the fittings at his own cost; (2) that while the Corporation should renew the incandescent lamps when required owing to ordinary wear and tear, the electricity department shall not be called upon to make good wilful damage or destruction; (3) that the lamps be lighted, extinguished, and reported upon by the police department.

Telegraph Charges to the Colonies.—Sir Edward Sassoon, M.P., presided last week over the committee appointed at a recent meeting at the House of Commons to act in regard to the lowering of the Imperial telegraph rates. A discussion took place on the anomalies of the present system, and it was stated that the Viceroy and Government of India were entirely in sympathy with the committee in desiring a reduction of the telegraph rates to India. A letter was drawn up to be sent to the Chancellor of the Exchequer, the Secretary of State for the Colonies, and the Secretary of State for India asking for a parliamentary investigation into the present high charges for telegrams to British Colonies and Dependencies, with a view to the remedying of existing grievances.—*The Times.*

Hawkshead.—An application from Mr. Fowkes for sanction to extend his electric cable from his house to his farm at Town End has been acceded to. It appears that an application has been made to the Board of Trade by the Windermere and District Electricity Supply Company for a continuation of their provisional license, under which nothing had been done in this part of the district. The Board of Trade stated with reference to the communication from the Ulverston Rural District Council requesting the revocation of the whole order, that the undertakers had urged that as a supply of electricity had already been made to the Ambleside district, it was inexpedient to revoke the whole of the order, and asked that the order might be applied to Hawkshead and Claife districts.

British Insulated Wire Company, Limited.—The directors announce that in view of the growth of the Company's business—the output for the first four months of 1899 showing an increase of £80,000 in value over that of the corresponding period of 1898, and the Company having now on its books orders to the amount of more than £300,000—they have decided to issue the 12,500 6 per cent. cumulative preference shares of £5 each which form the part of the authorised capital still remaining unissued. The issue will be strictly confined to existing preference and ordinary shareholders, and will be allotted at a premium of £1, and in the proportion of one new share for every £5. 5s. share now held. Dividends on the shares of this issue will commence to accrue from July 1 next.

Keighley.—An extensive scheme of lighting by electricity is fast being completed by the Fleece Mills Company. About £2,000 will be spent in laying down a plant which is calculated to furnish the needs of a limited area, both as regards electric light and motors. The steam-engine formerly used for the mills has been yoked to a dynamo which has been supplying three of the company's shops. An engine and dynamo, by Messrs. Willoughby, which will increase the producing capacity threefold, has been started. The drapery stores of the Co operative Society have been connected, and probably 100 lights will be required by these stores, in addition to two arc lamps. Negotiations are also pending with a view to fitting the Victoria Hotel with the light.

United Asbestos Company, Limited. — A supplementary catalogue for the current year issued by this Company is devoted to their patent "Salamander" decorations for walls, ceilings, etc. These additional designs have been beautifully illustrated, and the catalogue will form a useful reference for architects and customers generally. As a combined fire resistant and decorative material it has even found its way into the cabins of the Royal navy. From what we have ourselves seen the effect produced by using these artistic designs in several offices, etc., is excellent, while an additional value is imparted by the admirable way in which such a form of wall ceiling decoration lends itself at various points for electric lighting. The offices and showrooms for the "Salamander" decorations is at 158, Charing Cross-road, W.C.

Southampton.—The Electric Lighting Committee's report, adopted at the last meeting of the Town Council, stated that 31,739 units were sold during the month of April, being an increase of 14,231 (or 81 per cent.) over the number sold in April, 1898; that the equivalent of 1,238 c.p. lamps were connected in April, bringing the total up to about 20,500; that the new coal elevator and conveyor were being got in position by Messrs. West, and would shortly be at work; and that the main coils of the arc lamps were about to be changed by the contractors to enable them to burn with a longer arc, thereby ensuring a better light. Mr. E. Manville has suggested that the contract for the battery-house should be placed with Messrs. Playfair and Toole, if that firm were prepared to go with the contract, at the present schedule of prices.

Stirling.—The proposal of the National Electric Free Wiring Company, Limited, now before the Police Commission, states that the company are prepared to charge 1d. per unit for the fittings, or to accept payment by small instalments on the hire-purchase system. In the event of an occupier who has entered into the agreement with the company leaving and a new tenant entering without coming to an agreement the Corporation would be under no obligation, as the company accepted all responsibility. The Corporation would not in any way be involved in financial responsibility in connection with the company's undertaking, and the manager stated his willingness to make this perfectly clear. No monopoly is granted to the company in the wiring of premises, so that restrictions are not in any way imposed upon the ordinary tradesmen.

Huddersfield.—Extensions have been approved for about 11½ miles of tramways on the circular route at £10 000; the total cost to complete the scheme will be £115,000. The approximate length of tramway proposed to connect the outer districts is 13 miles, and the total estimated cost is £130,000. The reduction in the price of electric light agreed to on Wednesday is from 6d. to 4½d. per unit, subject to a sliding scale of discounts, such reduction to take effect from July 1, 1899. The discount on 1,000 units will equal 1 per cent., and 15 per cent. on 6,500 units. This is in addition to the 5 per cent. discount for cash. There are now 875 consumers, and out of that number only 280 consumers have received discounts. The new scale will bring a reduction of 25 per cent. to more than 75 per cent. of the consumers.

Preston.—A company has offered, subject to arrangements to be made with Messrs. Harding and Co., Limited, to take over the remaining five years in which that company leases the tramways from the Corporation, upon the condition that the Corporation grant an extension of lease for a further 21 years. The applicants offer to pay 8 per cent. per annum as rent, and to substitute the overhead trolley system and a 4ft. 8in. gauge. Very considerable extensions are proposed. The lines would be continued within the borough of Preston, along Hartington-road to West Strand, and along Broadgate to Penwortham Bridge; along Deepdale-road to Watling-street, Fulwood; by way of London-road into Walton; and from the cemetery along the Blackburn-road to connect with the Blackburn trams. The line would be carried to Lytham by way of Ashton-lane.

Leamington —The Electric Light Committee have received the draft clause proposed to be inserted in the Corporation provisional order by the Board of Trade, and have decided that Mr. Passman, jun., should go to London and ascertain what modifications could be obtained, and report to a further meeting. The costs for promoting a provisional order for the supply of electricity, and opposing a similar application by the Midland Electric Light and Power Company, Limited, amount to £263. 3s. 11d., and the town clerk has been instructed to have these costs taxed and certified. A special meeting of the Town Council was held on Wednesday, when the Council accepted the order as amended by the Board of Trade, and resolved that the Electric Light Committee be instructed to forthwith enter into negotiations with the company with a view to acquiring the undertaking.

Worsley.—The District Council had under consideration last week important schemes of tramway extension It was stated in connection with the taking over of Bolton tramways by the Bolton Corporation and the working of those tramways by electricity, several schemes had been propounded whereby they could be extended beyond Farnworth, where the present line finished, right on to Walkden through Worsley and Winton, and a connection established with the present Manchester tramway system at Eccles. Such a scheme, it was pointed out, however, was only in its infancy, but it was quite possible. It was decided that two representatives from the Council be appointed to confer with the delegates from the Farnworth, Kearsley, and Little Hulton District Councils as to the advisability or otherwise of assisting in the extension of the tramways through their townships.

Mumbles.—A special meeting of the Mumbles Railway and Pier Company was held last week to consider and approve a Bill authorising the abandonment of a portion of the railway—from Blackpill to Dunns—and the leasing of the undertaking to the Swansea Improvement and Tramways Company. The Chairman (Sir John Jones Jenkins, M.P.) said the arrangement made with the tramway company, which was controlled by the British Electric Traction Company, was favourable to the Mumbles Company, and it would enable the tramway company to make a profit on the rental. The lease was for 999 years. The tramway company would take over all the stock and plant at a valuation. The Mumbles Company, in accordance with their parliamentary Bill, had to construct the new lines from Blackpill to Dunns at a cost not exceeding £20,000. The tramways company would pay 5 per cent. on the outlay.

Yeadon.—A conference was held last week of representatives of the Yeadon, Rawdon, and Horsforth Urban District Councils for the purpose of discussing proposals which have been made for the establishment of a tramway system between Yeadon and the Leeds city boundary at Kirkstall. The Guiseley District Council and the Menston Parish Council had also been invited to the conference, but neither authority was represented, the latter body having failed to secure a cab. The Guiseley Council wrote stating that, whilst regretting the inefficient railway accommodation to and from Leeds, they considered the present time inopportune for the consideration of providing tramways for the township of Guiseley. After some discussion, a resolution was passed unanimously to the effect that the three Councils approved of the proposal, and were prepared to consider the best means of carrying it out. The conference afterwards went into committee to consider communications which had been received from private syndicates offering to construct the suggested lines.

Birkenhead.—At a special meeting of the Town Council on Wednesday a report and recommendation of the Tramways Committee dealing at length with the matters which had been under the consideration of the committee, and pointing out the powers which had been acquired by the Corporation under their new Bill, was adopted unanimously. A resolution was passed as follows: "That the Council resolve and direct that application be made to

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the Board of Trade for the approval of the Board to the proposed scheme of Corporation tramways as set out in the report of the Special Committee. and for the sanction of the Board to the borrowing by the Council of the sum of £208,678. 19s. 10d., for the construction and equipment of the proposed tramways and works, and for the erection of buildings, machinery, and plant in connection therewith." The following new committee was formed, to be known as the Tramways Committee: Aldermen Bloor, Deakin, Rawcliffe, Shaw, Singleton, and Smith; Messrs. T. Cook, Gamlin, Hazlehurst, B. Jones, Kelly, Oates, Rees, and Snape.

Parliament.—During the past week in the House of Lords the following Bills were read a third time and passed: Manchester Corporation Tramways, Oldham Corporation, Glasgow Corporation (Tramways, etc.) Liverpool Overhead Railway, Dundee Gas, Street Improvements, and Tramways, Vale of Glamorgan Railway, Bexhill and St. Leonards Tramroads, Central London Railway, Great Western Railway, Midland Railway, Charing Cross, Euston, and Hampstead Railway, North-West London Railway, and the Great Northern and Strand Railway. In the House of Commons the following Bills were read a third time: Kensington and Notting Hill Electric Lighting, Wallasey Tramways and Improvements, London and North-Western Railway (Additional Powers), Baker-street and Waterloo Railway. The London, Walthamstow, and Epping Forest Railway and the City and Brixton Railway Bills were read a second time. Bills promoted by the Moss Side, Stretford, and Withington Urban District Councils, conferring on the respective Councils power to purchase and maintain tramways, and to lease by agreement tramways forming continuous routes outside the districts, were reported for third reading.

Weston-super-Mare.—At a recent meeting of the Lighting Committee the following letter from the Board of Trade was read: "With reference to previous correspondence on the subject of the proposed transfer of the powers, duties, and liabilities of the undertakers under the above-mentioned order to the Weston-super-Mare and District Electric Supply Company, Limited, I am directed by the Board of Trade to request that you will furnish them with a copy of the memorandum and articles of association of the transferee company. I am at the same time to state that in the event of the Board of Trade deciding to approve the proposed transfer, it will be necessary for them to obtain the assistance of counsel in considering the draft deed, and I am to request that you will forward to this department a cheque for £5 payable to an assistant secretary of the Board of Trade, being counsel's fee in the matter. I am to add that before approving the deed, the Board will require to be furnished with evidence that the proposed transferees are in a position fully and efficiently to discharge the duties and obligations which will be imposed upon them by the order and deed if approved."

Tillicoultry.—At a recent meeting Mr. Lea, district superintendent of the British Electrical Traction Company, explained to the Commissioners that the company proposed to carry an electric overhead tramway from Stirling to Tillicoultry and the station, with the terminus there, unless they went as far as Alloa. It appeared that the company were in treaty with the Stirling and Bridge-of-Allan Companies to acquire that right also, but that was unsettled. They did not want the Commissioners to be at any cost. Their terms of the proposal was that it should be an arrangement for 35 years and at the termination of that arrangement the various authorities would have the right, if they choose to exercise it, to take over at a valuation the traction tramway. The company asked that the support of the Commissioners be given to that effect to carry it through. It was agreed to delay action until further information could be procured, the Commissioners generally expressing themselves favourably to the scheme, although they were not prepared to commit themselves. The Clerk read a letter from Mr. Purves, Edinburgh, in reference to electric lighting, but it was agreed not to do anything at present.

Catalogue.—We have received from the well-known firm of manufacturing electricians, Harry W. Cox, Limited, of 10, Cursitor-street, Chancery-lane, E.C., their catalogue for the current year. Its pages, which number about half a hundred, contain a large number of illustrations, which generally correctly represent the actual articles the firm supply. Prominent among the contents is their Röntgen-ray apparatus, of which the firm make a speciality. There is also to be found some exceedingly useful and practical hints to beginners on the way in which they can set about X-ray work. In placing all this before the novice, it has been the aim of the firm to avoid as far as possible the use of all technicalities. These hints will prove to be of considerable value to medical men and others who purchase the apparatus. The catalogue also deals with various kinds of electrical apparatus suitable for hospitals and other uses; while a large amount of detailed and useful information may be gathered from the remaining pages respecting the firm's telephones, apparatus for demonstrating wireless telegraphy, batteries, heavy discharge induction coils, current interruptors, Wimshurst influence electrical machines, dynamos, and so on.

Bastian Meter Company, Limited.—From a circular just published giving an outline of the Company's operations up to April, 1899, we gather that the Bastian Meter Company, Limited, was originally registered on July 12, 1897 as the Penny-in-the-Slot Electric Supply Syndicate, Limited, and the name has been changed because they have turned their attention more to the manufacture of ordinary meters for measuring electricity than to the manufacture of penny-in-the-slot meters, the reason given being that the former was the more profitable occupation until a larger demand had been created for the prepayment type, which was rapidly extending. The Company had been manufacturing the ordinary type since September, 1898, and had sold over 900 to the Corporations of Glasgow, Bradford, Llandudno, Stockport, Brighouse, Dundee, Oldham, Dewsbury, Manchester Nottingham, Barking, and to various electrical companies, whilst sample meters are now under test in Birmingham, Edinburgh, and many other towns. The Company have purchased the undertaking known as the Electric Lighting Extension Syndicate, Limited, and so extinguished the royalty of 4s. per meter which was payable to them under their original agreement as vendors to the Company.

Newcastle Tramways.—A meeting of the New Tramways Committee of the Corporation was held on the 15th inst. A letter from Mr. Hopkinson, referring to details of the laying of the new electric trams, and also as to a siding, or some such communication, with the North-Eastern Railway to the proposed central power station in the City-road, and as to sites of the proposed car sheds, was referred to a sub-committee. It was stated that the building of the car sheds would cost several thousands of pounds, and there was a general agreement among the committee that if possible the matter should be put in the hands of local architects for competition. A long discussion took place as to the new sections and through routes of the new tramlines. Owing to the fact that the sub-committee have been unable to come to any satisfactory terms with the tramways company, in all probability there will be no tram service after November until the electric system is in operation. Mr. Laws, the city engineer, has been empowered to visit and consult with Mr. Hopkinson as to the particular class of rails, etc., which will be required for the electric lines. An interview is to be granted to a syndicate which is offering certain terms in connection with the electric trams.

Blackburn.—The Joint Lamp Sub-Committee reported at the last meeting of the Council, according to the *Weekly Standard and Express*, that they had considered the report and scheme of the electrical engineer for the erection of further electric lamps in the centre of the town, and recommend "that electric lamps be erected as shown on the plan submitted, subject to the Electricity Committee supplying electricity, including the carboning and trimming of the lamps on the following terms: for each all-night arc lamp, £18 per annum; for each arc lamp burning till 12 o'clock and then turned out and incandescent lit up in its place, £15 per annum. These figures are on the basis of 2½d. per unit, the price at present charged being 3 3d. The lighting by gas of the districts in which it is proposed to put the new electric lamps, is estimated by the electrical engineer to be costing at the present time £1,342 per annum, exclusive of men's time in lighting and turning out and cleaning. Under the new scheme, the estimated cost is £1,035 per annum. The capital expenditure for the new lamp-pillars which will be required will amount to £500, but against this there is the saving in the cost of lighting. In connection with the lighting of Preston New-road, the sub-committee have decided to have a meeting some evening after dusk to specially consider the matter." The report was adopted.

Hendon.—Mr. Robert Hammond has been asked to prepare a general report on the terms submitted by various engineers in connection with the electric lighting scheme. The Council have agreed to allow the Vestry of Hampstead to supply the Castle Hill, Child's Hill, and the houses known as Cranhurst Chatris and Derwin, Hermitage-lane, with electricity. It was reported at the last meeting of the District Council that a conference in regard to the proposed construction of light railways in the following districts had taken place in the Guildhall between the Parliamentary Committee of the County Council of Middlesex and representatives of the Hendon Council and other district bodies: (*a*) a line of railway commencing at Kilburn, traversing Edgware main road *via* Edgware to the foot of Stanmore Hill; (*b*) a line of railway commencing at the Edgware main road, passing along Cricklewood-lane, through Regent's Park and Finchley main road, to a junction with the Great North road at Tally Ho Corner; (*c*) a line of railway commencing at the Edgware-road, passing through the Burroughs, Hendon, traversing Brampton-grove, Brent-street, and Hendon-road to Golder's Green. A letter was read from the Middlesex County Council asking if the Council would supply them with plans showing the line which the Council thought would be best to follow in regard to the proposed local light railway. It was agreed to supply the plan desired.

Cardiff.—We quote from an account of the proceedings of a recent meeting of the Lighting Committee of the Corporation from the *South Wales Daily News* as follows: At the previous meeting the committee accepted the tender of Mr. Jackson, of Cardiff, for lamp-pillars. Mr. Jackson now wrote stating that owing to the advance of the price of iron of 10s. per ton, he was unable to carry out the tender at the price named. He asked for an extra 2s. 6d. on the ordinary pillars, of which 200 were needed, and 3s. 6d. on the special pillars, of which 25 were asked for. The Chairman said the tender had been given to Mr. Jackson in order to encourage local industry. He thought they should put an end to the farce of tendering and the constant changes in prices made by the contractors after their tenders were accepted. Should that be the desire of the committee, he was ready to move that in future contractors who attempted to vary the amount of their tenders should be excluded from the list of Corporation contractors. The tender of Messrs Rogers and Co., of the Pengam Works, being the next lowest, it was decided to offer the contract to them. In the event of their not accepting it, the clerk was instructed to issue fresh advertisements. The deputy town clerk Mr. Broad, submitted counsel's opinion with reference to the dispute between the committee and Messrs. Ferranti respecting the delay which had taken place in the erection of an engine at the works. Counsel advised that the Corporation had a good cause of action, and it was resolved that the town clerk issue a writ for the

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recovery of damages from Messrs. Ferranti arising from delay in the completion of the contract, the penalties claimed being at the rate of 1 per cent. per week over the last 2½ years, the percentage being based on the purchase price of the engine (£3,250). At a Town Council meeting last week these minutes were adopted. The Council also decided to recommend that customers using the current for power in the daytime should be charged at 2½d. per unit if they used under 4,000 units, and 2d. a unit if they used over 4,000 units per annum.

London County Council.—The Council on Tuesday passed a resolution consenting to application being made by the London United Tramways, Limited, for power to reconstruct, in accordance with the overhead trolley system of electrical traction, the tramways in that part of Uxbridge-road between the Askew Arms public-house and the railway station, and from Uxbridge-road railway station *vid* Goldhawk-road to Young's-corner, on condition that the company do also reconstruct, according to an underground system of electrical traction, the tramways from Young's-corner *vid* King-street to Hammersmith-broadway; it being understood that should the Council, when the proper time arrives, decide to purchase those portions of the company's tramways which are situated within the county of London, the Council shall pay the "then value" of the tramways above referred to. The report of the Highways Committee contained a minute with regard to the Blackheath and Greenwich District (Extension) Order, stating that the Board of Trade had substantially adopted the amendments suggested by the Council, with the exception of those relating (*a*) to reduction in the standard price per unit, and (*b*) to the supply being by continuous current. With reference to the latter point, the Council had asked the Board to reconsider its decision, in view of the fact that in the order granted in 1897 in respect of a district co-terminus with that which is the subject of the present application by the same company, provision was made for the supply to be by continuous current. With regard to a reduction of price, the Council asked that in all orders granted this session the initial price might be reduced from 8d. to 6d. per Board of Trade unit. The Board, however, had stated that it did not consider it desirable to adopt the former suggestions, but that it will consider any representations which the Council may make with respect to the reduction of the initial price in provisional orders applied for in future sessions. Sanction to lay mains, etc., under Electric Lighting Acts and orders was granted as follows: the Vestry of St. Pancras; Westminster Electric Supply Corporation; County of London and Brush Provincial Electric Lighting Company (3)—under the Wandsworth Order, 1892, under the Holborn and St. Giles Order, 1898, and under the Southwark Order, 1892.

PROVISIONAL PATENTS, 1899.

MAY 8.

9606. Improvements in electric telephony. Charles Adams-Randall, 63, Chancery-lane, London.

9607. Improvements in phase transformers and the application of the same to starting monophase electric motors. Edmund Basil Wedmore, 83, Cannon street, London.

9616. An improved method of displaying advertisements, pictorial or otherwise, by projection with lenses and clockwork movement or electric motor. Walter Thomson and the "Jactho" Patent Automatic Advertising Lamp Company, Limited, Strawberry House, St. James-street, Newcastle-on-Tyne.

9622. Improvements in electrically-heated smoothing irons or the like. William Deeble Ferguson and Thomas Henry McMurray, 5, Iveagh-chambers, North-street, Belfast.

9631. Improvements in or connected with electrical conductors and anodes for electrolytic and similar purposes. The General Electrolytic Parent Company, Limited, Luke Hargreaves, and William Stubbs, 51, Egerton-street, Liverpool. (Complete specification.)

9632. An improved high-insulation lampholder. F. W. Heaton and Harry Smith, Salford Switch Works, Sidney-street, Salford. (Complete specification.)

9659. Improvements in electrical signalling instruments. Herbert Watson Sullivan, 19, Great Winchester-street, London.

9672. Improvements in electric switches. James Ernest Spagnoletti and Joseph Crookes, 70, Palace-chambers, Westminster, London. (Complete specification.)

9674. Improvements in telephones. Ernest Wilson, Charles John Evans, and Herbert Godsal, 64, St. John's-park, Blackheath, London.

9681. Improvements in circuit breakers. Reginald Belfield, 322, High Holborn, London. (Lewis Buckley Stillwell, United States.)

MAY 9.

9707. A new or improved magneto-electric machine. Henry Alfred Dawson, 18, Hertford-street, Coventry.

9721. Improvements in electrical distribution boards. John Richardson Craig, jun., 115, St. Vincent-street, Glasgow.

9729. Improvements in or relating to the Marconi system of wireless telegraphy. George Henry Smith, 37, Daniel-street, Cathays, Cardiff.

9750. Improvements in printing telegraphs. Benjamin Joseph Barnard Mills, 23 Southampton-buildings, Chancery-lane, London. (John Richard Tucker, Charles Clifford Hinckley, and Kirk Himrod, United States.) (Complete specification.)

9791. Improvements in apparatus for receiving "Hertz" electric undulations or waves. Eugéne Ducretet, 321, High Holborn, London. (Complete specification.)

9811. Improvements in or relating to the manufacture of insulating material for electric cables and the like. George Edward Heyl Dia, 6, Lord-street, Liverpool.

9813. Improvements in telephones, microphones, and the like, and in switch mechanism for same automatically operated by the introduction of a coin. Johann Planer and Ferdinand Hirschhorn, 22, Southampton-buildings, Chancery-lane, London.

MAY 10.

9822. A new or improved switchboard or block for electrical purposes. Albert Llewelyn Williams Ward and Kilner Wilson, 94, Bradford-road, North Fartown, Huddersfield.

9848. Improvements in electric letter boxes and call boards. Joseph Pemberton Moore, 55, Chancery-lane, London.

9882. Improvements in electric lighting apparatus especially applicable for railway and other vehicles. Edwin James Preston, of the firm of J. Stone and Co., and Arthur Bernard Gill, 77, Chancery-lane, London.

MAY 11.

9938. A new or improved protective conduit for the current conveyors of electric railways. Arthur Petzenbürger and Anna Haisl, 100, Wellington-street, Glasgow. (Complete specification.)

9966. Improvements in the manufacture of protecting casings or tubular structures for electric cables. Alfred Julius Boult, 111, Hatton-garden, London. (Johann Jungbluth, Germany.) (Complete specification.)

9972 Inverted third-rail electric railway system. Louis Edward Walkins, 40, Chancery-lane, London.

9981. Electrically-driven machines. Theodore Harold Joseph and James Jacob Ehrenreich, 322 High Holborn, London.

9987. An improved binding post or device for connecting electrical apparatus. Henry Harris Lake, 45 Southampton-buildings, Chancery-lane, London. (Albert Richardson Shattuck, United States.) (Complete specification.)

9989. Improvements in and relating to the governing of engines used for driving electric generators in electric distributing systems. Henry Alexander Mavor, 46, Lincoln's-inn-fields, London.

9999. Automatic electrical ring-off appliance for telephone stations. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske, Actien-Gesellschaft, Germany.) (Complete specification.)

MAY 12.

10016. Automatic electromagnetic switch applied to incandescent lamps for lighting the same in series to prevent the possibility of a pillar being in darkness. Frank Carter, 2, St. James's-street, Brighton.

10029. Improvements connected with the controlling of shop window illuminating electric lamps and the like. Walter Douglas, 15, Water-street, Liverpool.

10035. Improvements in apparatus for the production of ozone by electricity. Joshua Henry Lamprey, 7, Staple-inn, London.

10040. Improvements in printing telegraphs. Luigi Cerebotani and Albert Silbermann, 111, Hatton-garden, London. (Complete specification.)

10081. Improvements in electrical resistances and similar apparatus. Max Levy, 40, Chancery-lane, London.

MAY 13.

10094. A device for shielding fallen wires from overhead electrical conductors and for supporting the latter. George Sockett Holmes, 10, St. George's-crescent, Liverpool.

10095 A device for shielding fallen wires from overhead electrical conductors. Thomas Holmes and Arthur Smith, 10, St. George's-crescent, Liverpool.

10103. Improvements in telegraph and like poles. Howard Cochrane Jobson, 24, Southampton buildings, Chancery-lane, London.

10105. Improvements in and relating to incandescent electric lamps. Frederick Sadler, 10, Windmill-road, Wandsworth Common, London.

10109. Improvements in joint boxes for electrical installations and connections therefor. George Wilkinson, 73, St. Stephen's road, Upton Park, London.

10119. Improvements in electrodes for batteries. Gustavos Heidel, 111, Hatton-garden, London. (Complete specification.)

10153. An improved method of controlling mechanisms by means of Hertzian waves. Ernest Wilson, Charles John Evans, and Herbert Godsal, 108, Castelnau, Barnes, London.

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10124. Improvements in telegraphic instruments. Percy Beresford Wright Kershaw and Hugh Haswell Shanks, 94, Piccadilly, London.

10130. Improvements in and relating to electric arc lamps. John William Ewart, 11, Southampton-buildings, Chancery-lane, London.

10133. Improvements in systems of control for electrically-propelled vehicles. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William B. Potter, United States.) (Complete specification.)

10134. Improvements in controlling devices for electric motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Frank E. Case, United States.) (Complete specification.)

10135. Improvements in controlling devices for electric motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William B. Potter, United States.) (Complete specification.)

10136. Improvements in systems of controlling electrically-propelled railway trains. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Harold W. Buck, United States.) (Complete specification.)

10163. Improvements in magnetic circuit breakers. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (William Maxwell Scott, United States.)

10164. Improvements in interruptors for electric currents. Hermann Theodor Simon, 45, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1898.

9197. Telegraphic transmitting apparatus. Creed.

9299. Overhead trolley wires for electric traction, overhead electric cables, or other wires. Hacking.

9493. "Starting boxes" or combined rheostats and automatic cut-outs for electric motors. Boult. (Herdman.)

10245. Automatic electric cut-in and cut-out. Bottone.

10483. Electrical switches. Abbott and Bill.

10818. Electricity meters. Hookham.

11282. Electric check clocks or alarm signal apparatus. Reich.

11320. Electrical ignition apparatus for gas-burners. Urquhart. (Actiengesellschaft für Fabrikation von Broncewaaren und Zinkguss vorm. J. C. Spinn und Sohn und von Romocki.)

12191. Reflectors chiefly designed for incandescent electric lamps. Bartenstein.

12232. Telemotor apparatus for working, steering, telegraphing, indicating, and other apparatus from a distance. Brown.

12431. Apparatus for the production of electricity in railway carriages and other vehicles. Preston. (Gould Coupler Company.)

13300. Screens, shades, or covers for electric lights. Bruff.

13657. Electric arc furnaces. Day and Acetylene Illuminating Company, Limited.

13969. Trembler interruptors for electric currents. Wylts and Rochefort.

14012. Electric light fittings. Brown.

16172. Voltaic battery cell with hot air depolarisation. De Lavison.

22872. Electrolytical apparatus. Loiselet.

1899.

633. Printing telegraphs. Hachmann, Pfeifer, and Ernst.

3717. Switch throwers for steering electric tramcars and the like. Ward.

3736. Secondary batteries. Schwirsky.

4699. Ceiling rose for electric lights and the like. Clayton.

4957. Electric devices for controlling the power supply of motors and the like. Bowen and Knox.

5030. Control apparatus for electric hoists and elevators. Imray. (Maccoun.)

5545. Induction motors for alternating electric current circuits. British Thomson-Houston Company, Limited. (Rice and Steinmetz.)

5546. Induction motors for alternating electric current circuits. British Thomson-Houston Company, Limited. (Rice and Steinmetz.)

5547. Devices for changing the frequency of alternating currents in systems of electrical distribution. British Thomson-Houston Company, Limited. (Steinmetz.)

5550. Self-starting alternating electric current motors. British Thomson-Houston Company, Limited. (Steinmetz and Berg.)

5941. Incandescent electric lamps. British Thomson-Houston Company, Limited. (Rice.)

6024. Electrical incandescence lamps. Feeny. (Allgemeine Elektricitäts-Gesellschaft.)

6026. Electrical incandescence lamps. Fenny. (Allgemeine Elektricitäts-Gesellschaft.)

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1899.	Corresponding week 1898.	Increase or decrease.	Total receipts for half-year. 1899.	1898.
		£	£	£	£	£
Birmingham Tramway Co.	May 13	4 162	3,746	+ 416	73,570	67,656
Blackpool and Fleetwood Tramroad	,, 13	362	—	—	4,722	—
Bradford City Trams	Feb. 5	145	—	—	6,733‡	—
Bristol Tramways and Carriage Co.	May 12	2,863	2,648	+ 214	—	—
City and South London Railway	,, 14	926	958	- 32	21 279	20,679
Dover Tramways	,, 13	154	135	+ 19	2,885	2,217
Dublin U.T., elec. cars	,, 12	1,130	892†	+ 238	17,751	14,282†
Dublin S.D. Electric Tramways	,, 12	819	545	+ 274	12,893	8,313
Halifax Corporation Tramways	Mar. 29	312	—	—	10,712*	—
Liverpool Overhead Railway	May 14	1,339	1,446	- 107	26,919	27,884
South Staffordshire Tramways	,, 12	625	606	+ 19	11,730	11,267

* Since June 30, 1898. † Including horse cars. ‡ Since July, 1898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	23½-24½
Bournemouth and Poole Electric Supply, Limited, Ord.	10	13½-13⅝
—— 4½ per cent. Cum. Pref	10	10½-11½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	18-19
—— 6 per cent. Cm. Pf., 30,001-40,000 (all paid)	10	13½-14½
—— 6 per cent. Cm. Pf., 40,001-60,000	10	13½-14
—— 5 per cent. Perpetual Debenture Stock	100	126-129
Brush Electrical Engineering, Limited, Ordinary	2	1½-2⅛
—— Non. Cum., 6 per cent. Pref.	2	2⅛-2½
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	102-106
Callender's Cable Company, Debentures	100	114-117
—— Ordinary	5	12⅜-13½
Central London Railway, Ordinary	10	11-11⅛
——	8	9 9⅛
—— Pref. Half-Shares	8	8⅛-8⅜
—— ,, ,,	5	5⅜-6⅛
Charing Cross and Strand	5	11-12
—— 4½ per cent. Cum. Pref.	5	5⅜-6⅛
Chelsea Electricity Company	5	8-9
—— 4½ per cent. Debentures	100	114-116
City of London, Ordinary	10	16½-17⅛
—— 6 per cent. Cumulative Pref.	10	15-16
—— 5 per cent. Debenture Stock	100	125-130
City and South London Railway, Consolidated Ordinary	100	68-70
—— Ordinary	3	4⅛-5⅛
—— 4 per cent. Debenture Stock	100	132-134
—— 5 per cent. Pref. Shares	10	14⅛-15⅛
—— ,, ,, ,, '96	10	14-15
County of London and Brush Prov. Elec. Light Co., Ord.	10	11-12
—— 6 per cent. Cum. Pref.	10	14-15
—— 4½ per cent. Prov. Certs.	—	54-56
Crompton and Co.	3	3⅛ 4
—— 5 per cent. Debentures	—	98-101
Crystal Palace District, Ordinary 5 per cent. Stock	100	130-135
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2-2⅛
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	96-98
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5⅛-5⅜
Electric Construction, Limited	2	2⅛-2⅜
—— 7 per cent. Cumulative Pref.	3	3-3⅛
—— 4 per cent. Perp. 1st Mort. Deb.	100	103-106
W. T. Henley's Telegraph Works, Ordinary	10	24½-25½
—— 7 per cent. Preference	10	18-20
—— 4½ per cent. Debentures	100	112-115
House-to-House Company, Ordinary	5	8⅛-9⅛
—— 7 per cent. Preference	5	9-10
Imperial Tramways, Limited	6	24½-25½
India Rubber, Gutta Percha, and Telegraph Works	10	21⅛-21⅝
—— 4 per cent. Debentures	100	101-105
Kensington and Knightsbridge Ordinary	5	12-13
London Electric Supply, Ordinary	3	3⅛-3⅛
—— 6 per cent. Pref.	5	6⅛-7
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	106-108
Metropolitan Electric Supply, Limited, Ord., No. 1-62,500	10	16⅛-17⅛
—— ,, ,, No. 62,501-85,000	10	15⅛-16⅛
—— 4½ per cent. First Mortgage Debenture Stock	100	118-121
National Telephone, Ordinary	5	4⅛-5
—— 6 per cent. Cum. First Pref.	10	11-13
—— 6 per cent. Cum. Second Pref.	10	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	4⅛-5⅛
—— 3½ per cent. Deb. Stock, Red.	100	99-101
Notting Hill Electric Lighting Company, Limited	10	16⅛-17⅛
Oriental, Limited, 1879	1	1⅛-1⅜
—— £5 Shares	5	7⅛-7⅜
—— £4½ Shares, New	4½	6⅛-6⅜
Oriental Telephone and Electric Company	1	⅞-1
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6⅛-7
Royal Electrical Company of Montreal	1⅛	165-185
—— 4½ per cent. First Shares Mortgage Debentures	100	105-107
South London Electric Supply, Ordinary	3	3⅛-3⅜
St. James's and Pall Mall, Limited, Ordinary	5	17-18
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	36-40
—— 5 per cent. Bonds	100	106-108
Waterloo and City Railway, Ordinary	100	107-110
Westminster Electric Supply, Ordinary	5	14⅛-15⅛

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NOTES.

King's College.—As we announced in a previous issue, the annual dinner of old students of this college will take place at the Holborn Restaurant on Monday, June 26, when Prof. W. S. Playfair, M.D., LL.D., F.R.C.P., will preside.

Electrical Engineers (R.E.) Volunteers.—The members of this corps will attend at the headquarters of the 1st Middlesex Engineers (R.E.) Volunteers, College-street, Fulham-road, S.W., on May 27, for Morriss tube practice, from 2 p.m. until 5 p.m.

Tidal Power and Electrical Energy. — Our American contemporary *Electricity* states that there is a scheme on foot at Bath, Maine, to utilise tidal power in the production of electrical energy. The scheme is to secure an old mill site where at one time 10 sawmills were run by tide power, to repair the dam there, and to generate electricity by the same force that in former years operated scores of saws.

Article Club Exhibition.—The industrial exhibition organised by the Article Club is to be opened at the Crystal Palace on Tuesday by their Royal Highnesses the Duke and Duchess of Connaught. The exhibits are said to be of a varied character. Engineering, as well as electrical engineering, are stated as being well represented, and we hope to give fuller details of what is to be seen after the opening ceremony.

The Pacific Cable.—The Government proposal with respect to the all-British Pacific cable has been submitted to the New South Wales Cabinet. We learn from a Reuter telegram that this Cabinet dissents entirely from the view of the Imperial Government on the subject, and agrees with Canada in considering that the cable should be jointly owned with the home Government, and not subsidised. This decision was telegraphed to all the other Colonies, and we trust that it will induce the Imperial Government to reverse their decision, and to enter into the scheme as originally proposed.

Swiss Tramways.—We understand that Mr. R. McCulloch, who for some years has been electrical engineer of the Spencer and Orthwein lines in St. Louis, has resigned his position to become the general manager of the Compagnie des Tramways Suisse, at Geneva, Switzerland. Mr. McCulloch must be congratulated on the step he has taken, and we are glad to see that Swiss engineers are not above taking practical advantage of the strides made in America in electrical traction. Mr. McCulloch is a young man of about 35 years, but he has had a great deal of experience in civil work.

Holiday Tramway Traffic at Bristol.—Considering the unfavourable state of the weather on Whit Monday, which must have deterred many from venturing out of doors until the day was somewhat on the wane, the Bristol Tramways Company at least had little cause to complain of inactivity. As many as 124 cars, carrying 140,885 passengers, were run on that day, as compared with 121 cars and 131,851 passengers on the previous Whit Monday. This shows an increase of 10,034 passengers. It may be added that the electric lines show their growing popularity by having contributed 5,341 of this surplus.

Fire Risks.—We notice in the *Bulletin des Usines Electriques* an abstract of the Prefecture de Police of Paris on the various causes of fire which the fire brigades attended last year. Of these 132 were due to the fall of oil lamps, 25 to gas explosions, 29 to escapes of gas, 9 to candles, and so on; but we do not find that in any case electricity is put down as the cause of an outbreak. The question is raised in the report as to how far incandescent electric lamps may be a source of danger, but our contemporary holds that even under the most favourable conditions it is practically impossible to cause a fire by the breakage of an incandescent lamp. Hence, the statement in the above-mentioned report that candles are the safest light is to be deprecated. With this conclusion we quite agree.

The Electrophone.—We are informed that on the 24th inst. experiments were made at Windsor Castle with an electrophone which was connected to Her Majesty's Theatre in the Haymarket and also to St. James's Hall. A prophetic letter, saying how much the Queen was pleased with the electrophone, reached us through the post at the time the experiments were timed to be commenced. This letter concludes as follows: "Those assembled by invitation in Mr. Beerbohm Tree's theatre, and the audience at St. James's Hall, were the most-to-be-envied people in the kingdom, for they knew that what entertained their ears was simultaneously heard by their Queen, at whose birth, 80 years ago, the very boldest and advanced scientist would not have dared to foretell such a triumph of man's ingenuity."

Motor Control.—Mr. H. W. Corse, of Melrose, Massachusetts, has been granted a patent for a method of varying the speed of electromotors over very wide limits. The invention consists in an extra attachment to the armature, which is of the Gramme type, so that the number of coils in use can be varied. The apparatus for changing this is placed on the opposite side of the armature of the commutator. At first sight it would seem that the device might be serviceable for certain changes of speed, but if the matter is considered closely, we are afraid it will be found that the complicated nature of the added connecting gear will be so great as to render it out of court commercially. It will not be enough, as the inventor seems to think, to cut out a number of adjacent coils, as this will entirely upset the commutating arrangements and cause destructive sparking.

Finsbury Technical College.—The annual report of the Finsbury Technical College shows that some 185 students are now undergoing courses. Of these, 65 are working in the chemical department, and 60 each in the mechanical and electrical departments. Reference is made in the report to the increase in the number of students attending the mechanical department since Prof. Dalby has been in charge, and to the success of the special course of lectures which have been arranged during the past winter. Amongst these was one by Prof. S. P. Thompson on "Recent Advances in Electro-Chemistry," while the second course, by Prof. Dalby, was devoted to locomotive engineering. The third special course was by Mr. Philip Dawson, and a single lecture on "Electric Welding" was given by Mr. Reginald W. Jones. We understand from the report that the students find no difficulty in getting employment when they have completed their college course.

Royal Institution. — In commemoration of their centenary next month, the Royal Institution have elected the following foreign honorary members: Prof. S. Arrhenius (Stockholm), Prof. C. Barus (Brown University), Prof. H. Becquerel (Paris), Prof. G. L. Ciamician (Bologna), Prof. N. Egorof (St. Petersburg), Prof. A. P. N. Franchimont (Leyden), Prof. A. E. Gautier (Paris), Prof. H. G. Kayser (Bonn), Prof. W. Korner (Milan), Mr. S. P. Langley (Washington), Prof. G. van der Mensbrugghe (Ghent), Prof. A. A. Michelson (Chicago), Prof. H. Moissan (Paris), Prof. R. Nasini (Padua), Prof. W. Nernst (Gottingen),

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Prof. W. Ostwald (Leipzig), Dr. E. Solvay (Brussels), Prof. R. Thurston (Cornell), Prof. E. Villari (Naples), Prof. J. L. G. Violle (Paris), Dr. E. Ador (Geneva), Dr. L. Bleekrode (The Hague), Prof. J. S. Ames (Johns Hopkins University), Prof. G. F. Barker (Philadelphia), Geheimrath Prof. Dr. O. Liebreich (Berlin), and Dr. W. L. Wilson (Washington).

Electric Cabs.—For the last week or two we have missed the well-known yellow electric cabs from the streets, and we were afraid the cab company found the up-keep of these too expensive to admit of their continuous running. In view of the success of the same type of cab in Paris, and of electric cabs in New York, we were grieved that this should be so. We have now, however, Mr. Walter C. Bersey's authority for the statement that the temporary withdrawal of the cabs was only in order that improvements might be made in them. We also learn that some 50 new vehicles have been constructed, and that these, with the old ones, are now plying for hire in the public streets. The company are making a special feature of private electric broughams, which can be hired by the hour, day, or any longer period. We are glad to note that Mr. Bersey has been made managing director of the London Electric Cab Company, and we are sure his experience will greatly assist the company in their future operations.

Japanese as Electricians.—Our New York contemporary, *Electricity*, publishes the following interesting extract from a lecture on "Japan," which Prof. A. G. Bell has delivered in Washington: "Everywhere in Japan the English and American instructors in the college and the factory are being supplanted by natives. They make it plainly understood that Japan is for the Japanese. Their success in electricity and mechanics has been wonderful. A student at the university planned a work of such importance in commercial life that his idea will undoubtedly be used elsewhere. This Japanese genius conceived the idea of building a canal to connect two lakes of different altitudes. He tunnelled mountains and overcame other difficulties, but the chief point of interest lies in the fact that he built a railroad over which the canal boats were transported, as they left the water, to the next lake. Electricity was used, and enough was derived to light the city of Kioto and furnish power to 60 factories. This shows the wonderful ability of the Japanese."

A Frequency Indicator.—Mr. Carl Kinsley publishes in the current number of the *Physical Review* a description of a method he has tried for the measurement of the frequency of alternating currents. This consists in the use of an iron rod which is weighted in the centre. The rod is clamped at one end, and at the other is acted on by an electromagnet energised by the alternating current whose frequency has to be measured. The author claims, and gives experiments and figures to prove his contention, that this method of using a weighted bar is much more accurate than that of obtaining synchronism by varying the length of the bar. This contention is practically obvious from first principles. The author experimented with various bars in order to prove that the formulæ developed are correct. It seems that a rod 2in. to 3in. long was used in making the experiments, and it was found possible to so arrange the rods that a comparatively large amount of the weight tuned them for a very small difference of frequency. It seems to us, however, that the author even then has not obtained a frequency-measuring instrument with a wide range.

Telephone Rates.—With respect to the reduction in the rates charged by the National Telephone Company for private house telephones, we find that by a quibble the reduction in many cases has not been conceded. The National Telephone Company explain, in answer to a correspondent, that the £10 rate only refers to private houses in the county of London, as distinguished from what was previously known as the company's "inner London area." The company add that any private residence in the county of London can be connected at £10 per annum on a five years' agreement. From what we can gather from the correspondence which has just taken place, the National Telephone Company argue somewhat as follows: that the county of London only consists of those parts of London which are not inside the National Telephone Company's inner London area. We cannot conceive what advantage the company hope to gain by advertising a proposed reduction which in a large number of cases they do not intend to give. It is obvious that the outlying parts require longer lines and more trunk wire than those inside the inner district, and hence there is no natural reason why such a curious distinction should be made.

The Maritime Electrical Association.—We see from the columns of our contemporary, the *Canadian Engineer*, that the second annual convention of the Maritime Electrical Association has recently been held in Halifax. The president, in delivering his annual address, commented on the growth of the association, and also on the electrical industries of Canada. From the secretary's report, we see that this new society has not as yet a very large number of members, but the balance sheet shows that no financial loss was incurred during the first year, which speaks well for the method of organisation adopted. Mr. F. A. Huntress, of Halifax, was elected president for the ensuing year, and the following papers were read and discussed during the convention: "Iron-Armoured Conduit Installation at New Drill Shed," by J. R. Griffin; "Fire-Alarm Telegraph Systems," by P. R. Colpitt, the city electrician, of Halifax; "Reminiscences," by F. A. Hamilton; "Church Wiring with Iron-Armoured Conduit," by J. A. Anderson; "Steam Engineering," by P. Freeman, the chief engineer, of the Halifax Tramway; "Electric Meters," by R. T. MacKeen; "Telephones," by J. H. Winfield, of New Glasgow; and "History of Electric Lighting in Halifax," by W. Pickles.

The Volta Centenary.—The electrical exhibition in New York is looked upon by American engineers as their own commemoration of the centenary of Count Alessandro Volta. Our contemporary the *Electrical World* in this connection says that it is most becoming that Volta's pioneering work in electrical science should be fully recognised by all. It adds that the enormous significance of his discovery is apparent when we reflect on the state of electricity previously, and on the great consequences which during the next third of a century flowed from it. Until then the only source of electricity was the static machine, which, with its infinitesimal capacity for the transformation of energy, remains to-day, in this electrical age, an entirely negligible factor. The voltaic cell first made man acquainted with electricity as a recognisable form of energy. Possessed of this potent source, experiments in every direction immediately followed, the science of electro-chemistry at once sprang into being, and finally by its means the great discovery of Faraday was made. Though we now see in the great electrical development of to-day only reminders of Faraday, sight should not be lost of the fact that the discovery of electromagnetic induction sprang from the discovery of Volta, whose commemoration was observed by the opening of the international electricity exhibition and the national silk industry exhibition at Como on Saturday last by King Humbert.

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The Manacles Rocks.—The wreck of the "Paris" on the Manacles Rocks, occurring as it did such a short time after the disastrous accident to the "Mohegan," has given rise again to numerous speculations as to the influence of these rocks on compasses. We see that the *Daily Telegraph* quotes as a noteworthy fact the statement that the Brixham fishermen, when passing up or down Channel, invariably observe variation in their compasses. Consequently they allow two points each way on the proper course. We also learn from the same source that at a meeting of the Royal Institution of Cornwall held on Tuesday last, the Rev. W. Jago drew attention to the fact that nine years ago Mr. Clark, an associate, pointed out that the rocks on the south coast of Cornwall possessed magnetic properties which constituted a peculiar danger to navigation. The Manacles themselves were not so strongly magnetic as other rocks in the neighbourhood, possessing an affinity for the magnet equal to only one ton in 3,000, but at other places the attraction was much greater. We do not understood the valuation of the magnetic forces referred to, and are quite sure that, even if such forces had existed, they are not sufficient to explain the cause of these two disasters. Any magnetic effects which may exist locally would be equally apparent on all ships, and the large number of vessels which pass the coast in safety when the climatic conditions are such that the lighthouses are not visible, disproves the hypothesis that there is serious magnetic disturbance at the Manacles.

Ozone.—In the May number of the *Journal* of the Chemical Society there appears an interesting abstract of an article by Marius Otto in the *Annales Chimiques et Physiques*, in which the author discusses the various forms of ozonisers, and describes an apparatus constructed for use with alternating currents, by means of which 15 per cent. of the theoretical amount of ozone can be produced — the yield obtained from Siemens's and Andreoli's ozonisers is less than 2 per cent. Methane at ordinary temperatures is oxidised by ozone to methylic alcohol, formaldehyde, and formic acid. At 100deg. the latter substances alone are obtained. Ethylene, treated with ozonised oxygen containing less than 50 milligrammes of ozone per litre, yields acetaldehyde and acetic acid. Neither ethylic alcohol nor glycol could be detected among the products of oxidation. The author proceeds to describe reactions which he has found possible to effect with ozone, among which we may give the following as interesting: Acetylene, which is decomposed by ozone with explosive violence, and carbon is deposited; glycol, which gives aldehydic and acidic substances, but the only substance isolated is glyoxal. Glycerol furnishes similar products, but their exact nature is not determined. The mono- and di-hydric phenols are attacked by ozone, but resinous products are obtained, except in the case of catechol, which gives a small quantity of a substance resembling purpurogallol. Isoeugenol, isosafrole, and anethoil are oxidised to vanillin, piperonal, and ani-aldehyde respectively. Aniline is oxidised to quinone and azobenzene, and paratoluidine to parazotoluene.

New York Exhibition.—This year the electrical exhibition in Madison-square Garden, New York, was opened on May 8 by Mr. Chauncey M. Depew. In the inaugural ceremony, after reading congratulatory telegrams from President McKinley and the Governor of New York State, Mr. Chauncey Depew went on to extol the advantages of electricity, and to give instances of the great strides which have been made in the science and in its practical applications. He was most enthusiastic over wireless telegraphy, and predicted that telegraph stations would soon be equipped in mid-Atlantic for receiving and transmitting messages by this means. According to Mr. Depew, if messages can be sent 36 miles without the use of wire they can certainly be sent 3,000 miles. We presume in the same way Mr. Depew would hold that a capitalist with sixpence in his bank was a millionaire. Speaking of the great advances which have been made in regard to electrical communications in time of war, he stated that when the battle of Bunker Hill was fought it took two weeks for the news to reach the Continental Congress in Philadelphia. When Cervera's fleet was sunk in 13 minutes by the guns of the American ships off Santiago, it was known in 10 minutes afterwards. There was, he went on to say, a small fleet of American men-of-war 6,000 miles from there, on the other side of the ocean, in the Eastern Hemisphere. By the declaration of the war with Spain they were not permitted to coal, not permitted to get supplies anywhere—all ports were closed. They went out upon the ocean, America lost sight of them for a week. They sailed finally past forts, over mines, into Manila Bay, and there they met the foe and conquered him, met the ships of the Spanish navy and sunk them. That was 6,000 miles away, but the knowledge of that victory was received there before the smoke of the guns disappeared from the harbour of Manila.

Central Technical College.—We notice from the report of the City and Guilds of London Institute that the increase of students at this college is causing considerable inconvenience in the laboratories. The increase during the last year has tended towards a reduction in the number of students taking special courses, and to an increased number of those students who have matriculated and are taking a regular three years' course. In glancing down the list from 1885 to the present time, it is interesting to note how the engineering, physical, and chemical departments have shared the students. In the early nineties the physical and electrical engineering course was easily first with about 95 students, as against 20 students in the chemical and 70 in the engineering course. During the last two years the engineering course has attracted most attention, partly due, no doubt, to the examination now required by the Institution of Civil Engineers. The numbers for 1898 are: engineering course, 111; physical course, 83; chemical course, 24. Owing to removal of the wood-carving department, a certain amount of extra accommodation has been secured for the mathematical department of the college, but the dean emphasises very strongly the need of greatly extended facilities for the teaching of applied electricity. Large laboratories, which will enable more machinery to be laid down, and the present dynamos and engines to be mounted in a way and which will conduce both to safety and greater facility in experiments are required. He holds that it will be necessary to entirely remodel the electrical engineering branch, for which purpose a new building is required. In this way other departments would be able to occupy the present laboratories with advantage. We are pleased to note that Prof. Armstrong speaks up so strongly for the electrical work, and reserves a small paragraph on the needs of his own, the chemical department, which has done and is doing very good service.

Maximum Demand Meters.—Mr. E. S. Halsey, writing in the *Electrical World* of New York, describes a new maximum demand indicator and meter combined which contains many novel features. He points out the need of an instrument which will combine cheapness, durability, and accuracy with simplicity of construction and operation, and which will also be so arranged that the maximum energy taken should be registered somewhat

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slowly, so that a sudden short-circuit could not upset the reading. The author suggests that from two minutes up to an hour ought to be allowed at maximum output to ensure a maximum record. In spite of this, it is important that the apparatus should not affect in any way the recording of the meter. The one described by the author, but to which we can find no maker's name appended, is constructed as follows: The indicating gear and brake are practically the same as used in the Thomson integrating wattmeter, but the spindle between the motor armature and the Foucault brake wheel is not continuous. The main shaft, although interrupted for the purpose of registering the maximum torque transmitted, has its halves connected by means of a spiral spring. The upper or motor portion is thus flexibly coupled to the lower or dragging portion. As a damping agent, a small quantity of viscous material is inserted in the sleeve between the two portions, so that rapid change will not cause a displacement of the maximum indicator. This indicator consists of a pointer on the upper part, while the brake disc is calibrated in kilowatts. The ratchet wheel and pawl prevents the needle going back from the maximum indicated current. It seems that the device can be easily added to the ordinary type of Thomson meter, but, as mentioned above, we do not find from the text who are the makers of the apparatus. From first principles it would seem that the combination is all that can be desired, and the addition of the maximum indicator and pointer would serve as an easy means of checking a meter in case its calibration was disputed.

Tramway Roturns.—Mr. Albert B. Herrick sends a letter to the *Electrical World* complaining of an editorial article on street railway returns which he considers to be unduly hard on electrical tramway engineers. Mr. Herrick says that when attention was first called to the matter of the destruction of subterranean conductor systems parallel to railways with the ground return formed by the rails, casualty predictors foresaw frightful destruction of such systems. Their prophecies did not immediately mature, but in 1891 another wave of terror passed over the country, during which frequent pictures were drawn of the havoc which would arise from these ground return currents, and in the present day we have another popular outcry against street railway systems. In several cases the water companies have had the dangers so magnified to them by rail-bond manufacturers and promoters of electrolysis panaceas, that they have been forced into taking a stand which has been in no wise warranted by the facts of the case. Speaking from practical experience as to the remedies which are possible, Mr. Herrick holds that there are no simple means applicable in every case, but that every system has to be considered *de novo*. He states further that he has had to inspect over 1,200 miles of railroad in the last four years, locating and determining these matters of destruction by electrolysis. Summing the whole thing up, he has not been able to find more than 800ft. of lead service pipe and 300ft. of water-mains and 140ft. of gas-mains which have been so deteriorated by electrolysis as to render their further service doubtful. Eighty-two per cent. of this damage occurred in three systems. It may be pertinent to remark here that the worst case of electrolysis he met with, and the one where the management was the least inclined to take preventive measures, was in a case where the water company's property and railway property were owned by the same persons. He concludes by remarking that street railway managers are not at all ignorant regarding this destruction by electrolysis. A great deal of money has been spent in America to improve the ground return, and frequent inspection of bonding is being carried out on a number of systems.

The Diatto System.—We learn from the columns of our contemporary *L'Energie Electrique* that at the end of last month the Diatto system of electric tramways was inaugurated in the town of Tours. We gather from the article describing the opening that it is at present only used in the centre of the town, the overhead trolley system being employed in the outskirts. Still, about eight miles of the Diatto system is either laid or is to be laid shortly. With this method the contacts are placed centrally between the rails, as in most other contact systems. The mechanism below the surface of the roadway is exceedingly simple, but from the illustrations given by our contemporary we do not think that it will be found to last well in practical work. The whole of the mechanism for actuating the contact-making plunger under the stud is situated on the car itself, and a magnetic pull transmitted from the car is relied on to close the contact when the car is over the stud. On the under side of the tramcar three iron sliders are placed, which run the full length of the same. The central one makes contact with the studs, while the two on the outside simply form magnetic returns for the lines of force which actuate the plunger. These outer iron bars do not touch the ground. Electro-magnets are placed between them, and they are connected in such a way that the central bar is throughout its entire length of opposite polarity to the two outside bars. The separate connecting box and stud contains a central iron plunger working in mercury. The head of the plug is made of hard carbon, cone shaped. The magnetic pull forces this cone into a female cone of carbon just above it. In order that the magnetic lines may freely pass down into the plunger, iron arms project to the right and left of the same, and these are bent upwards in a block of asphalte until the ends come vertically below the two outside bars under the car. It would seem to us that carbon contacts are likely to give trouble in course of time, as there is no rubbing action when the plunger is lifted, such as would serve to remove any small irregularities caused by the spark on breaking. The electro-magnets for energising the collecting gear are excited by the main current, and also by a local circuit on the car, in which a few accumulators are placed. The controlling gear is so arranged that when the main current is turned off, this local circuit is closed, so that the connection with the mains is not disconnected.

Polarisation.—In the April number of the *Physical Review* there is an interesting article by Mr. Barry MacNutt on "The E.M.F. of Polarisation of Electrolytic Cells for Very Small Current Densities." The author considers the actions going on in electrolytic cells, and also what happens if a current is forced through such a cell. Out of this investigation comes up the question of the polarisation effects, and on this a number of experiments are described. The author found results which he explains as follows: that there is a difference in the polarisation E.M.F. after the time that the cells have stood with no current passing through them, and, again, when current has been flowing through them. The author considers that after the cells have stood with no current passing through them, the surface of the electrodes and the crystals of the deposited ions may not be as clean as when the current has been established and the crystals are growing. Now, the ionic tension or osmotic pressure is probably not so great when the crystals are clean and growing; hence, if so, the initial E.M.F. would not have to be so great to push the current through the cell as when the crystals are dull.

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The results shown by the current and E.M.F. curves indicate that this polarisation E.M.F. does not become zero with the smallest current intensity used, and that therefore the expenditure of power in the cells is due to an irreversible thermo-dynamic action, and the laws of thermo-dynamics are not applicable to the action of polarisation in an electrolytic cell. At the end of the above article a note from Prof. W. S. Franklin is given, and reads as follows: "It is a question whether the polarisation E.M.F. of an electrolytic cell approaches zero with current density on the electrode surface. If it does not, then even the slowest deposition of ions at an electrode would depend upon a finite supersaturation of the ions in the solution at the electrode, and the electrolytic cell, instead of presenting a genuine case of thermo-dynamic equilibrium, would present a case of what Duhem calls false equilibrium, the analytical treatment of which is very different from the treatment of true equilibria. The trend of Mr. MacNutt's curves for very small current densities does not indicate with certainty that the polarisation E.M.F. is other than zero for *zero current*. The behaviour of an electrolytic cell which has been for a long time on open circuit is interesting. When current is started through such a cell, the polarisation E.M.F. very quickly reaches an abnormally large value, and then falls off for some hours. On the other hand, if the cell has been on open circuit for a few moments only, the polarisation E.M.F. rises steadily when the current is started, and reaches its maximum value in several hours."

"Photography."—We notice that Mr. R. Child Bayley, late assistant secretary of the Royal Photographic Society, has taken up the editorship of the enterprising weekly named above. In the current issue of this journal there appears an interesting article by Colonel J. Waterhouse, I.S.C., on the problem of the developable photographic image. The author points out that after 60 years of constant investigation of this subject we are still without a satisfactory explanation of what happens when a sensitised film is exposed to light. After briefly mentioning the chemical theories, Colonel Waterhouse continues as follows: "The first action of light must necessarily be physical. To what extent it may or may not be directly connected with the electric or magnetic theory of light, as propounded by Clerk Maxwell, is an open question, but that there is a connection is shown by the very early work of Becquerel and Robert Hunt with electric actinometers, as well as by the later researches in the same direction of Minchin, Abney, Rigollot, and others, and, perhaps, most clearly and definitely by Röntgen's discovery of the action of the X-rays, and the researches by various physicists on the action of ultra-violet light in connection with electrical discharges and conductivity. Becquerel showed that the effect of light falling upon coatings of silver iodide, chloride, or bromide on silver plates immersed in a suitable conducting fluid, one plate being exposed to light and the other not, was to generate an electrical current of which the force and amount are capable of being measured and estimated by the ordinary methods of electrical measurement. The action of electrical currents must, however, be accompanied by chemical decomposition. If in the case of the photographic plate it can be shown that the chemical decomposition of the exposed parts of the film is a direct result of an electric or magnetic action of light, it would go far to solve our problem from the physical side. That the question is worthy of consideration from this point of view may be gathered from the following extract from the English translation of Nernst's 'Theoretical Chemistry,' p. 626. Under the sub-heading of 'The Theory of Photo-Chemical Action,' the author says: 'Thus far only vague surmises have been expressed regarding the mechanism by dint of which the energy of vibrations of the luminiferous ether is applied to the performance of chemical work. But in consideration of the fact that in the sense of the later views the light vibrations are produced by electric agitations, therefore it is an immediate inference to suppose that in the chemical action of light we are dealing with phenomena which are not far removed from the formation and decomposition of chemical compounds under the influence of the galvanic current."

Cloth-Pressing by Electricity.—At a recent meeting of the Industrial Society of Elbeuf a report was presented which dealt with a new process invented by M. Chedville for pressing cloth by means of boards heated by electricity. The result is declared to be most satisfactory, and the report, reproduced in the *Journal* of the Society of Arts from that supplied by the United States consul at Roubaix, in explaining the new method, goes on to state that the body of the press board is composed of asbestos paste, covered by a netting of German silver. This is again covered by paper pulp, which gives a pliable surface without materially increasing the thickness of the press board, which measures from ·071in. to ·157in. The press boards have a trapezoid projection, of which the two obtuse angles are covered with copper. Spring clips provided with a metal connection and attached to a pliable conductor serve to transmit the electric current to the copper-covered corners of the boards, when the press is arranged for work. The electric press boards are used in the following manner: on a plate of sheet iron is placed a piece of cloth, between the folds of which are placed at equal distances three electric press boards; then there is another plate of sheet iron, another piece of cloth, and so on until the press is full. An ordinary press holds eight pieces. The required current for a press board measuring 39·37in. by 27·5in. is two amperes under a pressure of 110 volts. A press of eight pieces with 24 press boards demands a current of 48 amperes to heat the press, and the amount of electric force expended in 1½ hours is as follows: 48 × 110 × 1·5 = 7,920 watt-hours. The mechanical force given a dynamo of 90 per cent. working efficiency is 12·5 h.p. The work done in 1½ hours is as follows: 12·5 × 1·5 = 18·75 h.p. hours. Estimating coal at £1 per ton the maximum cost of heating a press would be about 7d. Comparison being made between the amount of coal required by the new system of pressing and the old—*i.e.*, direct heating in a special oven by means of sheet-iron plates interspersed between the folds of the cloth—it is found that the old method is slightly dearer than the new. But besides an economy in fuel by this system, the heating of each press, and even of each piece, can be regulated mathematically, either by varying the number of press boards, or by increasing or diminishing the length of the heating. The cloth is heated slowly and without the inequalities resulting from the old system, under which the two ends of each piece were almost in contact with plates heated to 500deg. All manufacturers who have employed the new system speak of this point as a great advantage. A second advantage is the extreme cleanliness with which the pressing can be effected. The old style of plates heated in an oven often resulted in soiling the cloth, which is now entirely avoided. Another advantage is the economy in laborious handling necessitated by heating and transporting heavy cast iron plates. The workshops can also be kept at a lower temperature, and if there is already an electric plant in the establishment the expense is, of course, reduced. The new process is described as a most important invention, and one which should be generally adopted.

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THEORIES AND FACTS RELATING TO CAST IRON AND STEEL.*

BY BERTRAND S. SUMMERS.

At the last meeting of the Iron and Steel Institute, held in London recently, a most interesting paper was read by Mr. Bertrand S. Summers on the general theories of the composition of cast iron and steel, in which a number of useful observations on actual experiments are given. The first part of the paper is devoted to the discoveries made with respect to the physical composition of cast iron and steel as revealed by the microscope, and the relations of such physical structure to the chemical composition. The

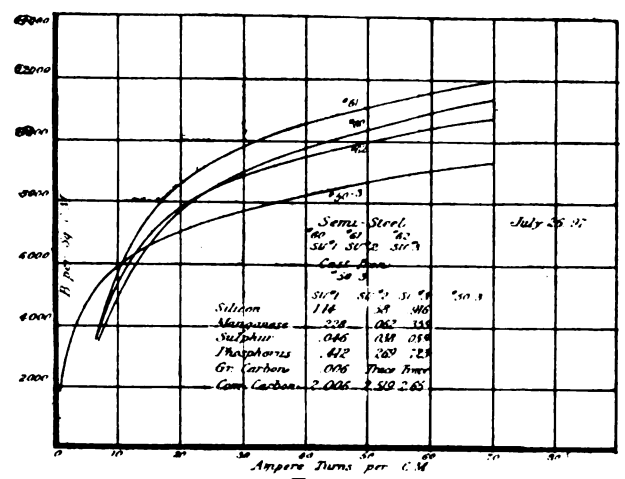

FIG. 1.

author considers the influence of the graphitical condition of carbon on cast iron, and its variation when other different metalloids are present. After having briefly discussed the general physical properties in relation to the chemical composition of cast metal, the author goes on to regard the magnetic properties in the same light. When dealing with the effects of chemical composition on permeability, Mr. Summers points out that magnetism and magnetic permeability seem to be properties of the iron itself, but are influenced to a very great degree by the metalloids commonly associated with iron. It can in nearly every case be assumed that magnetism and magnetic permeability are opposed to each other, and that a state of the metal

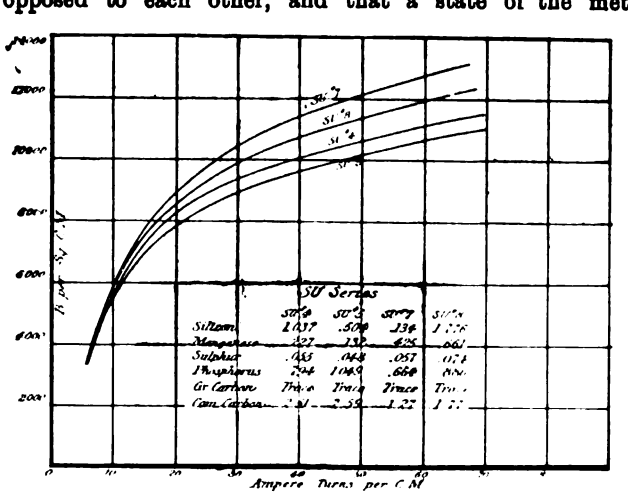

FIG. 2.

favourable to one will be unfavourable to the other. In examining an iron for magnetic permeability it is also quite necessary to take into consideration another property of iron—viz., hysteresis—that is, the energy lost in magnetising iron due to the magnetic inertia of the metal, or the resistance a metal offers to magnetisation. This lost energy is usually rated in watts per pound lost under given conditions. In general, a metal of high magnetic permeability will usually have a low hysteresis, but there seems to be little or no relation between these two properties. It is not infrequent to find a metal of high magnetic permeability and high loss by hysteresis. These two properties of iron are what govern its adaptability for dynamo construction and similar purposes. It is with these that the metallurgist is chiefly concerned in the foundry, and as this investigation has been carried on very largely with cast metal, most of the deductions are drawn from these varieties of the metal. In experimenting with cast iron it is exceedingly difficult to draw any trustworthy conclusions, for the reason that the large contents of metalloids make it almost impossible to trace the variations in permeability to any one or any combinations of the metalloids. The high percentage of graphite is particularly obstructive in this way, and although it has but little or no chemical effect, its effect on the physical

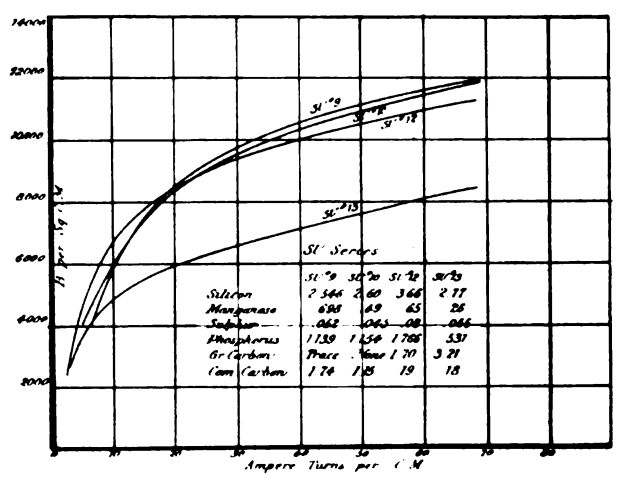

FIG 3.

character of the iron makes it difficult to experiment under the same conditions at different times. After endeavouring to draw some conclusions from numerous tests on cast iron, attention was devoted to making some special alloys. For this purpose wrought-iron borings were mixed with varying proportions of ferro-silicon of the following analysis:

Silicon.	Graphite carbon.	Combined carbon.
Per cent.	Per cent.	Per cent.
7·25	1·95	0·31
Sulphur.	**Phosphorus.**	**Manganese.**
Per cent.	Per cent.	Per cent.
0·044	0·597	0·88

With these two ingredients a series of irons was made. They were placed in a graphite crucible, and heated in an

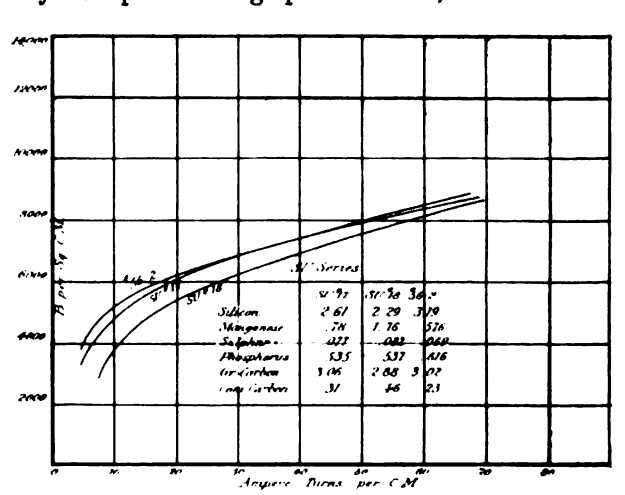

FIG. 4.

ordinary brass-foundry furnace for several hours. When the metal had come to perfect fusion, test bars were cast and tested, and drillings from the same analysed. These alloys were decidedly peculiar. They did not contain more than a trace of graphite, but the content of combined carbon was usually over 2 per cent. The content of silicon was varied by adding different amounts of the ferro-silicon iron. A phosphorus iron was made by adding red phosphorus to wrought iron, and when it was desired to raise the phosphorus content, this alloy was added to the mixture of ferro-silicon and wrought iron. Some of the more characteristic curves (Figs. 1 to 8) are here appended, in

* Abstract of a paper read before the Iron and Steel Institute.

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order to make the comparison more clear. This series was designated as SU series, and the curves are so denominated. The alloys were compounded by endeavouring to keep the other constituents constant while the silicon was varied. This plan was a failure, owing to the uncertainties of mixing, and the variation of carbon due to the absorption of carbon from the pot. However, by selecting the curves where the least variation is noticed we are able to draw some deductions.

In comparing these curves let us first examine them with reference to the variation of silicon. The curve in Fig. 1.,

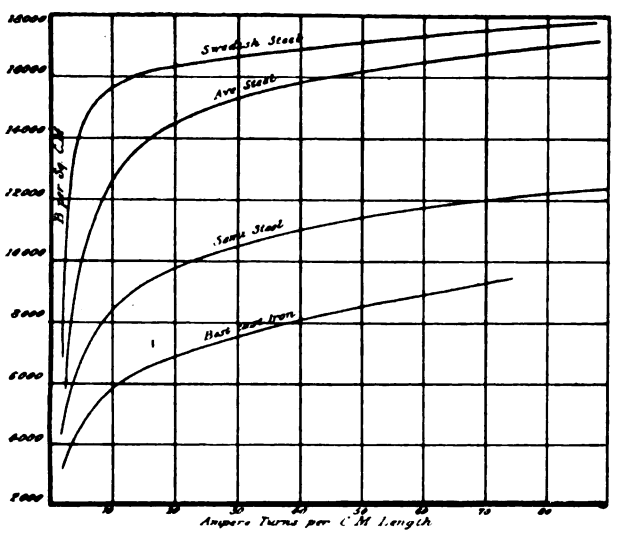

FIG. 5.

marked *50-3, is a curve of very good cast iron, and serves as a means of comparison. It will be noticed that curves SU*1 and SU*3 are more nearly alike than curve SU*2. It might seem at first sight as though this might be due to the silicon content, but a comparison with other curves will show it to be otherwise. We would naturally expect SU*2 and SU*3 to correspond more closely than SU*1 and SU*3, as the carbon contents are more nearly alike. The difference is due probably to a difference of the state of the carbon, and variation in casting condition, which we will discuss later. If we now compare SU*2 with SU*4, we will find that their carbon contents are almost identical, while the silicon content in SU*4 is nearly double that in SU*2. To be sure, the phosphorus varies somewhat, but

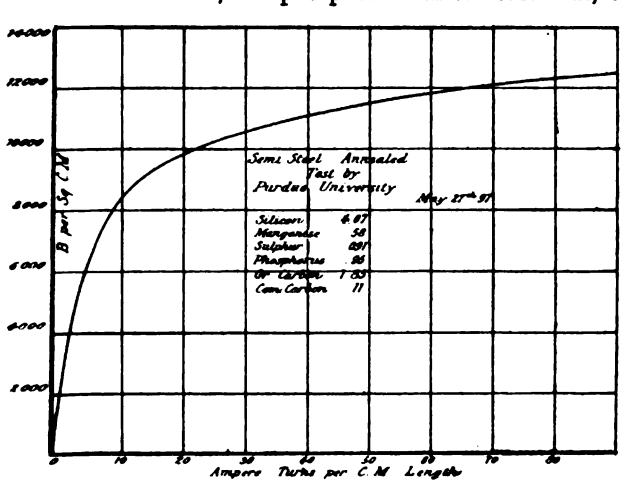

FIG. 6.

this does not appear to vary the results, as we will endeavour to show later. The curves correspond quite closely, showing that this variation in silicon could not have affected the permeability to any marked degree. Finally, if we compare curves SU*8 and SU*9, we notice that the carbon contents are about the same, but that the variation in silicon is about three-quarters of 1 per cent. The other constituents correspond quite closely, at least do not vary greatly. It would seem that if the variation of silicon had any marked effect, the variation is so marked in this case that there should be no effect traceable in the curves. The curves, however, are almost the same throughout the entire range. Also, SU*3 and SU*5 are identical, while the silicon varies considerably. These, with numerous other examples, have led to the belief that silicon has little or no direct effect upon the permeability of iron within certain limits. The same seems true in regard to phosphorus. Comparing curve SU*2 with SU*5, we notice that there is not a great variation in anything but the phosphorus. In this there is a variation of nearly 1 per cent. On comparing the curves, we notice that while there is some variation in the curves there is hardly what would be expected had phosphorus a marked effect on the permeability. Again, comparing SU*8 and SU*9, we notice that the variation in phosphorus has had no more effect than the variation in silicon. The test bars designed to test the effect of sulphur and manganese were unfortunately so hard that they could not be turned. It must be here noted that the comparisons above given are

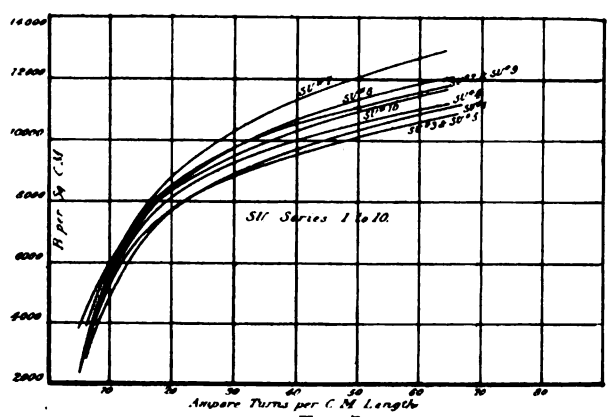

FIG. 7.

taken only as a general indication, and not as absolute proof. It is only in connection with other experiments that these ideas are more clearly substantiated.

It now remains to consider the relation of carbon in the above series. Unfortunately, the writer has not had opportunity to distinguish the different state of the carbon in the different test bars, but it would seem, from a comparison of the curves, that much light would be shed upon the matter if this were done. In a general way, it will be noticed that the test bars containing the least carbon are a little higher, although the contrary will be noted in particular cases. Thus SU*2, containing ½ per cent. more carbon than SU*1, is quite a little better than S*1; the same may be said of SU*3. Having noticed the results

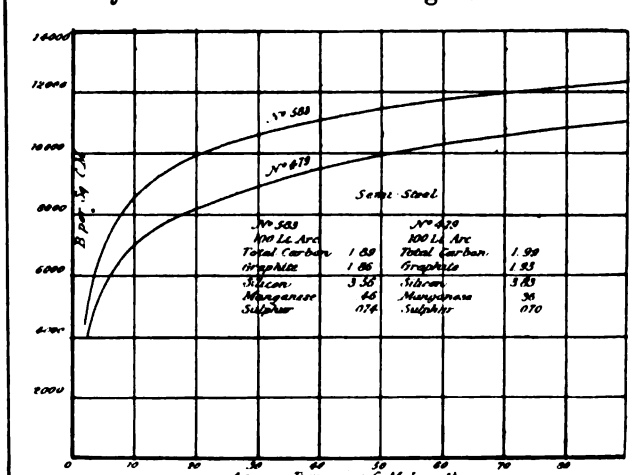

FIG. 8.

from this series, it seemed desirable to note the effect of manganese and sulphur. In order to discover whether manganese has a marked effect on permeability, a hand-ladle was filled from a regular dynamo cast iron, and a small amount of ferro-manganese, containing about 85 per cent. of manganese, was added. A test bar was then cast, and about the same amount of ferro-manganese again added, and another bar cast. The first bar contained 0·78 per cent. of manganese, and the second 1·76. The latter was considerably lower in permeability. It will be noted, however, that the combined carbon has been doubled by the addition of the greater quantity of manganese, and this

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probably accounts for the lower permeability (see curves SU*17 and SU*18). Manganese in all probability affects the magnetic properties through its effect on the carbon. This effect is largely governed by the content of carbon and the content of the other elements, particularly silicon. It is safe to say, however, that the influence of manganese plays a very small part when the content is below 1 per cent. This is especially true of high-carbon irons, such as cast iron. In general, what is said of manganese may be said of sulphur, as far as the indirect effect is concerned. However, a very small quantity of sulphur has a very powerful effect; this is especially true in low-carbon irons.

The experiments with sulphur were mostly carried on with a semi-steel, containing from 40 to 50 per cent. of steel rail scrap, and having a total carbon content of about 2 per cent., most of which was in the graphite state. In these irons, when the sulphur rose much over one-tenth of 1 per cent., it was nearing the danger limit, while 0·13 per cent. was fixed as the maximum for any metal of this composition, where even moderate results were expected. It must be noted, however, that a soft graphitic carbon iron could carry this content without much detriment to its permeability. If the sulphur was increased in these high-carbon irons, a very bad effect is noticeable. The effect of sulphur is undoubtedly indirect, and affects the permeability through its power of promoting combined carbon. One of the test bars of semi-steel, containing about 0·15 per cent. of sulphur, was so white and hard that it could not be turned, although the other constituents were normal, with the exception of the high content of combined carbon.

If we return to our consideration of the effect of silicon on the magnetic properties of iron alloys, and consider another alloy of iron, we will find our deduction from the first series confirmed. The alloy selected for these tests was the semi-steel above mentioned, except that the sulphur content was normal. It will be noted in the accompanying curve the relative position of the metal to cast iron and cast steel. With this alloy the silicon varied about three-quarters of 1 per cent., and in some cases nearly 1 per cent., without any appreciable effect. A variation of five-tenths of 1 per cent. produced no effect whatever upon the permeability. The silicon in this alloy is always kept above 3·75 per cent., consequently is always so high that the change in the content could scarcely affect the state of the carbon. However, it was found that the content of silicon had a marked effect on the hysteresis, the loss by hysteresis being very much less when the silicon was high. A variation above 3·75 per cent. had an effect on the hysteresis where none was noticeable on the permeability. It would seem fair to presume that silicon had no direct effect on permeability, and above the limit necessary for holding the carbon in the graphite state it is doubtful if it has any effect. This is also probably true in the irons containing no graphite, but there would undoubtedly be a limit in this case. In the same way, phosphorus can vary greatly in this metal without any noticeable effect. Within the limits that have been experimented with, nothing has been noticed that would lead one to think that phosphorus has any effect on permeability or hysteresis. This limit is over 1 per cent., and covers the range that would be met with in commercial work. The carbon is undoubtedly the chief factor in the chemical effect on permeability and hysteresis. Practically the same effects were noticed in the semi-steel as in the pot-irons previously mentioned. In general, a low content of combined carbon indicates high permeability and low hysteresis. It is often noticeable, however, as in the case of the pot-irons, that an iron containing more combined carbon than another would have a higher permeability. To discard physical effects, this is readily accounted for by the different state of the carbon.

It has occurred to the writer that there was some form of combined carbon that varied in irons high in combined carbon, and the permeability was more affected by the content of this form of carbon than by the total content of combined or graphite carbon. This form of carbon seems to be that which Prof. Ledebur calls hardening carbon, and is probably the complex crystalline mass isolated by the microscopist under the name of martensite. Although not having opportunity to investigate this question further from the meagre data at hand on this phase of the question, it would seem that this is the state of the carbon having the most influence in the different varieties of iron in which permeability and hysteresis are important. This is offered merely as a suggestion, and the writer has hopes of investigating the matter further. While graphite appears in cast iron as an inert body relating to magnetic properties, such cases as that above mentioned are by no means infrequent with semi-steel. This cannot help but lead one to think that graphite is quite a factor where it is the predominating form of carbon in metals such as semi-steel. In these alloys the carbon may be said to be in a condition more sensitive to change. With such a high silicon content one would naturally expect the predominance of graphite, but in some cases the combined carbon has amounted to nearly one-half the total carbon, which made the castings useless for magnetic purposes. Possibly in cast iron the content of graphite is so high that a variation in the amount or the condition of the same produces relatively no effect in the permeability curve; but in the semi-steel castings, where the permeability may vary 100 per cent., any change in the carbon is made naturally more apparent than in the former case. With steel these general effects should also hold, although the metalloids are present in such minute amounts, and the variation in the permeability is so slight, it is difficult to state anything positively. The physical state of the metal is equally or more potent in its effect on the magnetic properties of iron, and it is this effect that makes deductions from experiments on chemical effects more or less general. An almost carbonless iron will often be found of low permeability and high hysteresis in comparison with its class. After it is annealed, it will sometimes give results very much better than its class. This seems to be due to an internal stress, which has resulted from some heat treatment, and inasmuch as the specimen is nearly pure iron, it must be purely physical. This might be attributed to an allotropic state of iron similar to that proposed by Prof. Osmond, of France; but whatever be the facts, the physical condition of the metal must ever play an important part in calculations of this kind. It does not, however, make the chemical study useless. It is often surprising to note how closely one can figure from chemical results, and the chemical study of these irons has been of high commercial importance where it has been pursued.

Magnetic Retentivity or Permanent Magnetism.—Little can be said regarding the magnetic retentivity of cast iron. While combined carbon seems to be an important constituent, it by no means follows that the cast iron that contains the greatest amount of combined carbon will have the greatest magnetic retentivity. In this connection I here append a micro-photograph of a permanent magnet made of cast iron, together with a photograph of ordinary soft grade magnetically permeable cast iron, and a few of the special pot-irons mentioned above. While there is nothing of importance to be gleaned from examining these, a comparison of the difference of structure is very interesting, particularly when they are compared with the semi-steel, which has about 50 per cent. better magnetic permeability than the cast iron. These special pot-irons have practically no graphitic carbon, and contain an extremely high content of combined carbon, but their permeability is about 30 per cent. better than ordinary cast iron, and they have practically no permanent magnetism. Turning to Table IV., it will be seen that, although the combined carbon of the cast-iron permanent magnet is very much less, its magnetic retentivity is very much more than the pot-irons. This is probably due to the fact that the cast-iron permanent magnet has a proportionately high content of hardening carbon, while the pot-irons are poor in this constituent.

TABLE IV.—Cast-Iron Permanent Magnet Typical Analysis.

Silicon.	Sulphur	Phosphorus.	Manganese.
2·83	0·127	0·502	0·370
Graphitic carbon.	**Combined carbon.**		**Total carbon**
2·14	0·55		2 69

About 2,000 lines per square centimetre.

Pot-Iron Typical Analysis.

Silicon.	Sulphur.	Phosphorus.
2·54	0·052	1·139
Manganese.	**Graphitic carbon.**	**Combined carbon.**
0·698	Trace	1·74

Very poor retentivity, good permeability.

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The micro-photographs seem to indicate that almost the entire content of the pot-irons is in the carbide state. It is interesting to note that, in examining the structure of the cast-iron permanent magnet, the structure of carbide carbon is noticeable, although on a much smaller scale than in the former.

The Effect of Manganese.—The constituent which affects magnetic retentivity to the most marked degree, both in cast metals and in steel, is manganese. To trace the effect of this metal on iron alloys, different amounts of an 85 per cent. ferro-manganese were introduced into a ladle of the high-permeability semi-steel, similar to that above described, and the same magnetised, and the total lines of force emanating from bars of the same size determined. In every case manganese was seen to increase the retentivity to a marked degree. The following table shows this very clearly:

TABLE V.—Semi-Steel.

Magnetic lines before addition of ferro-manganese.	After addition. No. 1.	After addition. No. 2.
565	1,775	1,740
344	1,450	1,570

Magnetic Retentivity of Steel.—In selecting steel for magnetic purposes, although the retentivity is the main point in view, the physical qualities of the metal must be taken into consideration. The steel is usually bent cold, which requires a metal of considerable toughness, and must also stand a high hardening temperature without cracking. It is, therefore, a mean between maximum retentivity and maximum working qualities that is sought for. A better magnet might be obtained by increasing the carbon and manganese, but the metal would be so brittle, after certain contents were reached, that it would be of very little commercial use. It is a well-known fact that high contents of manganese, occurring simultaneously with high contents of carbon, have this effect, and a steel low in manganese will stand a higher carbon content without becoming brittle, assuming both the sulphur and phosphorus far below the danger limit. Regarding the effect of manganese on the physical properties of the metal, it is but natural that we should expect a marked effect on the magnetic properties, and this experiment shows to be true.

TABLE VI.—Analysis Showing Magnetic Lines per Square Centimeter, Average of Six Magnets for each Value.

No.	Lines per sq. cm.	Silicon.	Sulphur.	Phosphorus.	Manganese.	Carbon.
1	4,158	0·160	—	0·068	0·27	0·66
2	5,862	0·204	—	0·069	0·77	0·61
3	5,945	0·122	—	0·126	0 64	0·56
4	5,840	0·101	0·038	0·100	0 90	0·53
5	5,545	0·131	0·040	0·078	0·81	0·53
6	5,759	0·063	0·037	0·111	0·87	0·57
7	5,400	0·120	0·042	—	0·74	0·56
8	3,860	0·110	0·035	—	0·38	0·72
9	5,400	0·170	0·039	0·017	0 74	0·52
10	5,502	0·140	0·038	0·120	0 73	0·51
11	5,348	0·113	0·022	0·137	0·77	0·51
12	4,842	0·122	0·009	—	0·79	0·51
Higher heat.						
—	5,063	—	—	—	—	—
Highest heat.						
—	5,352	—	—	—	—	—

TABLE VII.—Showing Effect of Standing without Armatures on Magnetic Retentivity.

Dates. 1898	Lines per sq. cm.	Silicon.	Sulphur.	Phosphorus.	Manganese.	Carbon.
June 18.	6,411	0·173	—	—	0·74	0·52
July 5...	4,415	—	—	—	—	—
High heat.			Loss 31 %			
June 27.	5,352	—	—	—	—	—
July 7...	4,117	—	—	—	—	—
Extra high heat.			Loss 23 %			
June 27.	5,406	—	—	—	—	—
July 7...	4,360	—	—	—	—	—
			Loss 19 3 %			
Aug. 8..	5,348	0·113	0·022	0·137	0 77	0 51
Aug. 22.	3,725	—	—	—	—	—
			Loss 30 %			
Oct. 3...	5,063	0·133	0·009	—	0 79	0·51
Oct. 10..	4,403	—	—	—	—	—
			Loss 13 %			

In collecting data of this kind, difficulty is usually experienced on account of the change in magnetic retentivity due to the temperature of hardening, also of slight shock after magnetisation; but barring minor changes, the results, with but few exceptions, show clearly the effect of manganese on magnetic retentivity.

TABLE VIII.—Showing Effect of Temperature of Hardening on Magnetic Retentivity.

Lines per square centimetre.

Medium heat.	High heat.	Highest heat.
5,166	5,352	5,406

Analysis.

Silicon.	Manganese.	Total carbon.
0·173	0·74	0·52

Lines per square centimetre.

Medium heat.	High heat.	Highest heat.
4,842	5,063	5,352

Analysis.

Silicon.	Sulphur.	Manganese.	Carbon.
0·122	0·009	0·79	0·51

It is a curious fact that the steel in Table VI. having the highest carbon content, has the lowest magnetic strength. We notice, however, that it is considerably below the remainder of the steels in manganese with but one exception. The next lowest in magnetic strength in this table brings this fact prominently to our attention. In No. 1, containing 0·27 per cent. manganese and 0·66 per cent. carbon, 4,158 lines are reported per square centimetre. In No. 8, although the carbon has reached about its maximum for steel intended for magnets, being 0·72 per cent., the magnetic force is the lowest of any in the table, due in all probability to the fact that a steel of moderate carbon content and high manganese makes excellent magnets, while a high-carbon steel with low manganese makes rather a poor magnet. When the carbon and manganese are of average content for this grade of steel, say between 0·60 per cent. and 0·70 per cent., good magnets may be expected, but considerable loss is liable to occur in working them. The writer is accustomed to specify the carbon between 0·50 per cent. and 0·56 per cent., manganese 0·70 per cent. and 0·80 per cent., sulphur not to exceed 0·05 per cent., phosphorus not to exceed 0·10 per cent., and silicon not to exceed 0·15 per cent. This steel gives very good satisfaction in practical use. The sulphur and phosphorus are limited on account of their effect on the working qualities of the steel. Relative to silicon, it is probably true that ordinary contents of silicon usually found in magnet steel have practically no effect on magnetic retentivity. If this metalloid occurred in too high a content, it would seem, judging from its effect on permeability, that it would tend to weaken the magnet. Regarding the life of a magnet without its armature, there does not seem to be much difference. In the table here appended, the data are rather meagre. Unfortunately, the tests are collected from numerous records, and no standard time element is taken into consideration; but figuring the loss proportionately on a common time basis, it will be seen that very little difference is noticeable. Relative to the effect of the temperature of hardening on the magnetism, the common belief is certainly true, that the higher the temperature at which the magnet is hardened, the more magnetism is found. Isolated cases are sometimes found where this is apparently contradicted, but further examination will usually prove this to be an error. Repeated experiments with practical working seem to demonstrate that high heats are preferable. In this particular a moderate carbon and high manganese steel is found to excel. A higher hardening temperature can be utilised without great loss by breakage. This is not the case when the carbon content is high, or when carbon and manganese both exceed something like 0·60 per cent.

Deductions from the Effect of Manganese upon the Magnetic Properties of Iron.—The magnetic properties of iron, both permeability and retentivity, are regarded as properties relating to iron and carbon and iron respectively, and the effect of manganese is certainly worthy of attention. Permeability seems to be a property of iron itself, and is not notably affected by any of the metalloids usually associated with iron, other than carbon and manganese. Carbon is usually considered essential for permanent magnets, but I am unaware that manganese is regarded in this light. It

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seems but a fair assumption that hardening carbon is the state of the carbon favourable to permanent magnetism, and few metallurgists will dispute the fact that the carbon is in combination in this state. If, therefore, the carbon in combination has such a marked effect upon magnetism, and only when it is combined, why is it not legitimate to assume manganese in the combined form? There is little doubt of the powerful effect of manganese upon the magnetic properties of iron, and as metallic manganese possesses practically no noticeable magnetism, is it not peculiar that manganese alloyed with iron should have the effect of making iron retain magnetism? It seems, therefore, no more than legitimate to conclude that manganese in steel is in the combined form. Now, as the effect on the permanent magnetism of steel of manganese and carbon bear some mutual relations, we would naturally look for a combination between these two elements. It hardly seems equitable to argue that manganese is simply in the alloyed form. There is no reason why manganese cannot be combined in steel, and its effect, both on the physical and magnetic properties, tends to bear this assumption out. I think Mr. R. A. Hadfield is arguing along the right lines, and certainly the effect of manganese in magnet steel has not satisfactorily been explained on any other assumption.

It is to be regretted that the data here appended are not more complete, but such data are rather difficult to obtain. They, however, have the advantage of representing tests on a commercial scale. The permeability bars, for the most part cast as lugs on large dynamo-electric machinery castings, and the magnets taken from carload lots and average results from several magnets of each batch, make up the tables here given. In this connection I wish to acknowledge the help I have received from Mr. Herbert R. Kingman and Mr. George D. Hale in the electrical testing, and Mr. E. J. Ericson in the chemical examination, whose excellent help has greatly aided me in collecting such information as this paper presents.

RARE OXIDES INCANDESCENT LAMP.

We have received from Mr. F. M. F. Cazin, of Hoboken, N.Y., a long communication on his invention in connection with incandescent electric lamps using rare oxides in and about the filament. The first part of this communication deals with the controversy going on between Mr. Cazin and one of our electrical contemporaries in America, and we do not propose to reproduce the discussion in question. About the details of his lamps, which have been protected by various patents dating from 1892 to 1897, he points out that heat is too valuable to be allowed to escape indiscriminately into space in such enormous quantities as his calorimeter has proved to be the case from an incandescent vacuum lamp. The general form of Mr. Cazin's lamp is shown in Fig. 1, and the description which follows is given in his own words.

By permitting a minor part of the inner bulb to project and to remain in direct contact with the cooling atmosphere, the special advantage is secured of condensing within such minor projecting part all the products of evaporation from the luminous body, and of keeping the bulb proper free from all darkening deposits on its inside. Incidentally, and as a matter of great economy, he has designed an all-glass base part, requiring no cementing and less manipulation in the manufacture of the lamp.

Passing from these features to the more (or equally) important one, relating to the luminant proper of the lamp, a short review of its evolution may be given. In the matter of conductivity, it was found that a luminous body of carbon and oxides in direct contact not only rapidly decreased in resistance, but afterwards entirely loses its conductive qualities. Investigation showed that the carbon filament had almost entirely disappeared, and a very irregular scattering of spots of reduced metal remained on the contact face of the oxides. When he applied the remedy of chemical insulation by coppering the carbon filament or gilding a filament of metal, equally apt to oxygenate as carbon, though of an extremely high point of fusion, he had to intercept the insulating coat by ring-shaped intervals to prevent increase of conductivity. While this resulted in a practical luminant, not only did the exterior, corresponding to the interception of insulating, appear in more brilliant incandescence, but investigation showed that also in this case the stated reaction had taken place, but had been confined to the narrow angular interceptions, causing an alloy coating on the contact face. This metal coating, conjointly with reduced metal from the oxides, must in the second use of the lamp have acted as the conductor until the oxides, sufficiently heated, filled the gap, or the conductor stubs must have acted as arc pencils until the oxides became conductive and offered less resistance than the automatically intercepted filament. In this connection attention should be directed to the important fact that no arc lamp proper can possibly utilise rare metal oxides for increase of light efficiency, for the simple reason that oxide pencils do not conduct, and that in order to become fit for such utilisation the arc lamp must cease to be an arc lamp and must become a continuous lamp or a filament lamp by inserting the hot oxides as conductors. With a continuous conductor, though of different material at intervals, the condition of practical success consists in so regulating the initial resistance that it be higher than that of the heated

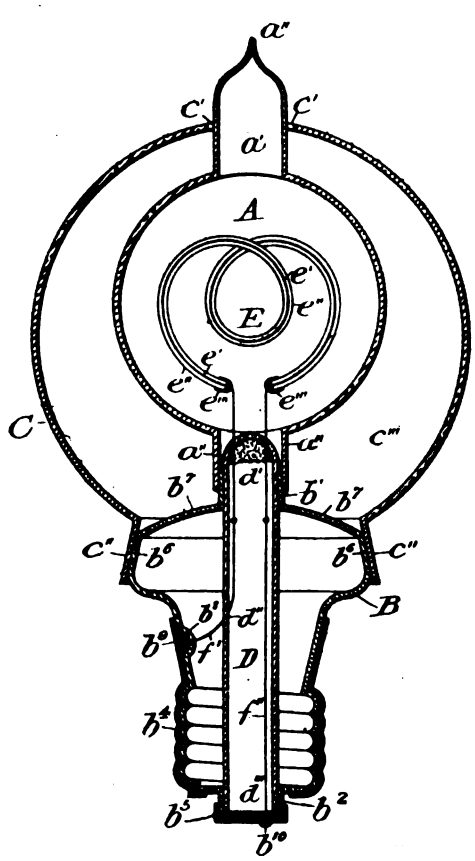

FIG. 1.

oxides. Of the experience thus described, Mr. Cazin says he took advantage in applying the coat of oxides only to those parts of the conductor where the insulating coat was intercepted and where they showed the higher brilliancy of incandescence. But in locally bridging over the gaps in the insulation he still preferred to decrease the solid volume and to increase the light-emanating surface, by applying the oxides in the shape of pseudo-fibres or fabrics, fritted into adhesiveness and cohesiveness by an admixture of fluor-spar and application of momentary excessive current to the well-protected conductor. It is evident that with a complete protection of the core against oxygenation, the vacuum may be dispensed with.

Patent No. 620,640 is said to secure the luminous body of the conductor and oxides with the indispensable intermediate insulating stratum, in proof of which the following claim is cited: "(1) A three-part electric incandescent vacuum lamp, consisting of a suitable base, and air-exhausted glass bulb, and a body or structure of solid matter, which latter part constitutes a cohesive entirety, and as such

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consists of two main constituents—namely, of a continuous linear semi-conductive current-passing filament, which resists to a passing electric current to the effect of giving off light and heat, and which filament is electrically and chemically insulated from the other constituents, by a protecting stratum, and a stratum of matter, which by the heat given off by the filament becomes luminous, as and for the purpose set forth." But the same patent secures also the luminous body of oxides, with a filament of material not in affinity with oxygen, by the claim: (3) "A three-part electrical vacuum lamp, consisting of a suitable pole-connecting base, an air-exhausted glass bulb, and a body or structure of solid matter, which latter part consists of two or more adhesive parts, which are in permanent contact with one another, these parts or constituents being: a linear continuous semi-conductive current-passing filament, which is electrically and chemically neutral or insulated as against the other constituents, and solid matter, that is peculiarly adapted to become luminous by heat and exceeds in main volume that of the filament, as and for the purpose set forth."

Patent No. 621,291 is said to secure the use of oxides in the shape of pseudo-fabrics, as may be shown by citing two claims of eight—namely: (5) "In an electric incandescent lamp a luminous body, which consists of two or more cohesive parts—namely, an inner or filament part, and an outer part or parts, which mainly consist of refractory rare metal oxide, such outer part or parts covering the inner part in part only—as and for the purpose set forth." (8) "In an electric incandescent lamp a three-part luminous body, consisting of an inner core and filament, of an insulating stratum on such core, and of an outer partial cover or pseudo-fabric of rare metal oxide, as and for the purpose set forth."

Mr. Cazin adds that preparations are being made for putting his new lamp on the open market, and adds that it will then be time to speak with full precision of the virtues of the new lamp, which, aside of the regular current, requires no other, and requires no flame, and no magnets to set it a-glowing, has no features of any practical doubtfulness, and which costs only a few cents (and not dollars) more to make than the present lamp, and is protected by priority, and by broad and specific claims in all its essential features, which covers the whole practicable ground to the exclusion of all more recent attempts in the same direction.

The author's claims are naturally wide, and one can but wish that his descriptions were clearer.

ELECTRIC LOCOMOTIVES IN PRACTICE, AND TRACTIVE RESISTANCE IN TUNNELS, WITH NOTES ON ELECTRIC LOCOMOTIVE DESIGN.

BY PETER MCMAHON, MEMBER.

The following is an abridgment of the author's valuable paper, which was read before the Institution of Electrical Engineers on May 4, and which is too long to be reprinted in full.

The paper contains the result of tests and observations made on electric locomotives in everyday work on the City and South London Railway, and extends over a period of about two years. The first series of observations made was on the effect of "varying the starting current" upon the acceleration of the train, and shows that the amount of current taken by the locomotive at starting has not much effect, within fairly wide limits, on the time taken to run a particular section, or the total energy drawn from the line. This, of course, applies to a series motor, with plain series method of regulation. Experiments were then made to determine the nature and amount of the various losses in the locomotive, both at starting and when the train had attained its full speed. To arrive at this some of the motors were tested under various conditions as stationary motors, and the results are compared with tests of the motors running on the rails under ordinary conditions of working. The "locomotive dynamometer" with a rubber diaphragm was used in tests for runs extending over 100 miles; it is still in good condition, and was calibrated before and after a test, time after time, and its readings agreed with wonderful accuracy. From the results of locomotive tests with dynamometers on the rails, the "tractive resistance" of the trains running in the tunnels was obtained. Upon these experiments were based all the calculations and deductions arrived at in the notes on locomotive design. The "tractive resistance" per ton of train as shown by the tests may appear high as compared with the results obtained on ordinary steam main lines. This high resistance is no doubt due to the skin resistance of the train to the air in the close-fitting tunnel. Further, it must be remembered that the train wheels are only 2ft. in diameter, which is about half that of a main-line carriage wheel. Fig. 1A shows the outline of locomotive and train in the tunnel. Experience of some thousands of observations on the locomotives shows that the values of current, speed, and draw-bar pull vary within certain limits over the same piece of track without any apparent reason. To ensure accuracy the curves and figures given by way of illustration were chosen as representing a fair average of several trials, and the horse-power, efficiencies, etc., are the mean of these averages. In dealing with the question of locomotive design, the results on a level piece of road only were considered, but obviously the conclusions arrived at also apply to a line with varying gradients, due allowance being made for the effect of gravity.

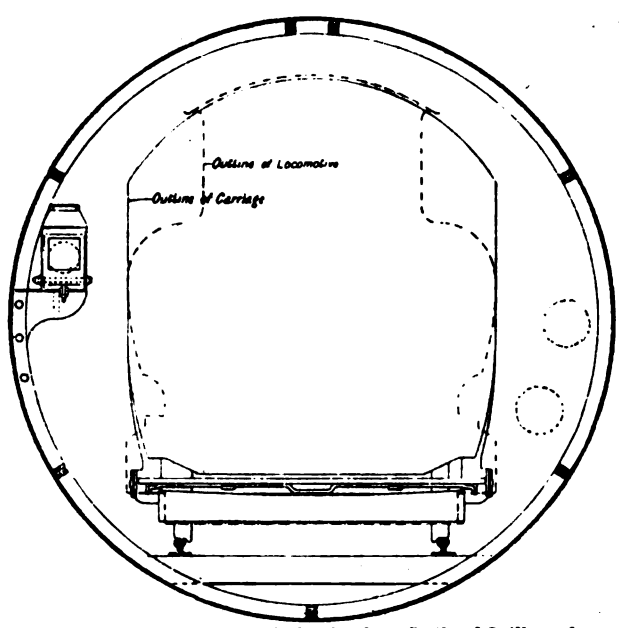

FIG. 1A.—Section of Tunnel, showing Cross-Sectional Outlines of Locomotive and Carriage.

Description of Locomotives and Carriages.—Before describing the experiments or detailing the results, a short description is given of the locomotives and carriages employed. The three locomotives used, Nos. 12, 15, and 17, were built to the same general design and overall dimensions, the only outward difference being in the shape of the cab, which in the case of 15 and 17 is bulged at the sides instead of straight, as in the case of No. 12. The leading dimensions are as follows: gauge, 4ft. 8½in.; overall height above rail-level, 8ft. 5½in.; overall length, buffer to buffer, 14ft.; extreme width, 6ft. 10in.; wheel base, 6ft.; diameter of wheels, 2ft. 3in.; width of tyres, 4¾in. Each locomotive has two motors, the armatures of which are fixed directly on the axles. The motors are arranged in series, and the regulating gear consists of a reversing switch which changes the armature connection, a simple rheostat switch in series with the motors, and a main break switch.

The electrical particulars of the motors are as follows: No. 12 locomotive has a Gramme ring armature of 17½in. diameter and 17in. long, wound with 540 turns of No. 10 wires. The magnets are 17in. by 10in. in section. The armature resistance is ·30, and the total resistance ·80. The motors are of the Edison-Hopkinson type. No. 15 locomotive contains motors of the two-pole Siemens type, with drum armatures 14⅜in. diameter and 24in. long. These are wound with 500 turns of ·400 by ·078 conductor. The magnets are 24in. by 10in. in section,

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The armature resistance is ·1810, while the resistance of the whole locomotive is ·1650. No. 17 locomotive contains motors of the two-pole Edison-Hopkinson type, with Gramme ring armature of 17½in. diameter and 20in. long. Except in the length of the armature and in the field these motors are practically the same as those of No. 12 locomotive. The armature resistance is ·3150, and the whole locomotive ·850.

Dynamometers.—Some sort of dynamometer was found necessary in the earlier tests of the static pull, and the author describes the type used, and its defects. These were internal friction, which prevented small readings being accurate, and also the awkward size of the apparatus. It was therefore necessary to design a compact dynamometer in which the internal friction was a minimum. This was effected in the design shown (Fig. 3), which was inserted in the train draw-bar cradle in the place usually occupied by the spring. The available space in this cradle was limited to 6in. across, and even if a larger cradle had been made, the clearance between the centre of the draw-bar and the conductor at the crossings would have prevented anything greater than a 6in. diameter being used. The difficulty was again increased by having to allow a 1¾in. hole in the centre to take the shank of the draw-bar. The containing vessel or chamber was a cast-iron ring 5⅞in. in diameter, with a $1\frac{15}{16}$in. hole in the centre. A recess 1in. wide and ½in. deep was turned in the face, and two steel rings were screwed on to make the joint between the face

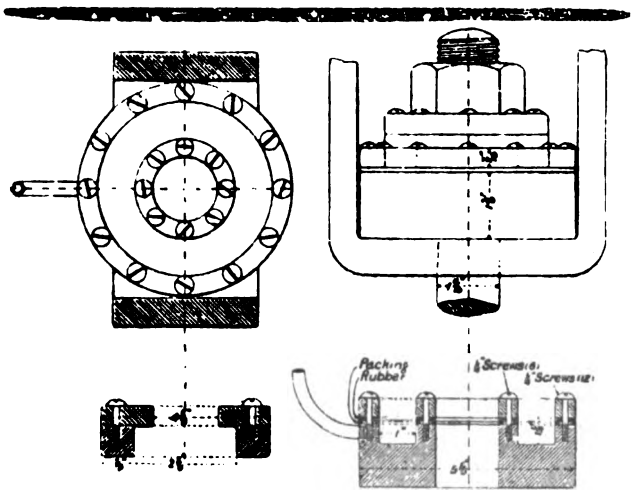

FIG. 3.—Hydraulic Dynamometer for Carriage.

and the diaphragm. The circular ring and cap exerted pressure on this diaphragm. This was transmitted to the water, and its amount was recorded on the gauge. This form, which we may call the train dynamometer, gave very satisfactory results, but it was found inconvenient to have the dynamometer fixed permanently (during testing) in the train draw-bar. In order to get the dynamometer on the locomotive draw-bar the design had to be completely altered, on account of the space available. The same idea was retained, but two diaphragms were employed with a passage between the chambers. The dimensioned sketch (Fig. 4) probably makes further description unnecessary. In actual working, this locomotive dynamometer gave even better results than the train dynamometer. Considerable difficulty was experienced in finding a suitable material for the diaphragm. Very thin sheet copper was first tried, but the sudden and uneven jerks tore the copper close to the joints. Plain indiarubber about $\frac{1}{16}$in. thick was next used, but with this it was difficult to make a joint, as when the rings were screwed up sufficiently to make a joint to stand a pressure of about 200lb. per square inch, the rubber expanded considerably and raised a bulge in the middle, which affected the working of the dynamometer. Rubber insulation with wire gauze failed, owing to the wire gauze cracking close to the joint and piercing the rubber. A diaphragm of rubber and canvas insertion was next employed, and so far has proved satisfactory. Calibration curves of these dynamometers were obtained in each case by testing the dynamometer in position on the respective draw-bars with a spring balance and lever, with knife-edge bearings. In the case of the train the necessary pull was exerted by a screw between the train and a fixed point. With the locomotive the draw-bar was attached to a fixed point and varying currents were used; then the locomotive static pull was checked at the same time, and compared with the pull as tested by the first dynamometer.

The first experiments carried out by the author were on the effect of varying the starting current on the acceleration of the train and the running speed. These experiments were conducted with the object of determining if there existed any particular value of the tractive coefficiency per ton pull at starting and while running which would give a minimum time between stations combined with a maximum efficiency for the energy expended. For this purpose two complete round trips were made under ordinary running conditions, the only exception being that in the first trip the starting current was limited to 100 amperes and kept steady by the regulating switch until all the resistance was cut out, and the current commenced to

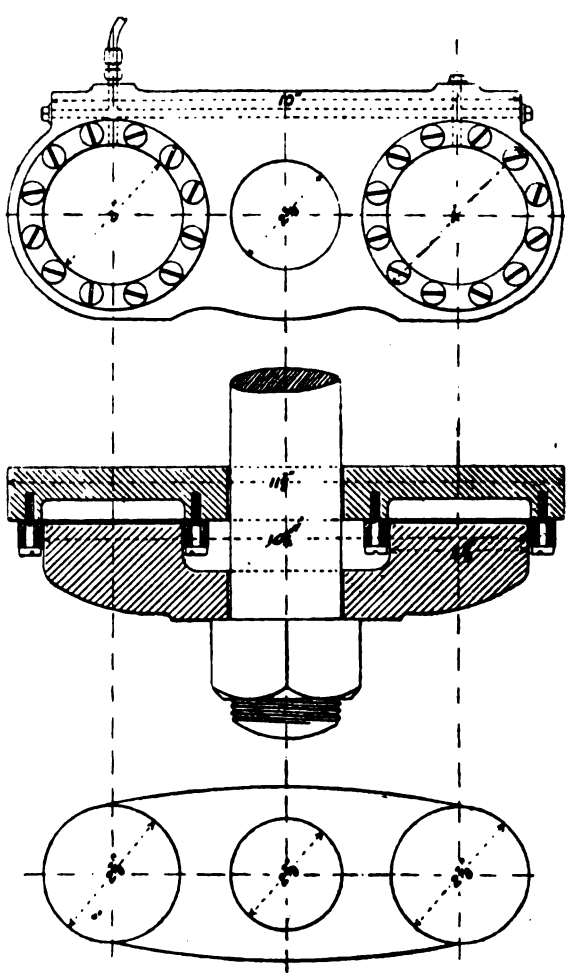

FIG. 4.—Locomotive Dynamometer.

drop on account of the back E.M.F. of the motors. The second trip was made with a starting current of 120 amperes, the third with one of 140 amperes, the fourth with 160 amperes, and the fifth with 180 amperes—starting from each station, and maintaining these various currents steady, as in the first case, until the back E.M.F. brought the current down. After giving the results, the author draws conclusions from those obtained between the Elephant and Castle Station and the Kennington Station. On this section, for starting currents of 100, 120, 140, 160, and 180 amperes, the velocities are 13, 14, 14·5, 14, and 14·75 miles per hour respectively; the difference in the speed attained is more marked at this station than the others, probably on account of the rising grade on leaving the station. The mean speed is 14·05, but generally it seems to be independent of the value of the starting current. There is, however, a difference in the time taken to attain this velocity, the time decreasing as the starting current is increased—viz., 60, 50, 45, 40, and 45 seconds for current values of 100, 120, 140, 160, and 180

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amperes respectively. It will be noticed that this relationship decreases as the higher values of current are reached; this is caused by the current falling off more quickly for higher values, the average current during the start being, therefore, much below its proper value. An inspection of the speed and current curves makes the reason clear; as the current or tractive force per ton is increased the acceleration (in feet per second per second) becomes greater, and in consequence the back E.M.F. of the motors prevents the initial value of current being maintained until the train has received its velocity.

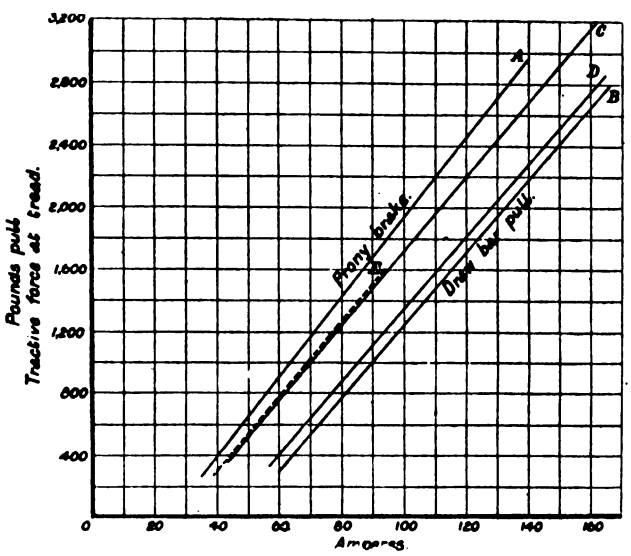

FIG. 6.—Locomotive No. 15.

Motor Tests.—The author then proceeded to investigate conclusions he had arrived at to the effect that the actual draw-bar pull at starting does not correspond to the horizontal effort at the tread of the wheel as obtained by the Prony brake. He found that the draw-bar pull was only about 73 per cent. of the actual tractive effort at the tread of the wheel of the motor. In order to find where the difference lay, several tests were made under various conditions. With the aid of a Prony brake the motor was

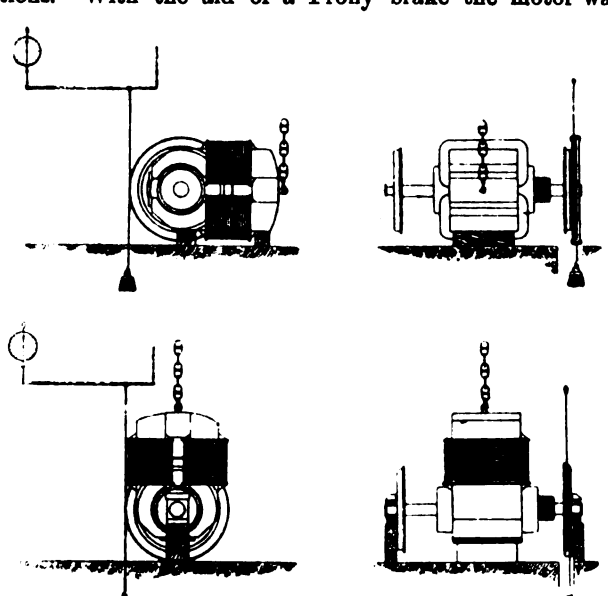

FIG. 7.—Tests of Motor of Locomotive No. 15 under Different Conditions.

first tested lying on its back, with the weight of the armature and wheels on the bearings, as in the case of an ordinary stationary motor. Currents varying from 15 to 170 amperes were passed through the motor, and the voltage, speed, torque, and current were observed; from the torque the tractive force in pounds at the tread of the 27in. diameter wheel was calculated; this tractive force and current being plotted gave a straight line (A, Fig. 6), 15 amperes being the amount taken to start and run the motor light. The speed and voltage need not be taken into consideration for our present purpose. The actual draw-bar pull of the locomotive on the level rails was next obtained by coupling, first a dynamometer, and afterwards a spring balance, between the draw-bar and a fixed point, this giving a condition of affairs similar to a train starting from dead rest. It may be mentioned, however, that the current necessary to just start the light locomotive was 50 amperes (the result of about 30 trials), the dynamometer being of course uncoupled for this test. The least current with which the locomotive would exert a pull that could be measured with tolerable accuracy was 60 amperes, the pull being 300lb. The current was then increased to 200 amperes by steps of 10, and the pull in pounds was noted. This static draw-bar pull was measured under several conditions—viz., backwards and forwards, on clean rails, rusty rails, and rails that were fairly worn, with two different hydraulic dynamometers, and with a spring balance and lever—the results in every case agreeing within

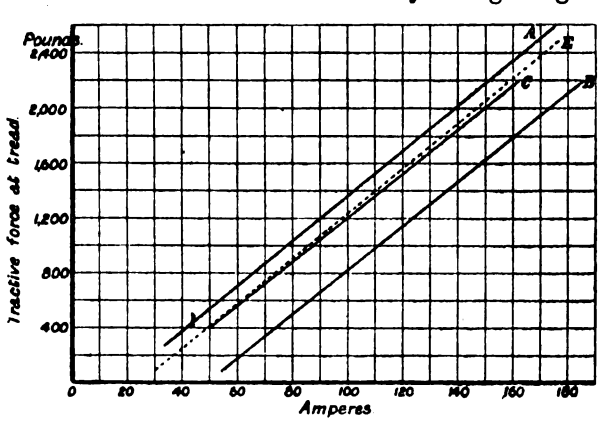

FIG. 8.—Locomotive No. 12.

the errors of observation. The curve plotted (Fig. 6) is the result of quite 200 observations. It is worth recording, however, that better results were obtained with the spring balance for the lower readings on account of the friction between the piston-rod and gland of the dynamometer. Comparing the tractive force at the draw-bar (Fig. 6) with the tractive force at the tread of the wheel in the Prony brake test, we can see there is a difference between these two curves of 620lb. at 60 amperes and 800lb. at 150 amperes; taking the mean, there is thus a loss of over 700lb. to be accounted for. It is well known from steam railway working that the friction of bearings at starting is many times that obtained in running, due no doubt to the fact that the film of oil that exists between the surfaces of the axle and brass when the axle is at rest is squeezed out,

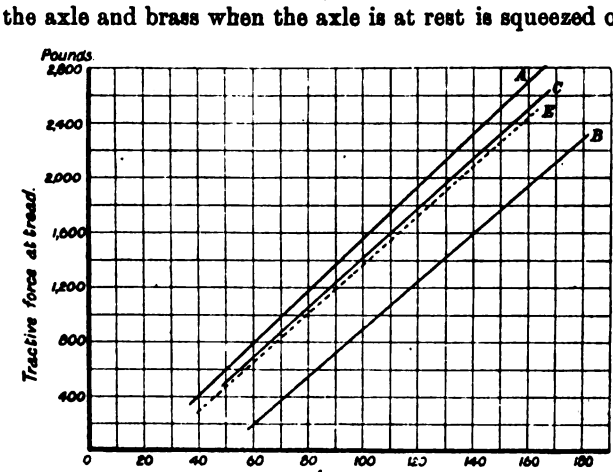

FIG. 9.—Locomotive No. 17.

and the surfaces are in metallic contact. With a view to determine whether this loss of 51lb. per ton was all due to the above cause, further experiments were made as follows: One of the motors was tested lying on its back, as in the Prony brake test, but the armature was only allowed to make a small fraction of a revolution—in fact, it only turned an amount allowed by the elongation of the spring of the balance (Fig. 7); in this manner the static pull at the tread of the wheel was measured, with currents varying from 30 to 180 amperes, the current increasing by steps of 10. The result of several such trials, some beginning with high

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currents and coming down, are given by Curve C (Fig. 6). There is a difference of 120lb. between Curves A and C at 50 amperes, and of 280lb. at 150 amperes. It would seem as though the increased loss of 160lb. at 150 amperes was caused by the magnetic pull of the field magnets on the armature (due perhaps to the armature being slightly out of balance magnetically with respect to the field), tending to further squeeze out the oil for higher values of current, this squeezing out of oil being opposed to a certain extent by the revolving armature in the Pony brake test keeping the bearing properly lubricated. In order to find the loss due to the weight of the magnets a test similar to the last was made, but in this case the motor was allowed to work on its outside bearings or axle boxes, the motor being kept in a vertical position, as shown by sketch (Fig. 7). In this manner the total weight of the armature and magnets was borne by the outside bearings, and the additional loss due to the weight of the magnets was obtained, the results plotted giving Curve D (Fig. 6), which shows 360lb. less than C for all values of current, indicating that the loss due to the additional weight of the magnets is constant. If we now assume that the friction in the motor bearing is proportional to load, the additional loss due to the weight of the locomotive cab switches, resistances, etc., is 350lb. The total loss then between the static tractive effort with the motor lying on its back and the draw-bar pull should be 710lb. This loss as actually measured and shown by the vertical distance between the Curve C and the draw-bar pull is about 700lb. Having to some extent accounted for the loss between the tractive force at the tread of the motor wheel and the draw-bar pull, the question then arose, What is the draw-bar pull when the locomotive is running on the rails? Taking the value of the draw-bar pull from the Curve B for 60 amperes, the average value of current during a run between stations showed that this pull, 300lb., was not sufficient to overcome gravity alone, not to speak of other resistances. Clearly, then, the pull exerted in running must be considerably greater than that exerted at starting for the same value of current. An attempt was made to analyse this by further tests in the shops, but without success. Tests were made in a similar way with No. 12 and No. 17 locomotives, and the results are plotted on Figs. 8 and 9.

(To be continued.)

THE DISCUSSION.

Mr. J. W. Swan, the president, occupied the chair at a meeting of the Institution of Electrical Engineers held on Thursday, the 18th inst., when Mr. McMahon's paper was discussed.

Mr. C. E. Grove said that although they accepted the author's results with respectful gratitude, yet when he left the facts and began to explain them, and, still more, when he went to broad theory, he was not quite so happy. He criticised the way in which the term draw-bar pull had been introduced, remarking that this had not been treated by Mr. McMahon with the precision they might have expected. Quoting the paper, he called attention to the statement that "experience shows that the actual draw-bar pull at starting, as measured by a dynamometer, is only about 73 per cent. of the actual tractive effort at the tread of the wheel of the motor;" and Mr. Grove pointed out that further on the author, still dealing with the same subject, said that "at Kennington at five seconds after starting the draw-bar pull, as shown by the dynamometer, was 1,075lb." There appeared to be some confusion on these matters. Proceeding to enter upon further criticisms, he said the author had mentioned that "between Stockwell and the Oval the average draw-bar pull was 268lb. for an average current of 36·8 amperes at an average speed of 18·4 miles per hour (during the running period). The average tractive force due to acceleration, plus or minus gravity, was 8·36lb., leaving 259·71b. as the tractive force at the draw-bar of the locomotive on the level at a constant speed. From the Prony brake test the tractive force at the tread of the wheel for a current of 36·8 amperes was 340lb., leaving 80lb. as the locomotive losses, in which are included journal and rail friction and air resistance." Surely, said Mr. Grove, rail friction and air resistance were not locomotive losses. Having criticised the Prony brake test and referred to other points suggested by the paper, he proceeded to deal with the curve diagrams, and then, reverting to the earlier part of the author's observations, in which reference was made to the attempt to obtain the efficiency of No. 15 locomotive under actual running conditions, he took exception to the following passage: "That the tractive effort at the tread of the wheel as calculated from the tests of the motor with a Prony brake was the same as the draw-bar pull, the locomotive hauling a load came out with an efficiency of over 100 per cent." There must, Mr. Grove said, be some error in regard to this, either in the figuring or in making the measurements. He concluded by referring, as a matter of personal experience, to the difficulties of taking accurate results.

Mr. A. M. Taylor was afraid he could hardly do justice to the paper from one point of view, as he had not had time to consider it. Three years ago he took up this matter of tractive resistance, and he was rather surprised to find that his results differed materially from those of the author. The first discrepancy he noticed between their results was with reference to locomotive No. 15. Having explained the nature of this, he referred to other divergencies between his figures and those obtained by Mr. McMahon.

Mr. W. M. Mordey, having congratulated the author on the valuable results obtained, expressed a hope that some of these would be criticised that evening by their American friends, who had had so much more experience than they themselves on many points. He was particularly pleased with the controller the author had shown, as it worked well, and yet was a radical departure from the American practice. He had been thinking over the question as to why this controller worked well without a magnetic blow-out, and thought the explanation was probably this: that the current was always switched off when the motors were running at full speed. In the case, however, of ordinary tramway work, it was very frequently necessary to break a current at low speeds, which set up a much more destructive sparking. In 1886, in some remarks before this Institution, he had called attention to the fact that much heavier sparking occurred when interrupting the current of a generator than when breaking that of a motor.

Mr. Clark intimated that he would send in his remarks in writing.

Mr. R. P. Brousson said he had listened with very great interest to Mr. McMahon's paper, and appreciated the amount of work this represented. He quite agreed with the author as to the necessity of taking frequent readings. He (Mr. Brousson) had recently been making experiments in America on the trial locomotive for the Central London Railway. In this case they had used an oil dynamometer to measure the draw-bar pull, and had found it necessary to take readings of this and of the electrical quantities every two seconds. He did not consider that the maximum acceleration given by the author of 1·46 was high. On the elevated railways in Chicago an acceleration of 2·25ft. per second per second was used without inconvenience to the passengers. On street-car service considerably higher accelerations were met with in America. The passengers did not feel a high acceleration so much as the sudden change in that acceleration. Mr. McMahon was to be congratulated on the results he had obtained.

Prof. Smith referred to the tribute of gratitude and admiration that was due to the author for the immense amount of work the paper represented—this tribute, which was very greatly deserved, coming from everybody interested in the subject. It was not only the work represented by the taking of measurements and experiments, but in this case the work done in making calculations from these experiments was even greater than that involved in taking the actual measurements themselves. In the present case the results were taken at five seconds' intervals, and therefore there was the possibility of very much more refinement of calculation. That such refinement had been aimed at with all the labour attendant upon it was shown throughout those diagrams; the strange shapes the acceleration curves took in all of them were the results of laborious calculations. He himself had frequently advocated the absolute necessity of taking observations at very frequent time intervals in investigating this subject, and was very glad to have heard, at least in one case, of two seconds' intervals. He did not think this was too close, his idea being that they should go a good deal closer even than that. He thought that acceleration could be with nicety in instrumental design measured with as great accuracy, perhaps greater, than velocity. (**Prof. Perry**: Greater.) He quite agreed with Prof. Perry, and, he might add, with greater ease in avoiding errors In the course of his criticisms he said the difficulty of understanding the paper had been increased by vagueness of expression throughout. For instance, with regard to draw-bar pull, a very unnecessary amount of doubt and difficulty was carried on through a good many parts of the paper before the author seemed to recognise the immense importance of acceleration. He concluded by offering further criticisms.

Prof. C. A. Carus-Wilson was very much obliged to Mr. McMahon for his attempt to solve the problem of air resistance in tunnels. They were not, however, told what the air resistance experienced by the locomotive itself was, and when the author published his paper he (Prof. Carus-Wilson) would be glad if he could add any information on the point, because in tunnels the friction on the sides of the cars was a very small proportion of the resistance to the whole train, and if Mr. McMahon possessed any further data—anything to add with respect to the air resistance encountered by the head of the train—this would be of great value. Having dealt with other points suggested by the paper, he thought the author should be congratulated on what he had done with respect to field shunting as a means of control.

Mr. McMahon, in his reply, said he was very flattered with the way in which the Institution had received the paper. If he had been more particular in the way in which he used the phrase, "draw-bar pull," he might have saved a great deal of discussion. He then proceeded to explain the experimental means he took to find out what result was obtained in pulling a train along, and having referred to Fig. 17 and to p. 13 of the paper, he explained that the actual pull measured by the draw-bar was obtained from

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experiments made practically at rest and on the level. Having more fully explained himself in regard to other points raised during the discussion, he proceeded to deal with Mr. Taylor's comments. With reference to what had been noticed by Mr. Mordey, he himself had noticed that the difference in sparking found when switching off a motor or a dynamo was very great indeed. After explaining the reason why no magnetic blow-out was used in the controller, he referred to Mr. Brousson's allusion to the 1·46 acceleration. This, it was thought, was high enough, as if the stopping was effected at a greater rate persons travelling complained of being thrown against each other. If this was the case in stopping, it would naturally take place also in starting. Therefore no good would be derived in spending energy in starting too quickly. As to Mr. Brousson's remark respecting the acceleration not being uniform, he explained that Diagram 37 was one of the earlier of these, and he would refer him to Fig. 47. He (Mr. McMahon) also thought that simplicity in the controlling arrangements was almost the first thing that should be aimed at. Having replied to Prof. Smith, he next turned his attention to Prof. Carus-Wilson's enquiry as to the air resistance on the front of a train. This, Mr. McMahon said, was a very difficult result to arrive at, and he then proceeded to describe the method employed in carrying out his experiments to attain this end.

The **President** said he was sure all present would agree with him that they were greatly indebted to Mr. McMahon for having placed before them his most interesting and valuable paper, representing as it did an immense amount of painstaking work on a subject of very great importance, and at a very opportune moment. Up to the present time they had been singularly backward in the means they had employed in using electricity for traction. He had noticed that the chairman of the committee of the House of Commons, in dealing with the question of the London railways, had put in the form of a question, "Are there not a large number of underground electric railways in the air at this moment?" By doing so the chairman of the committee conveyed the fact that they did appear to be awaking up to the importance of electric traction, and Mr. McMahon's paper came, as he had already said, at a most opportune moment. It had elicited a most interesting discussion, and constituted an important addition to the records of the Institution. Having suggested that their appreciation should be conveyed to the author formally by acclamation (a suggestion which was cordially responded to), the president concluded his observations by announcing the date of the annual general meeting of the Institution, which was arranged for last (Thursday) evening, May 25.

INSTITUTION OF ELECTRICAL ENGINEERS.

The annual general meeting of this Institution was held last (Thursday) night at the Society of Arts, John-street, Adelphi. As no nominations were received other than those announced at the ordinary meeting on April 27 these were elected, so that the following constitute the Council and fill honorary offices for the ensuing year:

President—Prof. Silvanus P. Thompson, D.Sc., F.R.S.

Vice-Presidents—Prof. John Perry, D.Sc., F.R.S., W. E. Langdon, James Swinburne, M.I.C.E., Robert Kaye Gray.

Members of Council—S. L. Brunton, Major P. Cardew, R.S., Prof. J. A. Ewing, F.R.S., W. P. J. Fawcus, M.I.C.E., John Gavey, Robert Hammond, M.I.C.E., A. J. Lawson, P. V. Luke, C.I.E., E. Manville, W. M. Mordey, J. S. Raworth, M.I.C.E., R. P. Sellon, A. A. Campbell Swinton, Herbert Taylor, M.I.C.E., Charles Henry Wordingham, M.I.C.E.

Associate Members and Associates—S. Evershed, R. W. Wallace, Q.C., Arthur Wright.

Honorary Auditors—Frederick C. Danvers, E. Garcke.

Honorary Treasurer—Prof. W. E. Ayrton, F.R.S., past-president.

Honorary Solicitors—Messrs. Wilson, Bristows, and Carpmael.

At the same meeting the accounts for a period of 15 months were presented for adoption. These are as follows:

BALANCE-SHEET, DEC. 31, 1898.

Liabilities.			£	s.	d.
Premium fund			213	0	3
Telegraph jubilee fund			163	8	0
Life compositions—balance uninvested			173	0	6
Subscriptions received in advance			64	17	6
Salomons scholarship fund—balance of income account			14	4	6
Building fund—balance uninvested			1	2	1
Sundry creditors			46	17	7
General fund—balance as per last accounts	£4,549	3 8			
Add estimated value of books, etc., presented	43	0 0			
Add excess of receipts over expenditure	526	13 6			
	5,118	17 2			
Less amount transferred to building fund as above	500	0 0			
			4,618	17	2
			£5,295	7	7

Assets.			£	s.	d.
Investments, premium fund			213	0	3
Ditto, telegraph jubilee fund			163	8	0
Ditto, general fund			2,582	19	4
Furniture account (as per last balance-sheet)	£218	10 0			
Add new stand for index drawer	2	11 0			
Add new stand for bust of Sir Charles Bright	2	2 6			
			223	3	6
Stock in hand of Institution *Journals*—Ronald's catalogues, etc., as per last balance-sheet	409	12 0			
Cost of additions in 1898	65	0 0			
	474	12 0			
Less amount realised during the year	120	2 1			
			354	9	11
Books, pictures, etc., other than the Ronald's Library (as per last balance-sheet)	1,207	0 7			
Add value of books and periodicals since purchased, and cost of binding	17	10 3			
Ditto, presented	43	0 0			
			1,267	10	10
Sundry debtors for advertisements in the *Journal*			14	7	0
National Telephone Company's deposit			0	10	0
Suspense accounts (Cooke's manuscripts, etc.)			25	4	1
Cash balances at bankers	£381	14 6			
Petty cash account	69	0 2			
			450	14	8
			£5,295	7	7

Receipts.			£	s.	d.
Annual subscriptions			4,083	0	6
Entrance fees			646	11	6
Advertisements in the *Journal*			75	0	0
Publishing fund			1	1	0
Dividends on investments: premium fund, £8. 13s. 9d.; telegraph jubilee fund, £6. 7s. 6d.; life compositions, £143. 8s. 1d.; general fund, £84. 17s. 2d.			243	6	6
Interest on cash on deposit			9	5	0
			£5,058	4	6

Expenditure.			£	s.	d.
Salaries			1,155	15	6
Retiring allowance			264	5	8
Accountants' fees			10	10	0
Shorthand reporter			63	0	0
Attendance, refreshments, and petty expenses connected with evening meetings			99	12	3
Printing, illustrating, and advertising *Journal*, £731. 12s. 4d.; less cost of copies taken into stock, £65			666	12	4
General printing and stationery			356	13	0
Insurance			7	5	0
Cost of experiments in connection with wiring rules			10	2	6
Office rent, electric light, and firing			409	12	1
General office expenses: sundries, £139. 15s. 6d.; postage of *Journals*, notices of meetings, etc., £382. 4s.; cost of illuminated address to M. Gramme, £5. 5s.; cost of wreath for the late Mr. Latimer Clark (past-president), £5. 5s.; cost of redecoration of library and offices, £39. 14s. 2d.			572	3	8
Petty expenses of local honorary secretaries			3	17	8
Bank charges			1	6	11
Conversazione expenses (irrespective of printing and postage)			169	15	10
Premiums (1896-7 and 1897-8)			116	1	4
Contribution to *Science Abstracts*			624	17	3
			4,531	11	0
Balance carried to general fund			526	13	6
			£5,058	4	6

The life compositions account shows investments amounting to £4,239. 9s. 6d., while the Salomons scholarship fund stands at £2,126. 19s. 3d. The building fund account has now reached a grand total of £5,277. 0s. 6d.

The following were the candidates balloted for:

Member.—Mrs. H. Ayrton, 41, Kensington Park-gardens, W.

Associate Member.—Captain G. P. A. Ackworth, R.E., 9, Kingswood-villas, New Brompton, Kent.

Foreign Member.—Colonel F. Pescetto, Turin, Italy.

Associates.—P. F. Anley, 2, Venetia-road, Ealing, W.; A. E. C. Burgess, 127, Fordwych-road, West Hampstead, N.W.; J. Gray, 5, Allan-street, Dalmarnock, Glasgow; E. B. Greenall, 20, Peel-street, Nottingham; W. C. Grinyer, Science Buildings, Tunbridge Schools; C. H. Hainsworth, Woodleigh, Millhouses, Sheffield; J. S. Plumtree, Messrs. Wright's Finishing Company, Carlton-road, Nottingham; R. C. Roberts, 26, Russel-road, Kensington.

Students.—L. A. Creasy, 60, Comeragh-road, West Kensington, W.; J. T. Haynes, 43, Brownswood-road, Finsbury Park, N.; R. H. Logan, 31, Hamlet-road, Chelmsford; G. W. Mayne, C. H. Millar, and W. T. Wheeler, Faraday House, Charing Cross-road, W.C.; T. P. Miller, Merlewood, Grange-over-Sands, Lancashire; Captain W. J. Underwood, 4, West Park-road, Newport, Mon.; F. P. Williams, 32, Hamlet-road, Chelmsford; F. N. Younger Hillside, Moulsham, Chelmsford.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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ANY PRINCIPLES OR NOT?

There is an old Oxford wheeze which winds up with "the same old tale." Unfortunately, or, perhaps, fortunately, mankind has to preach the same old tale again and again in many directions, not the least important of which are those of a purely business character. The text of most business men is "expediency and self-interest," and a good text it is, but the following out blindly its teachings is sometimes apt to lead astray, or, rather, to lead away from undying principles. Since the introduction of municipal authorities into the position of central-station owners, a more or less mild controversy has been going on as to what the authorities should do with their profits, if any. With one accord two of our contemporaries dance on the boards as temptresses to the song of "Profits, profits, and aid to the rates," before the guileless one has fallen to the voice of the charmer: afterwards their song is somewhat different; but then it is always thus. Our contemporaries must be right because they act as if they claimed infallibility, and of course, being both judge and jury too, there is none to gainsay. At any rate, no one can read their pages without wondering at the height and depth of their knowledge, even to the erudition of a Max Muller in philology and grammar, and to the combined wisdom of a Kelvin, Rayleigh, and Lodge in physical science. But enough; we venture with many misgivings, and a shrinking from the lash of scorn that is to come, to hint that two songs with opposite teachings cannot be right. The tendency of the teaching and preaching before a municipality takes up the burden is well known. Let us examine the teaching after. Compare—though comparisons are odious—the working of a company with that of a municipality. The subject is touched broadly, many details being left to the imagination. It is usually assumed that the capital is obtained more easily and more cheaply by a municipality. That is not always the case. The authorities are always put to certain heavy expenses which often do not come prominently before those who haste to make comparisons, and if the company pays no promotion money, has no promoters' shares, or other similar arrangements, its capital — of course we refer to first-rate concerns—is usually over-subscribed, and the expense of getting it is not more than that of an authority. Our remarks, however, are intended to deal more with the after-work. Assume designs, work of installation, and organisation equally good. Assume revenue satisfactory, and the balance on the right side. What does each party do with its balance? The company in its balance-sheet depreciates its property, but does not decrease its capital. It pays its shareholders a dividend, and maybe puts a small sum to reserve. It does not always make even slight alterations or additions out of revenue, but adds to capital. Just one word as to reserve. Few companies form a reserve from "principle," though they may do so from "policy." Then, again, much that a company does is far from being compulsory. If it can, it does; if it cannot, why it does not. That is a vital difference between the company and the

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authority. With one it is "may," with the other it is "must." Another fundamental difference is that with a company the matter is wholly and solely one of business. Its charges are as high as they can be without injury, while we contend the work of the authority ought not to be carried on as a business, but in a very different fashion. These charming songstresses sing to a different tune, and we well know that for the moment any remarks we make will have little impression. The song is now that the balance-sheet of the authority should provide for the payment of interest—a compulsory payment; for the repayment of capital—again compulsory; for depreciation of plant; for reserve; and above all this, get a good lump sum in reduction of the rates. The last three items require the most careful handling. The examination of a good many balance-sheets of companies shows that depreciation does not run on all fours with compulsory repayment of capital. A large reserve is unbusinesslike in a company not over-capitalised. If its share capital is mostly watered stock, if it is burdened with promotion money and shares, then a reserve is needed to keep the Stock Exchange quiet, otherwise the only reserve that is needed is one to make right an unforeseen breakdown. As a rule, the extraordinary breakdowns that occur in central stations are few, and hence the amount of reserve needed is small—in fact, the better plan would probably be insurance against breakdown. The whole matter comes to this. A much heavier burden is laid upon the shoulders of the consumers in the early days of the undertakings than ought to be laid. They pay these profits; they repay the capital, and, if depreciation also goes on, repay it in half time; they pay the reserve or the insurance, and they pay the "aid to the rates." Poor downtrodden consumer! It is his credit that the fathers of the town trade upon; it is his pocket they pick to please the gallery, and to assist the work of the temptress whose cry is, "Profit! profit!" to his own undoing. Fie upon those intellectual technical papers who pretend probity and straightforward criticism! If they favour municipal socialism, let them plainly declare it and glory in the cry. That would be honest, but even then they might temper their exactions to the shorn lamb. As it is, they are trying to induce municipalities to follow a policy which is much harder upon the municipal consumer than it ought to be. The question may fairly be asked, What are the principles which guide them in making these suggestions?

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

RE NERNST'S LECTURE.

SIR,—As an old reader, and seeing that I have the *Boersen Courier* before me, I trust you will favour me by inserting one important extract, anent Nernst's lamp, from it—viz., "Prof. Nernst's lamp will neither supersede incandescent lamps nor arc lamps, but will serve as a welcome addition to both of them." These words were uttered by the chairman, Mr. Rathenau, at above lecture, and, in proof that he knew what he was saying, let me point out that he is a most clever electrician and the author of several works on electrical matters. He is also the director-general of Allgemeine Elektricitats - Gesellschaft, the company who purchased the European rights of Nernst's lamp, and would naturally say as much in favour of it as he could. Now, Sir, compare this expert's utterance with Mr. Jas. Swinburne's premature declaration when he lectured on the above on Feb. 8 last. Here are the exact words: "Once the Nernst lamp becomes so general that systems of distribution are laid out to suit it instead of to suit the carbon lamp, the carbon lamp is practically out of the running." These extracts will prove which of these gentlemen are to be relied upon. Personally, I pin my faith to Mr. Rathenau, because when he uttered the above words he was desirous to point to improvement; besides, he well knew that "a naked flame" was incapable of revolutionising the electric lighting world, but Mr. Swinburne's "booming war whoop" against carbon lamps was uttered but a month before the prospectus of Nernst Light, Limited, appeared. Then we found they wanted money to apply for patents in countries *where patent laws are unknown*. Small wonder the flotation was unsuccessful! As for the incandescent lamp being out of the running, it is whispered in Institute circles that one will shortly be introduced *that will supersede* even the epoch-making Nernst lamp, so there is every prospect of the "enclosed light remaining in the running."—Yours, etc., LUX.

MOTORCAR NOMENCLATURE.

SIR,—As the above question is continually cropping up, and many suggestions have appeared of late in the leading technical journals catering for the new motorcar industry, it is evidently a matter which should be fully ventilated, especially as the "automobile" industry in the future cannot fail to become as important as our railways, tramways, and omnibus organisations have become of late years both from an industrial and financial point of view. It, therefore, behoves all who are engaged as pioneers in the development and success of "self-propelled road vehicular traffic" to have a solid base upon which to build up the industry. We should, therefore, as a body fix upon suitable names and descriptions of the various types of vehicles used and methods of working them, with a view to educate and properly initiate the million as to the merits of the different systems being introduced, and by this means leave the public to judge for themselves the type and system of vehicle best suited to their special requirements.

Self-propelled road vehicles have undoubtedly come to stay, and the demand for this class of vehicle is on the increase, as the various types and systems being introduced for both pleasure and business purposes clearly show, the propulsion of which is carried out either by the aid of electricity, petroleum, steam, or compressed air. Hence my object in making a few suggestions at this juncture with a view to formulate a plan and decision relative to the matters in question.

Personally, as is well known in the trade, I am a staunch believer in electric propulsion for more reasons than one; but as oil, steam, and compressed air all have spheres of usefulness, I say by all means "let them all come," and thus give every system of self-propelled road vehicles a fair trial; and the one which proves itself the simplest to handle, the most economical in working, and safest to drive, and best suited to tastes of the million, whether the power be electric, petroleum, steam, or air, is the one which will carry the flag of fortune in front of it by securing the lion's share of the motorcar and automobile industry. I must confess I was never particularly struck with the early names given by some pioneer workers to their vehicles, such as "horseless cars, autocars, motorcars," or, as the French call them "automobiles," for the simple reason they do not disclose the class of power used. Therefore some 18 months back, when introducing the "Riker electric system" of American motorcars into England, in order to distinguish this system, my firm decided to call the Riker cars "self-propelled electric vehicles." The Press caught on to this title quickly, it being described as something new and distinct to other systems described. Although the title

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is a fairly good one, and has become fairly popular, I begin to think it is too long, and can therefore be improved upon, especially as there are now four competitive systems in the market; and with a view to clearly distinguish one system from the other, and in order to educate the public as to the merits and working of the four separate methods of propulsion, I would suggest, subject to the approval of the trade and the Automobile Club, that the different systems should be described thus: for electrical self-propelled vehicles of all kinds I would suggest as a distinct class that they simply be called "electromobiles"; for oil motorcars of all descriptions I would suggest the name of "petromobiles"; steam-driven vehicles should be called "steamobiles"; and for compressed-air methods of propulsion I would suggest "airomobiles"; and as a distinctive type for any special class or type of vehicle it would be easy to add a prefix, such as "electromobile-cabs," or perhaps better still for shortness' sake, call it an "electro-cab, electro-victoria, electro-phaeton, electro-brougham, electro-dogcart, or electro-van," as the case may be. The same would apply to "oil-motor systems," as petro-cabs, petro-carriages, petro-vans, etc., whereas for steam systems, and for shortness' sake, the words "steam-wagons, steam-buses, steam car or lorry or dray" could be used, and so on according to the type of vehicle used; and then, if such or similar titles were decided upon, all the public would have to ask is "What system of propulsion is this?" and the answer would be, "Electro," "Petro," "Steam," or "Airo." By this means complication would be prevented and time and money saved in giving long and exhaustive descriptions of each one's systems, as now. All three-wheeled vehicles I would suggest should be described as a distinctive class as motorettes, thus: electro-motorette, petro-motorette, and instead of the word "driving," as now used for horse-driven vehicles, the distinctive word "moting," like yachting, biking, coaching, hunting, boating, etc., would suffice, and soon become to be well understood by the public, and thus convey the mode of travelling employed. For instance, one would say, "Gone out for a trip, or electromoting to Brighton," or "Gone petromoting to Birmingham," or Edinburgh. The word "moting" would be a suitable and applicable one for all methods of road vehicular travelling. Now as to drivers, instead of "coachman" I would suggest "motorcarist or motorman," and for gentleman drivers "automobilists," as one would say, for instance, "Captain Brown has got a good motorcarist or motorman who steers remarkably well," or one would say in speaking of a gentleman driver, "Lord So-and-so is a splendid 'automobilist'; just see how he handles the brakes and controllers when moting down to Brighton in his electro-coach."

For housing mechanical vehicles the word "stabling" is too horsey. "Docking, used by some motorcarists" is absurd, as it reminds one of tail clipping. I would suggest the place be called "the motorage," and if this distinctive name is decided upon country roadside hotel proprietors would soon be found hanging out the usual signs, such as "Good motorage accommodation," "Electricity supplied at 2d. per Board of Trade unit while you dine." Petromobilists would also find the signs, "Benzine and petro stores, first turning to the right or the left," as the case may be; also notice boards, "Experienced ostler engineers kept for repairs." If in all provincial districts hotel proprietors will lay themselves out for the accommodation of road-vehicle travellers at moderate charges, the sooner will the whole country benefit out of the money which will be expended by supporters of country trips, all of which tends to enhance the new and healthful "automobile industry."—Yours, etc., ARTHUR SHIPPEY.

THE ELECTRIC LIGHTING OF IPSWICH.

At the last meeting of the Incorporated Association of Municipal and County Engineers, at Ipswich, Prof. A. B. W. Kennedy, F.R.S., contributed a discursive account of the electric lighting installation he has designed for Ipswich, which we herewith produce. Prof. Kennedy said that, in giving a short account of the reasons for the arrangement adopted, he would mention that this contained no startling originalities. He was told that in doing so he was speaking to gentlemen who were engineers, but who were not electricians except in a few special cases. He hoped the electricians, therefore, would pardon him if he treated the electrical part of the matter in a very elementary fashion. In the first place, for their electric light station they must catch their electricity. Might he remind them that what they had to do in this case was what they had to do with water? They had any amount of material, but it was all at the wrong pressure, and if they were to make any use of it they had to raise the pressure, as in the case of water. The dynamo was simply an apparatus for raising the pressure of electricity, in order that it might do work very similar to what water did when it lost head. Of course, they were quite aware that none of them knew what electricity was, and in that respect it was not comparable with water. The first point to be decided was the source from which they should obtain their power for the generation of electricity. Ipswich was not in a country where water power with high falls was obtainable. Therefore that might be put out of the question. It was certain in any such case the power must be either gas or coal, and on the scale which was necessary for an electric light station coal seemed to be the best arrangement. Therefore he had adopted the ordinary system of generating power by boilers and steam-engines. Might he there say just a word about the question of coal which came in at this point—coal and the economy of coal? The economy of coal was a matter of great importance. The cost of coal was from 30 to 40 per cent., roughly, of the total works cost of generating electric energy. The total works costs were about half the total cost—that was, the capital charges made the other half. Therefore the total cost of the coal was, speaking roughly, 15 to 20 per cent. to a corporation of the cost of the supply of current. He thought that was a figure it was very advisable for all practical men to bear in mind, because every now and then it was somehow thrown at their heads that if only they did something at their coal pile they could manage to save one-half or three-quarters of the cost. He need not point out that they could not save 50 per cent. out of 15 or 20 per cent., and even if they halved the cost of the coal they were not going to save more than 10 per cent. Of course 10 per cent. saving was not to be sneezed at, but they could not halve the cost of the coal at Ipswich except at the cost of not getting their electrical works near where they were wanted, and it was a very easy matter to spend 10 per cent. in additional capital charges. Therefore they must look with caution and care on any schemes which involved great cost for capital charges and the transmission of current at a saving in the cost of the fuel. It was merely a matter of financial arithmetic. At this stage of the work of an electric light station came in the question of how far they could economise coal by using condensing engines. That was also a matter of £ s. d., but they were almost certain to save very considerably in the cost of their coal. Possibly they might save as much as 20 per cent., certainly they should have a net saving of 15 per cent. if they could use condensation steadily and had not to pay too much for water. In Ipswich he thought they would be able to save considerably, because at very little cost they could get as much water as they required for condensation. Next there came the question of the consideration of the type of engines and boilers one would use. Well, that was a question which would be settled by every engineer according to the particular circumstances of the case. He did not think it could be definitely said that there was one boiler better than all the other boilers. He dared say they all received periodically circulars which pointed out in glowing terms the advantages of a new form of firegrate by which was effected a saving of 50 per cent. in fuel. He presumed those circulars, which they all received, went in the same direction—that was, below the table. There were many good firegrates and many good boilers, but he did not know that there was one that was so infinitely better than all the others that one would use it as a matter of course. In large stations and places where space was of very great importance and a matter of expense, he thought most of them were in the habit of using some form of tubular

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boiler simply for the reason that they got a larger output on a smaller floor by the use of boilers of the type of the Babcock and Wilcox, the Hornsby, the Stirling, or some other similar form. At places where ground was not so expensive, it was often advisable to economise cost and use the simpler form of Lancashire boiler; and if it was worked reasonably with good stokers, he did not think one boiler was better than the other. Of course, one boiler would give a greater output per square foot of surface than the other, and in most cases that was the determining factor in the matter. As to the particular type of engine one used, he had only to say he thought that they ought to use engines which would drive their dynamos or generators direct—that was, without the intervention of any belting. Belting was used a great deal a number of years ago; he was happy to say it had been found unnecessary, and consequently there was not only a quantity of belting they could do without, but economised space in their engine-room. There was a great deal of difference of opinion as to the type of engine to use, even with direct driving. In America it had become the custom to use slow-speed engines with large flywheels and generators of large diameter. They worked admirably, and there was nothing to be said against them from the engineering point of view, except that they occupied a large amount of space. They were neither more nor less economical. All that could be said was that a good slow-speed engine was very economical, a bad one was not. And that was true of all engines. In this country it had been more usual to drive the engine direct with a high speed—that was, a short stroke and a great many revolutions per minute. That was adopted here because at the time electrical work became general they were fortunate enough to have one or two engines of high speed of a satisfactory type. He had adopted them, and used them with very great success indeed. It would not be advisable that he should enter upon any controversial matter as to one engine or another. Personally he thought the advantages in almost every case lay on the side of the high-speed engines and the small floor space occupied. He was quite aware that engineers quite as good as he preferred the slow speed. He ought to say he had had high-speed engines working for 10 years on electric lighting, and the cost of maintenance had been very small and the attention required certainly a minimum. Therefore the fear they had some years ago—and he admitted at one time he shared it—that these engines would knock themselves all to pieces in a short time had proved quite groundless. It was that type of engine he proposed to use in Ipswich and had shown on the drawings sent into the Corporation. They got next to the question of dynamos. With apologies to those who were already acquainted with the subject, he could not resist the temptation to quote Mr. Preece's account of how a dynamo worked. It was much the best description of a dynamo he had ever seen to those whom the working of a dynamo was not a matter of everyday practice. Mr. Preece pointed out that it was well known that they had always to start with something, and that in this matter they started with the knowledge that if a conductor were moved between the poles of a magnet what was called a current of electricity would flow in that conductor. The earth was a magnet, though rather a feeble one, and if a man took a copper wire in his hands and skipped with it—if they could imagine him doing anything so frivolous—in the plane of the earth's magnetism, north and south, a current of electricity would pass through that wire and through his body. Such a current would be infinitesimally small, but there it was, and they could measure it if they had instruments delicate enough. Instead of taking one single wire, however, they took a very large number of wires and arranged them in proper fashion; instead of taking a man's movements as the source of power they took an engine of 50 h.p. or 5,000 h.p.; instead of taking a very feeble magnet, like the earth, they took a very powerful copper magnet—there was the dynamo. Then, instead of getting a current which could only be measured by the most delicate instrument, they got a current sufficient to light all Ipswich, to drive all the tramcars running in the streets, and to drive all the knife-cleaning machines in the house of every good citizen who wanted power. They got, then, in the station boilers of some convenient and economical type, and engines whose sole and only function was to provide the power to cause the rotation of certain copper wires within the armature of a magnet, that armature constituting the dynamo. That was, however, only half the work. They had to get the current out and distribute it. There were various ways of doing that, but the way he proposed to adopt there, and the way very commonly adopted—he did not suggest it was original with him—was by what were called feeders, or trunk lines, and distributors, to which customers were directly connected. For the sake of those who were not quite familiar with electrical distribution, might he point out that what happened was this: If they had to pass a current of electricity through a copper wire, exactly the same thing happened as if they had to pass a current of water through a pipe—that was to say, the electricity encountered resistance just as water did, and the electricity lost pressure just as the water lost head. The loss of pressure depended on the amount of current they were passing through, just as the loss of pressure depended on the amount of water they were passing through. But their consumers, whether for power or light, required just the same pressure. Moreover, the Board of Trade stepped in, and said that the pressure should be kept within 2 per cent. of each side of a declared figure, therefore they were bound to supply to the consumers what was for all intents and purposes a constant pressure, quite independent of the loss of pressure which would occur in the conductors, which acted as pipes. That was why one used trunk mains and distributors also. The trunk mains were mains in which they could alter the pressure; the distributors were the mains in which the pressure was kept constant. Supposing their electric light station to be here [at this point Prof. Kennedy drew a diagram to illustrate the trunk mains and the feeders], and the consumers to be conveniently arranged in rectangular form, that was the form in which they ought to be, though consumers would never get in the right position, a defect due to the manner in which their predecessors had laid out the streets of large towns; therefore, they had to take out the feeder lines at different lengths to supply consumers, though all had to get the same pressure whether near to or far away from the central station. Therefore, they ran out trunk mains from the station to various points of differing lengths. Supposing they wanted a pressure of 100 volts at two places, and one trunk main was much longer than the other, they would make one main of a smaller section than the other, so that if they had 110 volts at the starting point there would be a loss of 10 volts to the point of the feeders, after which they drew all the consumers together so their pressure never varied more than 2 per cent. If the pressure varied more than 2 per cent., it would be the duty of the engineer to put another feeder out. They might, indeed, have 150 volts at one point and only 100 volts at the consumer's lamp, but the consumer knew nothing about that. It was their business, and not that of the public. There was another way. If they had a very long feeder, they might work it at 120 volts, and if they had a short one they could work that at 110. It was quite easy to do that at the station. Then the short feeder would only lose 10 volts in its short length, and the other would lose 20 volts in its long length, but the consumer would get his pressure equal at both points. That was the principle on which mains were generally laid out at stations. In this particular instance at Ipswich they would use lamps of 220 volts, and they would use them in two sets, making 440 volts. The consumer would get half that pressure at his lamps, making 110 volts. There were great advantages in using higher pressure at their feeders, and there was a considerable saving of copper as a consequence. That system was known as the three-wire system, and had been generally used at continuous-current places throughout the country. The next point he had something to say about was the station. The position of the station ought to be such that all its feeders should be of the same length, but that was, of course, quite impossible to attain. But in any case, the site should be such that conveniently long feeders could be carried to the different points to supply consumers. That had been found in Ipswich on the site known as Cannon's Marsh, from whence the distribution by trunk

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mains might be carried out very simply. It was sometimes said that the station should be in the centre of a district. That was not quite right. They should have the station where the feeders would be reasonably of the same length, and not where they would have one feeder five times the length of another, though that trouble could be easily got over. At Ipswich it was proposed to put down, independent of any question of traction, a little over 500 h.p., including reserves, and that horse-power would give current enough to light 8,000 8-c.p. lamps at once. Well, the question was how many lamps they might have in a city, and yet have only 8,000 alight at once. He had been told over and over again in various towns, "We are quite different here from every other town, we shall have very nearly every lamp alight at the same time." He wished he could find that happy land. He thought in Glasgow, soon after they started there, they did have 60 per cent. alight at once. In St. James and Pall Mall, London, where the greater part of the supply was to clubs, hotels, and places of the kind, he thought they had had 66 per cent. alight at once; but that was quite exceptional. In the district supplied by the Westminster Company, which covered St. George's (Hanover-square), St. Margaret and St. John, Westminster, they had never had more than 27 per cent. of the lamps alight at once. At any rate, in a place like Ipswich, for the first 10,000 lamps they might get very nearly half alight at once. He said at first, because afterwards when they got out into the suburbs and look up the private residences they would never have one-half alight at once. If they considered their own private houses, the number of lights installed, and the number actually alight at one time, they would see it was very much less than that. As a station grew the number of lamps alight to the number installed dropped at once. That did not affect the station at all, but was a fact of natural history. The next point was the cost of the electric light to the people using it. The Act of Parliament allowed a charge of 8d. a unit in every case, including Ipswich. Eightpence per unit meant about ¼d. per 8-c.p. lamp per hour. He did not think recently any station had been charging more than 6d. per unit, which meant $\frac{3}{16}$d. The tendency was to reduce that charge as much as possible, and the result of that policy was to increase the demand, and consequently to cheapen the production of electricity. It was proposed in Ipswich later on to try and supply current for driving electric trams from the electric light station. That was a thing which it was to the advantage of any town to do, as it gave them a long day load. Of course, they had to supply the current much cheaper than for lighting, but that they could afford to do because it was a continuous load extending over 14 or 16 hours of the day. The question whether the municipality should own the electric light was one which had practically solved itself. He had had the pleasure of dealing with a number of towns, and in every case he was pleased to say the electric light had proved a success, and had not imposed any cost upon the rates. Indeed, the time had come when they might say that a well-organised electric light station might be made to pay its way almost from the very beginning. Of course, he did not mean to say that the first month paid, but practically from the beginning it paid its way, and was not a burden on the rates.

MAGNETISM.*

BY PROF. JAMES ALFRED EWING, F.R.S., M.I.C.E.

(Concluded from page 636.)

The specimen is turned in the form of a rod, and is tested against a standard rod of the same size, whose permeability curve has been determined beforehand. What the bridge actually determines is the ratio of the magnetising forces which will produce the same magnetic induction in the two rods, and by making this comparison for several different strengths of magnetising current we have data for drawing the permeability curve for the rod under test. The process performed in this way is immensely simpler than the older method of testing, and it gives the curve as completely as may be desired. But under the impression that something even more rapid and direct would be useful, I lately brought out a third instrument, the magnetic balance (Fig. 7), which by, so to say, weighing the attraction between the test-bar and a fixed magnet allows the induction produced by a particular value of the magnetising force to be read directly upon a divided scale.

The various stages in the process of magnetisation, and the character of magnetic hysteresis, will be made more intelligible if I show you in action another instrument which I call a magnetic curve tracer, which enables the motion of a small mirror to exhibit magnetic curves upon a screen. The mirror receives two components of motion; it turns horizontally by amounts which are proportional to the magnetising force, and vertically by amounts which are proportional to the magnetic induction in a magnetic circuit of iron which forms part of the machine. Hence a spot of light reflected on the screen from the mirror traces out a curve which shows how the induction changes as the magnetising force is changed. By reversing the magnetising current repeatedly, we make the iron go over and over again through a cyclic process of magnetic reversal, with the result that the spot of light traces out a closed curve showing hysteresis and having all the characteristics of Fig. 3. The moving parts of the instrument are made very light, so that I can quicken the process sufficiently to make the path of the spot appear, by persistence of vision, as a continuously luminous curve.

There are many interesting features of the magnetising process on which, if time permitted, we might dwell. Effects of stress and effects of temperature have been very fully examined, with results which, in some particulars, are of practical import. One point which deserves special notice, on account mainly of its physical interest, is that when we change the state of a piece of iron that is being magnetised, whether by heating or cooling, or by pulling, or pushing, or twisting, or vibrating it, the first effect of the change in temperature, or in stress, is to reveal a certain instability in the magnetism, and it is only after several repetitions of the change of state that things settle down and the proper effect of the alteration in condition exhibits itself. This is a phenomenon closely associated with hysteresis, and we shall see presently that the molecular theory which explains hysteresis explains it also.

The effects of temperature on magnetic quality have a direct bearing on some of the engineering applications of magnetism. Some of those effects are immediate, and some only show themselves when the iron has been heated for a considerable time. The immediate effects of heating were examined by Hopkinson, and more lately they have been the subject of an excellent investigation by Mr. D. K. Morris. Briefly, the general effect of heating is to increase the permeability and reduce the hysteresis of iron until a certain critical temperature—about 780deg. C.—is reached, when iron loses nearly all its power of being magnetised. The change happens somewhat suddenly, for at temperatures only a little lower than that, the permeability is very great and the hysteresis exceedingly small. The curve (Fig. 8) taken from Mr. Morris's paper shows how the maximum permeability alters as iron is heated. There is a general rise in permeability, subject, however, to several set-backs in the course of the rise. The first of these happens about 250deg. C., the next between 400deg. C. and 500deg. C., and the greatest about 760deg. C. Now compare this with the curve shown in Fig. 9, which represents one of Sir W. Roberts-Austen's beautiful investigations of the rate at which a piece of iron cools from a white heat. There is a steady fall of temperature except at certain places where some internal convulsion happens which is associated with the giving out of heat. Note the points where this occurs, and you see that they connect themselves with what I have called the set-backs in the other curve. We may even trace a connection between the highest of these breaks and a change which is slightly apparent in Morris's curve about 900deg. C., though the iron then retains very little magnetic quality at all. The inference seems pretty plain that not only at the great magnetic critical point is there a transformation of structure associated with absorption of heat during the heating of the iron, but that a similar connection holds at the other points of arrest.

But it is with the effects of long-continued heating that engineers are more concerned. It was observed that transformers lost some of their efficiency after they had been kept at work for some weeks or months, and that this was due to an increase of hysteresis in the iron core. Mr. Mordey proved that this increase of hysteresis resulted from the prolonged baking of the iron; a transformer at work becomes warm largely because of the heat developed through hysteresis, and long exposure to a somewhat high temperature gradually alters the iron for the worse. The amount of this deterioration depends much on the degree of heat, and it is by no means the same for all specimens of iron; sometimes iron which is at first particularly free of hysteresis is most affected. Mr. Roget, who has investigated the matter in my laboratory, has found that continuous exposure for seven days to a temperature of only 160deg. C. has actually trebled the hysteresis of one very good specimen; but, what is most curious, a further continuation of the baking at the same temperature causes improvement to set

* The "James Forrest" lecture, delivered before the Institution of Civil Engineers, April 20, 1899.

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in. The hysteresis passes a maximum, which comes earlier the higher the temperature of the baking, and then tends to lessen when the baking is further prolonged. The curves (Figs. 10 and 11) relate to a ring of sheet iron heated at 200deg. C., and show the kind of change which happens, as well as how the changes in hysteresis are associated with corresponding changes in the permeability of the iron. At that temperature the maximum is passed after a comparatively short period of baking.

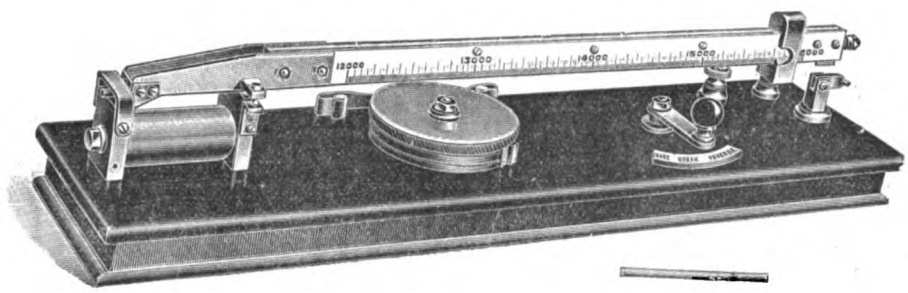

FIG. 7.—Magnetic Balance.

This augmentation of hysteresis is a serious matter in transformers, and much attention has been given to getting iron which will not show it. Some specimens were lately submitted to me which were not only extraordinarily free from this objectionable characteristic, but had much less hysteresis even initially than any iron I had tested before. Makers are naturally reticent as to the processes of manufacture by which such results are obtained, and they have in some cases an additional

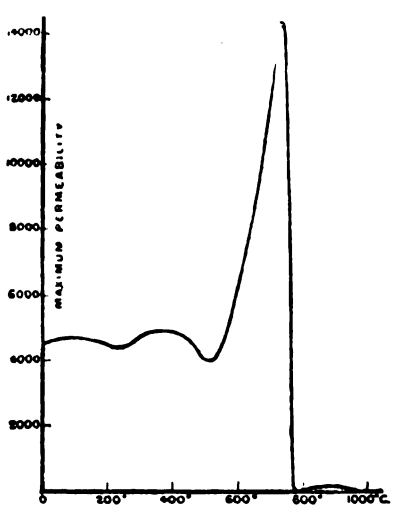

FIG. 8.—Effects of Temperature on the Permeability of Iron (Morris).

and excellent reason for reticence in the fact that they really do not know what the conditions are to which the good results are to be ascribed. It is probable that light will be thrown on these difficult questions by the application of the microscope, a tool the value of which the metallurgist is now fast coming to recognise.

Much that is obscure in the phenomena of magnetisation is made plain when we come to consider the molecular theory of the process. It is an old idea, due originally to Weber, that the molecules of iron are always magnets, and the process of magnetising a piece of iron is merely to turn the molecular magnets round so that they face one way. At first they are pointing every way at random, but when magnetising force is applied they gradually turn, and finally, when saturation is attained, they all lie with their magnetic axes exactly along the

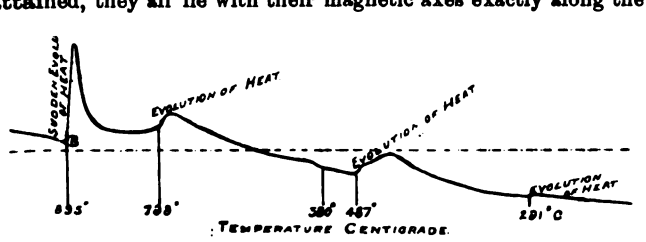

FIG. 9.—Record of the Cooling of Iron (Roberts-Austen).

line of force. To account for their not all turning at once, and also for the fact of residual magnetism, various hypotheses have been framed, as, for instance, that the turning of each molecule is resisted by what may be described as a miniature friction brake. A good deal of meditation on this matter led me to the conclusion that no such hypothesis was needed. The gradual turning of the molecular magnets and all the phenomena of hysteresis are simply results of the mutual actions between each molecule and its neighbours. We may demonstrate this by means of a model consisting of a large number of permanently magnetised needles set on pivots near together. When a weak magnetic field is applied, the pivoted magnets turn slightly and in a quasi-elastic manner, free from hysteresis; but as the field is strengthened the ties between them are overcome and instability ensues, the original groups break up, and the magnets enter into new combinations. Finally, as the applied field becomes stronger still, complete parallelism is gradually approached.

Thus the model reproduces with perfect fidelity what I have called the three stages of the magnetising process. Moreover, the dissipation of energy involved in the breaking up of molecular combinations corresponds exactly to what we know of hysteresis. The model shows not only how this cause

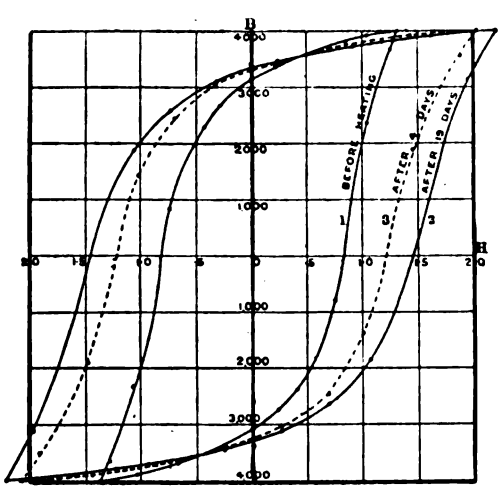

FIG 10.—Effects of Baking on the Hysteresis of Sheet Iron (Roget).

of hysteresis affects a cyclic process of magnetisation, but how it explains the instability which I mentioned as the first thing noticed when we heat, or cool, or stress a piece that is being magnetised. Any change of condition precipitates the breaking up of groups which were, so to speak,

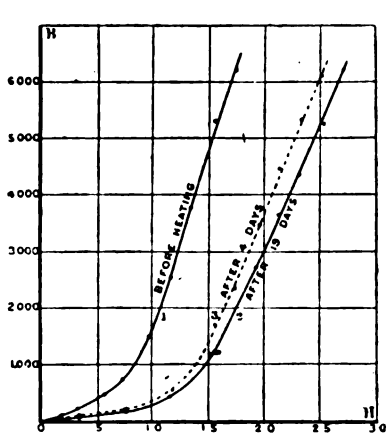

FIG 11.—Effects of Baking on the Permeability of Sheet Iron (Roget)

hesitating on the verge. By using a model with a large number of little magnets, we get the aggregate external magnetic effect of the group to vary with variations of the field exactly in the way in which the magnetism of iron varies, and the model indicates not only the main, but even the minor features of the process. It was pointed out by Mr. James

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Swinburne that my theory would involve this curious result—that a piece of iron when revolved in a very strong magnetic field would exhibit no hysteresis, though it shows much hysteresis when revolved in a weaker field. The prediction was experimentally verified by Prof. Baily. We may illustrate this in the model by turning round the plate which carries the little pivoted magnets, when you will notice that breakings up of molecular groups occur when the field is weak, but not when the field is strong.

I think this model has a bearing on other physical matters which concerns engineers. It is easy to believe that between the molecules of materials there are other polar forces acting distinct from magnetic forces, and common to non-magnetic as well as magnetic materials. When we make one body slide on another these intermolecular forces acting across the surface of contact may cause the molecular groups near the surface to become broken up and reconstituted, thereby giving rise to the dissipation of energy which we are familiar with under the name of friction. The action will be apparent if we make one group of the little pivoted magnets slide past another group. We may go further and say that all non-elastic deformation of solid bodies by strain is probably an action of the same kind. Experiments which I have lately carried out, in conjunction with Mr. W. Rosenhain, have shown that the plastic straining of metals occurs through a multitude of separate slippings of one part on another, in each of the crystalline grains of which the metal is made up. The model may be taken as illustrating how with molecules possessed of polar forces such slips involve an expenditure of work. But this is taking me away from my already too comprehensive text.

I have tried in this hurried sketch of a great subject to show how in some cases invention has followed as the fruit of discovery, while in others discovery has resulted from the interest created by invention. One word, in closing, to the student of research. Do not think that in magnetism, because much has been done, nothing is left to do. The upper workings of the mine may be exhausted, but there are deep levels whose wealth is unexplored. Every point gained is a starting ground for fresh enquiry. The patient and intelligent worker may rest assured that his labours will find a return, not, perhaps, in profit or in fame, but in that pure impersonal joy of discovery which, as those who have tasted it know, is the investigator's best reward.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. Questions may be sent at any time. Answers must be written on one side of the paper only, and should be kept as concise as possible.

QUESTIONS.

169. Define permeability. Describe some practical method of determining the permeability of a given sample of iron.—C. W. P.

170. For lighting the streets of a city with about 400 arc lamps, given choice of plant at a central station (alternating), would you prefer to use direct current arc lighters for series running, supply the lamps from the mains, or use rectifiers. Consider (1) lighting effect, (2) cost.

ANSWERS.

Question No. 163.—Detail the different tests you would make on electricity meters before putting them on circuit, giving the points to be ascertained, but not the methods of testing.

Best Answer to No. 163 *(awarded* 10*s.)* —The tests which should be made on supply meters before being fixed in consumers' premises will vary slightly with different kinds of meters, and with the purpose for which they are to be used. For instance, a meter for an arc circuit where the minimum current is about six amperes need not be very accurately calibrated at low loads. The following are, I think, the most generally necessary tests:

1. When the meters are unpacked and set up for testing they should be carefully looked over to see that no bits of straw, etc., have got amongst the clockwork, etc., and the connections should all be examined.

2. The clockwork should be inspected to see that it is in gear and also that the number of teeth on the wheels is correct. This can be done after a little practice by comparison with a standard clockwork, or it may be done by counting or by a time run.

3. The meters should now be tested for leaks: (*a*) main coils to case; (*b*) in the case of wattmeters for leak from shunt or pressure coils to main coils or to case. This should be done before any adjustments are made, as any defective meters can be laid aside for repairs and replaced by good ones without wasting time in testing them.

4. They should now be tested for accuracy at various loads and adjusted if necessary. For meters that have a straight-line law it will be sufficient if this is done at full load (or in very large sizes any load above one-third), and at a low load where the friction of the clockwork, etc., comes into account, say $\frac{1}{20}$ to $\frac{1}{25}$ load. Those meters whose law is not a straight line should be tested at more loads, say one-tenth, three-quarter, and full, so as to get them within the allowed error at all loads. Three or more wire meters should also be tested to see that they are correct with any one coil, in case the load at any time should come on one side of the system. Wattmeters should also be tested for creeping—*i.e.*, running on the shunt current alone—which in some meters is very marked.

5. All meters should be tried for starting—*i.e.*, to see what is the smallest current with which they will begin to register. All sizes up to 50 a should start well with 0·3 a, sizes from 50 a to 100 a with 0·6 a, and 100 a to 300 a, 1·0 a to 1·5 a.

6. All meters should be finally tested for insulation, as a meter that will pass the leak test may still have a very poor insulation resistance.—METERS.

Answer to No. 163 *(awarded* 5*s.)*.—The most important points to be ascertained before installing a new meter are:

1. Whether transit has impaired the accuracy. The accuracy of most types of meters may be checked by short-time tests, but no meter should be sent out without having been run for a considerable time, in order to see that the gearing train is in good condition and also that the declared face-dial constant is correct. Meters are frequently found stopping with several lamps on at some particular portion of the main, though the meter may go very well before and after the obstruction is passed.

2. All meters should be tested for accuracy at different currents, say, quarter, half, three-quarter, and full load.

3. Insulation between meter case and coil should be good, at least 5 Ω.

4. Every meter should be tested for starting current, as this is most important, especially where the supply is at 200 volts or more. No meter should be sent out which will not start and continue to register with an 8-c.p. lamp. It is, however, quite certain that not 50 per cent. of the meters now installed on consumers' premises will register the current taken by an 8-c.p. 230-volt lamp; indeed, it is doubtful if 20 per cent. of the existing ampere-hour meters will register a current of ·15 ampere.

5. If the meter has a shunt coil, insulation of same should be tested, and it must also be noted whether the meter runs on the shunt alone or continues to run for some time after the main current is switched off. Certain types of shunt meters are prone to this defect, especially when erected in situations subjected to vibration.

6. If commutator is used the brushes must be adjusted so that sparking is avoided, otherwise the commutator will soon get dirty and the meter slow up.

In the case of meters for alternating current, in addition to the above tests, they must be tested for accuracy of registration on inductive load.—E. M.

Question No. 164.—In a Thomson-Houston meter the shunt coil is of platinoid and the rotating disc is of copper. How will the rate be affected if the temperature rises 30deg. C.? The temperature coefficient for platinoid =0·00022; and for copper 0·00388.

Best Answer to No. 164 *(awarded* 10*s.)*.—The current in the armature part of the motor in this meter has no

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dependence upon the temperature, as it is affected only by the variation in the external circuit. We may therefore assume the current constant, and investigate the variation in speed under these conditions. The resistance of the shunt circuit increases with rise of temperature, and if the volts remain constant this will mean a corresponding diminution in the shunt current which produces the field in which the armature rotates. Now, since there is no iron in the circuit, the magnetic flux will be proportional to the magnetising force, and, therefore, to the ampere-turns of the shunt winding. But the turns remain constant in number, and hence, finally, the field strength is proportional to the shunt current. Further, therefore, the field strength is inversely proportional to the shunt resistance. Now, the torque is proportional to the field when the current remains constant, and hence the torque is also inversely proportional to the field resistance. The field resistance increases in the ratio of $[1+(30\times\cdot00022)]$: 1, or 1·0066 : 1. Hence the torque on the motor armature is now diminished in the proportion of 1 : 1·0066—*i.e.*, if T be the torque on the cold motor causing it to rotate, then the torque on the hot motor is $T\div1\cdot0066$.

This, then, is what is termed the "assisting torque" of the motor (an expression used by Carus Wilson in his work on the direct-current motor), and it must be balanced by the sum of the resisting torques. The resisting torques are two in number—namely, that due to the friction of the moving parts, and that due to the rotation of the copper disc under the poles of the permanent magnets. The friction torque is so small as to be practically negligible. Hence we need only consider the resisting torque caused by the rotating disc. This, according to experiments of Guthrie and Boys in 1879, mentioned in Thompson's "Polyphase Electric Currents," is directly proportional to the velocity of rotation and the conductivity of the metal.

The conductivity of the material is inversely proportional to its resistance; hence the conductivity is diminished in this case by the ratio $1 : 1+[(30\times\cdot00388)]$, or 1 : 1·1164. Now let S_H be the speed of the motor hot, and S_C the speed cold. Then the torque on the rotating disc is further altered in the proportion of $S_H : S_C$. But, neglecting friction, the torque on the disc, cold, was equal to the assisting torque of the motor, which is T. Hence the new torque on the disc is

$$T\times\frac{S_H}{S_C}\times\frac{1}{1\cdot1164}.$$

Again neglecting friction, the torque, hot, of the motor is equal to this new torque of the disc. Hence finally we have

$$T\times\frac{1}{1\cdot0066}=T\times\frac{S_H}{S_C}\times\frac{1}{1\cdot1164}.$$

Therefore $$\frac{S_H}{S_C}=\frac{1\cdot1164}{1\cdot0066}=1\cdot10908\text{ (approx.)}.$$

Hence the speed will go up by nearly 10 per cent., because the diminution of torque on the "resisting" side is more than the diminution on the "assisting" side, and consequently there is a surplus "assisting" torque.

It is not possible to find the percentage alteration due to friction, but, as the speed has increased, the effect of friction will be greater. Hence, actually, the speed will not increase 10·908 per cent., but rather less, and, roughly speaking, we may say that a rise of 30deg. C. produces a rise of 10 per cent. in the speed, correct to within ·9 of 1 per cent. of the actual speed.—T. C.

[NOTE.—In this answer the detailed arrangements of the meter are wrongly described, but this does not affect the correctness of the results or the argument.—ED. *E. E.*]

Answer to No. 164 (*awarded* 5*s.*).—In a Thomson-Houston meter the armature is in series with a high non-inductive platinoid resistance, and forms the shunt circuit of the meter. It is placed in the field caused by the series coils, and this field is obviously proportional to the strength of the current (C). The current through the armature is proportional to the pressure of the supply (V), and hence the driving torque is proportional to the watts, V C. Experiment shows that the mechanical friction in this meter is independent of the speed, and is practically constant. This friction is compensated for by putting a few extra windings of the shunt coil so as to strengthen the field caused by the series coil. Fixed on the spindle of the armature there is a large copper disc revolving in a constant magnetic field, and the retarding torque caused by the Foucault currents generated in it is proportional to the speed.

Now let a = the constant of the series coil;
b = the constant of the armature;
d = the constant of the extra coils on the armature;
r = the torque due to bearing friction (mechanical) which is independent of the speed;
F = the strength of the brake field (constant);
[gr.] w = the angular velocity. Then

$K F^2 w$ = the retarding torque due to the eddy currents, where K is a constant.

Hence the driving torque $= a C . b V + d V . b V$
$= a b . W + b d V^2$,

where W is the watts.

The retarding torque $= K F^2 w + r$.

For steady motion these two torques must equal one another; therefore,

$$a b . W + b d V^2 = K F^2 w + r \quad . \quad . \quad . \quad (1)$$

Now d is adjusted by experiment until $b d V^2 = r$.

In this case $$w=\frac{a b}{K F^2} W.$$

Hence the revolutions of the spindle are proportional to the watts supplied.

If the temperature rises 30deg. the current through the armature is diminished 0·66 per cent., and therefore the driving torque is diminished 0·66 per cent. The braking eddy currents are diminished 11·64 per cent., and hence the retarding torque due to the magnetic brake is diminished 11·64 per cent., whilst the mechanical friction is practically unaltered. On a very light load at the higher temperature it would therefore go slower than it should, as $K F^2 w$ would be small compared to r, whilst on a heavy load $K F^2 w$ would be large compared to r, and hence it would go much faster.

A Thomson-Houston meter made as described in the question has therefore a variable temperature coefficient At high temperatures it registers too little on light loads, and registers too much on heavy loads, the temperature correction at full load being much the most serious.—J. C. R.

X-RAYS IN SURGERY.

At a meeting of the Camera Club held last week, Dr. Mackenzie Davidson gave an interesting lecture on the use of X-rays for the localisation of bodies by means of stereoscopic photography. The lecturer described how at the outset he found the greatest difficulty in getting tubes which gave the sharp definition required for accurate work in delicate operations. He found that the rays from the cathode did not meet the anode in a thin line or a point, but that they were focussed at some distance between the cathode and the anode, loosely diverging from there, and therefore causing more or less blurred images. A tube was required in which the anode caught the ray at its sharpest point, thus allowing the patient to be brought nearer the instrument, and resulting in a sharp photograph. He showed by means of a wire screen, and by pinhole photographs taken of tubes through a very ingenious contrivance of his own, how the rays from the usual tubes came, not from a point, but from an appreciable surface, and therefore caused considerable diffusion in the image produced. He had used Dr. Muirhead's condenser with a 10in. coil; this produced a very thick spark, but when applied to the tubes these simply melted away. Osmium gave the best results as an anode, but that also melted and fell to the bottom of the tube, and even when the osmium was placed between the thin aluminium plates the latter melted; he then placed the osmium between nickel, with the same results; finally, he placed the osmium between two fine platinum plates, riveted together with platinum wire, in order to hold the osmium

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in position. The anode was arranged loose, so as to enable the operator to shake it into the exact position required to focus the rays at their finest point—this would then give the best results. He used round balls instead of points on the discharging pillars of the Ruhmkorff coil; when these were heated it allowed the resistance to vary within very wide limits. The density of the photograph varied with the size of the spark gap. It was not a matter of time of exposure, but of radiation. The trouble was that the action was so intense. He found the tubes made by Mr. Cosser gave by far the best results. He had tried the new electrolytic break, which with 100 volts gave a very noisy thick flame, which could be lengthened in a 6in. coil up to 15in. This he showed, and the spark issued like a gas jet from the two balls of the tube. When put through the tube, the osmium soon became white hot and the platinum quite red hot.

In the second part of his lecture Dr. Mackenzie Davidson explained in detail the various apparatus invented and used by him for the localisation of objects. Two exposures are made at a distance of 3in. apart, the average distance between the pupils of the eyes. By means of wires three imaginary planes are formed at right angles, and when the photographs are then placed on a table fitted with a perpendicular stand and three slots by means of threads, the exact distance of the object is localised in the three planes, and a simple triangulation gives the figures required to indicate its position in the body. This method made it possible to apply the X-rays to injuries to the eye. Electromagnets had been used, but their application was restricted to bodies made of iron and steel only. If bone, lead, copper, glass, or any other substance entered, as a rule, then, the eye had to come out; or if the patient refused and stuck to the eye, he most probably lost the use of both of them. He showed his method of taking stereoscopic photographs of the eye, by which even unconscious movement of the eye is avoided, and of ascertaining and measuring by means of a platinum wire attached to the eyelid before the operation, the distances of known points, demonstrating how by means of these and the localiser above alluded to the location and exact size of a circular piece of cartridge cap was found and successfully removed without injury to the eye.

The third part dealt with Dr. Mackenzie Davidson's stereoscopic appliance, by means of which the object is seen in the body in its exact position. This is an immense aid to the operator, as no figures, however exact, will produce an image in the mind. But given the exact figures, backed up by the mental pictures plus the necessary knowledge and skill, the oculist has now the means of performing by the aid of X-rays very delicate operations; and X-rays were now proving of the utmost importance in a branch of the science where it was formerly considered that they would not be of the slightest use whatever. A tube was wanted which gave an accurate focus, allowing the current to be to its utmost limits, so as to give the best results without melting the anode.

Dr. MacHardy, who performed the operations alluded to during the lecture, testified to the accuracy of Dr. Mackenzie Davidson's measurements, and spoke in the highest terms of appreciation of the value of his inventions, stating that the fact that such operations were possible were solely due to the ingenuity and perseverance of the lecturer. A short discussion followed. The lecture was illustrated by photographs, some of which were handed around, while others were displayed on the screen.

PHYSICAL SOCIETY.

At the ordinary meeting on May 12, 1899, Prof. Perry, vice-president, in the chair.

The **Secretary** read a note by **Prof. W. B. Morton** and **Dr. Barton** on the discussion of their paper **"On the Criterion for an Oscillatory Discharge of a Condenser."** In the discussion which followed the reading of the paper it was pointed out that the result obtained—viz., that on taking into account the distribution of the current in the wire, a condenser having the critical capacity on the simple theory gives an oscillatory discharge—seems to be contradicted by the well-known fact that the resistance of the wire is greater and the inductance less for oscillatory than for steady currents. The explanation of the apparent paradox is to be found in the effect of the damping on the inductance. When the damping is great and the frequency small, as in the neighbourhood of the critical case, what may be termed the equivalent inductance becomes greater than the steady current value. It is shown that this increase in L outweighs the increase of R in its effect upon the criterion for oscillatory discharge. An examination of the expression for the equivalent inductance in the case of iron, shows that it is greater than the steady current value if the ratio of one amplitude to the next is greater than $e^{\frac{n}{200}}$ where n is the frequency of the oscillation. Since the decrease of L with maintained oscillations is due to a surface concentration of current, it is suggested that there must be an axial concentration in the case of damped vibrations. Following the method of Maxwell for determining the current density at a distance from the axis of a wire, an expression for the current was introduced containing a damping coefficient. The "quasi-amplitude" of the disturbance at any point in the wire was thus obtained. An examination of the result shows that making the damping zero indicates a surface concentration. If, on the other hand, the damping is great, the expression for the amplitude increases as the distance from the axis decreases, and we get an axial concentration. Assuming sufficient damping to produce this effect it is shown that as we go through the point, $r=\frac{a}{\sqrt{2}}$, where a is the radius of the wire, we pass from a greater value of current density in the inner parts to a less in the outer than would correspond to a uniform distribution throughout the wire. From general reasoning the authors think that if a rapidly-damped disturbance is propagated into a wire from its boundary, and if the oscillations are slow enough to allow the current to penetrate to the core, we should expect to find an axial concentration in the latter stages of the phenomenon.

Dr. Lehfeldt said that Prof. Lodge had pointed out at the reading of the paper that the solution the authors obtained changed character at the critical resistance. As this point had not been considered in the note, he supposed that the change in character made no difference to the results obtained.

The **Chairman** expressed his interest in the proof of the existence of an axial concentration.

Mr. Addenbrooke exhibited and described a quadrant electrometer for application to alternating-current measurements. The author has substituted for cylindrical quadrants two sets of flat plates, the top set being adjustable. In this way the range of the instrument is considerably increased. The ability to remove one or more of the top quadrants makes the needle very accessible. By lowering the needle on to the bottom quadrants, and then bringing down one of the top plates, the instrument can be carried with safety. One of the top quadrants can be worked up and down by a worm gear, and by this motion the "electrical zero" of the electrometer is obtained. The suspension consists of a flat phosphor-bronze strip, the torsion of which is found to be perfectly uniform, there being no fatigue effect. The case of the instrument contains windows, so that the needle can be viewed from two directions at right angles, and there are screw motions to centre the needle with respect to the quadrants. To reduce the effect of air convection currents upon the needle the inside of the case is lined with cotton velvet. The quadrants are supported on brass bars passing through long ebonite sleeves in the bottom of the instrument. This gives good insulation without the use of sulphuric acid, and there is no Leyden jar or condenser in connection with the needle. When using the electrometer idiostatically with the finest strip, a light needle and the quadrants $\frac{1}{10}$in. apart, a difference of potential of one volt will produce a deflection of about 5mm. upon a screen 2m. distant. Using the instrument heterostatically with 100 volts on the needle, $\frac{1}{8}$in. between the quadrants and half a volt acting across them a deflection of 200mm. can be obtained. This sensitiveness is about 12 times as great as that got from instruments designed by Kelvin, Mascart, and Haga. Mr. Addenbrooke then showed how in conjunction with a voltmeter and an ammeter it was possible with his instrument to determine all the factors of an alternating-current system. The increased sensitiveness of the electrometer renders it possible to measure currents of any magnitude with a very small waste of energy.

Mr. Gaster pointed out that the measurement of self-induction with an electrometer could only be carried out practically if the current curve was a sine curve. He said that in curves obtained from a Ganz motor a correction amounting to 7 per cent. had to be applied.

The **Chairman** said that even if the curve obtained was a sine curve, the electrometer was never used in this country for measuring self-induction.

Prof. Herschell asked if it were possible to adjust the quadrants after the needle had been charged.

Mr. Addenbrooke then purposely disturbed the position of the adjustable plate, and after charging the needle reduced the deflection to zero by the worm gear. The author said that for high voltages the curve of calibration was different to that obtained from the ordinary formula.

The **Chairman** said that this discrepancy was probably due to want of perfect symmetry. In a paper read before the Royal Society by Perry, Ayrton, and Mather, it was shown that the presence of the guard around the mirror of an ordinary electrometer was sufficient to affect the needle when working with high voltages. In working with the plates very close together he was afraid the symmetry would be liable to be disturbed by a slight tilting of the needle due to electrostatic attraction.

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The **Author** observed that the plates were only very close together when working with low voltages.

SUNDERLAND ELECTRIC LIGHTING.

The following is the report on the working of the Corporation electric light station for the year 1898, by Mr. John F. C. Snell, A.M.I.C.E., the borough electrical engineer:

I have the honour to present my report on the fourth completed year's results of the electric lighting undertaking. The growth of the system continues rapidly. During the last year, in spite of the large number of lamps disconnected by reason of the disastrous fire at the Havelock House, 4,814 lamps have been added, making a total on April 1 last of 25,617. The current year (1899-1900) will bring about a very large increase, there being already as many new lamps applied for as were connected during the whole of last year, and I estimate that the lamps connected, or their equivalent, next April, will be over 35,000. Table I. shows the increase in lamps and consumers:

TABLE I.

Quarter ending	8-c.p. lamps or equivalent connected.	B.T. units sold.	Max. load in electrical h.p.	Number of consumers.	Capacity of station. In 8-c.p. lamps.	Capacity of station. In electrical h.p.
July 1, 1895...	2,894	8,324	46·0	33	4,900	210
April 1, 1896..	7,724	36,972	171·6	95	,,	,,
July 1, ,, ..	8,547	15,555	132·0	104	,,	,,
Sept. 30, ,, ..	8,764	19,797	157·8	104	,,	,,
Dec. 31, ,, ..	11,289	55,871	294·0	113	8,050	345
April 1, 1897..	12,672	55,162	256·0	125	11,100	480
July 1, ,, ..	12,953	30,789	250·6	128	,,	,,
Sept. 30, ,, ..	13,771	37,842	272 0	142	,,	,,
Dec. 31, ,, ..	19,177	95,393	483·8	165	,,	,,
April 1, 1898..	20,803	106,328	419·2	185	16,000	698
July 1, ,, ..	22,199	70,988	323·5	230	,,	,,
Sept. 30, ,, ..	21,839	80,804	423·0	250	,,	,,
Dec. 31, ,, ..	24,494	163,045	555·6	310	21,300	929
April 1, 1899..	25,617	157,506	531·8	340	,,	,,

NOTE 1.—Column 6 is obtained after deducting losses in distribution, but includes "stand-by" plant. NOTE 2.—The reduction in 8-c.p. lamps connected against Sept. 30, 1898, was due to disconnections caused by the fire.

The number of units sold has therefore increased from 270,209 to 472,240, representing an increase of 202,031 on the consumption of the previous year, or 75 per cent. This is a most gratifying result, and, moreover, the maximum demand on the station was only 556 e.h.p., as against 484 during 1897-8, whereas the units sold per "e.h.p. demanded" in 1897-8 were 559, and in 1898 9 were 844, which I attribute to the large increase of day load in motors and to the operation of the "maximum demand system" of charging for electricity. During the last year some considerable extensions have been made to the plant—viz., a 360-i.h.p. steam dynamo, built by the Sunderland Forge and Engineering Company, and which has given excellent results; three 8ft. 6in. by 28ft. Lancashire boilers, by Hawkesley, Wild, and Co.; and a water softener, by Mather and Platt, of Salford; besides an extension of the offices and buildings necessitated by our growth. The whole of the extensions, without exception, have given the greatest satisfaction. In addition there are three steam dynamos each of 200 i.h.p. on order which have to be delivered by July, in time for next winter's load. The estimated cost of the extension and the actual costs, including outstanding balances held as retention money on contracts, have been as follows:

	Estimate.	Actual.
Buildings	£2,050	£2,148
Steam dynamos, three boilers, steam, exhaust, and feed piping	10,678	10,999
Total	£12,728	£13,147

The estimate also includes a credit for three small machines, which will be disposed of next year, being too small for our requirements now. The expenditure will therefore be really several hundred pounds less than the estimate. The capital expenditure on the station now represents £58,637, or £66 per kilowatt installed. The average of all the other municipal stations (as extracted from the Board of Trade Returns) is £100. The motors connected to the mains are increasing rapidly in number; during the last year 15 motors, aggregating 96 h.p., have been added. These together make over 400 h.p. driven from the Corporation mains. The works expenditure and receipts have been as shown in Table II. (the last quarter has not yet been audited, but is approximately correct).

The year 1898-9 will be a memorable one, because it is the first year in which the undertaking shows a net profit after payment of the annual instalment of sinking fund and the interest on capital outlay. The year's profit on the station—that is, the sum available as dividend were the concern a private company—was £2,865, or 4¼ per cent. on the capital outlay. The sinking fund and interest was £2,501, leaving a net balance of £364 to the credit of the department. It must be also remembered that the charge for current in Sunderland is beaten by only two towns in the United Kingdom—viz., Edinburgh and Worcester—and the result, therefore, may be taken as highly satisfactory. In order to compare expenditure with estimate for the two half-years, Table III. has been prepared:

TABLE III.

Item.	Half-year ending Sept. 30, 1898 Estimated.	Half-year ending Sept. 30, 1898 Expended.	Half-year ending April 1, 1899. Estimated.	Half-year ending April 1, 1899. Expended.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Works costs	571 15 0	660 3 5	859 14 0	1,131 5 4
Standing costs	1,120 17 0	1,116 16 7	1,187 15 7	1,151 6 10
Total	1,692 12 0	1,777 0 0	2,047 9 7	2,282 12 2
Sinking fund	—	—	1,335 11 0	1,335 11 0
Interest	517 5 4	537 12 1	600 12 10	628 3 4
Grand total	2,209 17 4	2,314 12 1	3,983 13 5	4,246 6 6
Revenue	1,991 14 4	2,145 7 8	4,331 18 8	4,780 2 3

The expenditure has been increased on account of the increase in units sold, but the revenue has also increased much more in proportion. It will be noticed that it is only the engineering costs of production that have been affected to any extent, and these would naturally be increased with a larger sale of units. While the expenditure on the year has been £367 more than the estimate, the revenue has exceeded the estimate by £602, so that instead of the estimated net profit of £130 on the year's working there has actually resulted a net profit of £364 The engineering costs have been reduced from 2·27d. per unit to 2·03d.; this is a most satisfactory position. There are 60 municipal stations in existence and 39 companies' stations. Of these, many of which are very much older and larger, Sunderland is seventeenth from the top in cost of production. The first 16, containing 13 towns of the magnitude of Edinburgh, Manchester, Liverpool, and Glasgow, each of which sells over a million units a year, compared with our 470,000. The lowest recorded costs are 1 2d. at Edinburgh, selling over 2 800,000. and the highest (10·58d.) at Guildford, selling only 15,290 units. The plans for the extensions of the station, to meet the large demand for tramway purposes, will be brought forward for consideration shortly, with which increase a further reduction in costs may be expected. During the year several extensions of mains have been carried out, such as in Hendon-road, High-street East, etc., and a commencement has been made on the transference of the residential district from the alternating to the direct-current system, an alteration which will increase the efficiency of the station, and enable a uniform distribution to be given over the whole borough. The average price obtained for current sold during the year has been 3·78d. per unit to private consumers. The lowest recorded cost in the United Kingdom has been 3·45d. at Worcester, and the highest, Guildford, 8d. per unit sold. I beg to present a list of the extensions carried out during the last year, with their estimated and actual costs, as shown in Table IV.

TABLE II.

Half-year ending	Works cost.	Standing costs.	Total.	Revenue.	Profit on station.	Loss on station.	Resulting profit.	Sinking fund and interest.	Charge on rates.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Sept. 30, 1895...	74 16 3	515 12 5	590 8 8	482 3 8	—	108 5 0	714 13 11	1,357 6 1	642 12 2
April 1, 1896 ...	174 17 0	685 15 2	860 12 2	1,683 11 1	822 18 11	—			
Sept. 30, 1896...	199 13 1	670 4 8	869 17 9	780 17 3	—	89 0 6	690 7 2	1,672 12 10	982 5 8
April 1, 1897 ..	448 1 5	706 1 6	1,154 2 11	1 933 10 7	779 7 8	—			
Sept. 30, 1897...	328 10 9	800 15 6	1,129 6 3	1,103 9 2	—	25 17 1	1,674 3 10	2,256 15 11	582 12 1
April 1, 1898 ...	621 5 9	826 10 4	1,447 16 1	3,147 17 0	1,700 0 11	—			
Sept. 30, 1898...	660 3 5	1,116 16 7	1,777 0 0	2,145 7 8	368 7 8	—	2,865 17 9	2,501 6 5	Nil.
April 1, 1899 ...	1,131 5 4	1,151 6 10	2,282 12 2	4,780 2 3	2,497 10 1	—			

Net profit on station for the complete year, £364. 11s. 3d.

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TABLE IV.

	Estimated. £ s. d.	Actual. £ s. d.
Elms West	40 10 0	51 1 7
North Durham-street to Jos. Wilson Bros.	31 0 0	45 15 8
St. Thomas-street	47 6 0	32 11 9
Sans-street to Grey-street	176 0 0	207 19 9
Langham Tower	202 0 0	202 5 0
Doxford's to P.O., Stockton-road	71 11 0	36 12 9
Woodside	63 14 3	59 18 8
Vine-place to Holly House, Stockton-road	168 0 0	146 9 10
Infirmary	59 5 2	66 2 9
Hendon-road	538 16 8	587 3 9
Crowtree-road	222 8 4	212 0 0
Deuchar's, Bonner's Field	160 0 0	136 11 4
1, The Cloisters	30 13 0	30 0 2
Total	£1,811 4 5	£1,814 13 0

NOTE.—In the case of Sans-street extension heavier cables were laid than were estimated for, and at the infirmary a second small extension was made in addition to that estimated for.

Table V. records the efficiency of the station, and gives a comparison of this year's results with those of last year.

TABLE V.

Units generated.	Item.	1898-9. Number of units.	Per cent.	1897-8. Number	Per cent.
	Station and testing	13,833	2·48	5 693	1·57
	Battery	17,416	3·12	23 415	6 47
558,832	Motor-alternators	28,397	5·07	29,913	8·27
	Lost in mains and unaccounted for.	26,946	4·83	32,190	8·90
100 per cent.	Units sold	472,240	84·50	270 209	74·79
	Total	558,832	100·00	361,420	100·00

During this last year the engines, dynamos, and boilers have been thoroughly overhauled by the staff and the battery plates have been refitted by the Electrical Power Storage Company at their own expense, and according to their maintenance guarantee. I have to report, therefore, that the station plant is in a most satisfactory condition. A systematic test was also made during last summer of the cables over the whole network, and these results were also most satisfactory. I should like to record the services of the whole of the staff, who have all worked most ably and keenly in pursuit of the satisfactory results I am able to record.

KELVINSIDE ELECTRICITY COMPANY.

From the accounts of this company, just published, it appears that the total expenditure on capital up to Dec. 31, 1898, amounts to £27,556. 11s. 10d. An abstract of the revenue account and general balance-sheet is given below:

Dr. REVENUE ACCOUNT.	£ s. d.
Coal or other fuel, including all expenses	176 16 0
Oil, waste, water, and engine-room stores	22 9 7
Proportion of salaries of engineers, superintendents, and officers	46 0 0
Wages and gratuities at generating stations	164 17 3
Repairs and maintenance as follows: buildings, 17s.; engines and boilers, £48. 12s. 7d.; dynamos, exciters, transformers, motors, etc., £2. 18s. 7d.; other machinery, instruments, and tools, £35. 16s. 2d.; accumulators and accessories, £2. 0s. 8d.	90 5 0
Repairs, maintenance, and renewals of mains, transformers, etc.	0 7 7
Rents, rates, and taxes	209 14 2
Salaries of managing engineers, secretary, accountants, clerks, and messengers	170 0 0
Stationery and printing	7 15 5
General establishment charges	13 12 10
Postages	4 0 0
Auditor appointed under the provisions of the order	10 10 0
Law expenses	17 5 4
Special charges—insurances, etc.	31 18 3
Total expenditure	965 11 4
Balance carried to net revenue	681 0 10
	£1,646 12 2

Cr.	£ s. d.
Sale of current per meter at 6d. per B.T.U.	1,552 7 6
Rental of meters and other apparatus on consumers' premises	92 3 4
Sale and repairs of lamps	0 17 3
Transfer fees	0 12 6
Discounts	0 11 7
	£1,646 12 2

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£ s. d.
Capital account—amount received	29,953 0 0
Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, etc.	1,263 1 10
	£31,216 1 10

Cr. Assets.	£ s. d.
Capital account—amount expended for works	27,556 11 10
Stores on hand	1 18 6
Balance from net revenue account	2,766 19 2
Sundry debtors for current supplied	675 15 4
Other debtors	155 17 3
Cash at bankers and in hand	58 19 9
	£31,216 1 10

LEGAL INTELLIGENCE.

VESTRY OF PADDINGTON v. METROPOLITAN ELECTRIC SUPPLY COMPANY, LIMITED.

This was an application, made on the 16th inst. before Mr. Justice Phillimore in the Queen's Bench Division, by the plaintiffs by way of summons, which was adjourned into Court, for an injunction to restrain the defendants, the Metropolitan Electric Supply Company, Limited, from breaking up or excavating the roads in the parish of Paddington known as Grand Junction-road, Sussex-gardens, Westbourne-terrace, Westbourne-bridge, Westbourne-terrace-road, Blomfield-road, and Amberley-road for the purpose of laying a conduit in pursuance of notices of works dated Jan. 2, 1899, and April 12, 1899, until the trial of the action.

Mr. A. T. Lawrence, Q.C., and Mr. A. Lyttelton appeared in support of the summons; Mr. Cripps, Q.C., and Mr. C. H. Sargant for the defendants.

Mr. Lawrence said that it had been suggested by Mr. Cripps that it was probable that the parties might come to an arrangement if his Lordship would consent to an adjournment. The matter was one of considerable complication, and he (Mr. Lawrence) should be glad if his Lordship would grant an adjournment. The defendant company would give an undertaking that, in the event of the Vestry succeeding, the works which they had executed since the return of the summons should be restored to their former condition to the satisfaction of the Vestry.

Mr. Cripps, on behalf of the defendants, said that where, as in the present case, one party was a public body charged with public duties, and the other a corporation also with a public duty—viz., that of public lighting—an arrangement ought, if possible, to, and probably would, be arrived at. Unless the defendants went on with the works, they would not be able to supply their customers next winter, but they were quite prepared to give the undertaking Mr. Lawrence had mentioned.

Mr. Justice Phillimore ordered the summons to stand over generally upon the defendants giving the undertaking.—*The Times.*

ALLEGED ILLEGAL CONNECTION WITH A COMPANY'S WIRES.

We extract from the *Cambridge Chronicle* as follows: At the Borough Police Court on Tuesday morning Messrs. Baily, Grundy, and Barrett, electrical engineers, were summoned by the Cambridge Electrical Supply Company, Limited, for, on or about Feb. 1, connecting a wire in Bridge-street with those of the company's without the latter's consent. There was a second summons with respect to wires at Market-hill. The magistrates present were Dr. Cooper (who presided), Dr. Waraker, G. Smith and J. Burford, Esqs. Mr. J. E. L. Whitehead represented the complainant; Mr. St. John Raikes (instructed by Mr. Sidney Miller) defended.

Mr. Whitehead explained that proceedings were taken under Section 18 of the Gasworks Clauses Act, 1847. In this case it seemed that the Electric Supply Company had had certain mains laid down in Bridge-street, and they laid the mains leading therefrom to Mr. G. Nicholls's house. Subsequently Messrs. Baily, Grundy, and Barrett were called in by Mr. Nicholls to put in wires for additional lights to the house. The original wires, so far as the meter was concerned, were laid by the Electric Supply Company.

Mr. Raikes: These supply wires were laid down by my clients, and what the Supply Company did was to solder them under the main.

Mr. Whitehead: Yes. We do not allege that they have taken any electricity from these particular wires.

The **Chairman**: What you say is, they have made a connection with the other side of the meter and the supply will not be registered?

Mr. Whitehead: That is so.

Mr. Burford: Do I understand that Mr. Nicholls has got two people supplying him with electricity?

Mr. Whitehead: No, not at all. He has two different wires supplying him with electricity. Mr. Whitehead proceeded to explain that as soon as the complainants discovered the circumstances they sent a man to remove the wire and connect it with the meter so as to register the current properly. Their case undoubtedly depended upon the facts as to whether the wires

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were theirs or not. If they were not their mains then, of course, the case failed, but he hoped to be able to prove that they belonged to the company.

Mr. John Henry Barker, engineer and secretary to the Cambridge Electric Supply Company, Limited, said the company's mains ran past the house, and there were certain wires leading from those mains into the house. They were placed there first in 1893. The main and the meter he had no doubt were the property of the company. On Dec. 22 last year Mr. Nicholls called at the company's office and made a communication. Witness went to the premises and found that a wire had been laid to communicate with a wire which was, to the best of his belief, the property of his company. The wire was so laid that it was possible for the current to pass into the premises without being recorded in the meter. The company subsequently had the wire removed. The company imputed no charge through loss of electricity.

Mr. George Ernest Nicholls, jeweller, of 57, Bridge-street, said in December, 1898, he had electric light laid on certain portions of his premises, and in that month he gave instructions to the defendants to add certain lights. Before the work was completed the workmen told him not to use the lights because they were not properly connected; they said the current would not go through the meter and register the light. He did not use the light for any purpose, except to show the effect to his wife, until after the company came and did the work. He received an estimate from the defendants to do the work.

Mr. Raikes, for the defendants, contended that under the section they had no case at all. The section was not aimed at the person who carried out the work, but the person who caused the work to be done. It referred solely and entirely to the house-holder and not to the person whom he employed. The second point he wished to take was that the conduct of the company acted as a waiver. On hearing that something they believed to be irregular had been done, instead of taking any action and saying that they had laid themselves open to a penalty, they calmly completed the work and then, weeks afterwards, at any rate days afterwards, they approached a third party—namely, the agents who acted for Mr. Nicholls—and said they were going to proceed against them at law.

The **Chairman** said they over-ruled Mr. Raikes's contention on both points. If he desired it, they would certainly grant a case. They had not decided the question of fact.

Mr. Arthur Barrett, managing director for Messrs. Baily, Grundy, and Barrett, living at 6, Mortimer-road, said they were employed by Mr. Nicholls in 1893 to put in electric lights in his premises. The wires were supplied at Mr. Nicholls's cost. In December, 1898, the firm was called in to put in additional lamps. The wires he saw then were the same that were put down in 1893.

After a consultation in private,

The **Chairman** said that they had carefully considered the evidence in the case, and they found, as a fact, that an offence had been proved, that communication was made without the consent of the company. They fined the defendants £1, and they allowed £2 2s. for advocate and the Court fees. If Mr. Raikes desired a case, they would grant him one on the question of law he had raised.

Mr. Raikes intimated that he would make an application for a case in writing.

The second case was withdrawn.

COMPANIES' MEETINGS AND REPORTS.

TELEGRAPH MANUFACTURING COMPANY, LIMITED.

The directors have decided to pay a dividend on the ordinary shares at the rate of 6 per cent., and a bonus of 2 per cent., both free of income tax, being at the rate of 8 per cent. per annum. A balance of about £5,000 will be carried forward, after providing for depreciation and preference dividend due April 1, 1899, and £11,000 placed to reserve funds.

REUTER'S TELEGRAM COMPANY.

At the ordinary meeting of this Company on Wednesday at the offices, Old Jewry, Admiral Sir J. C. Dalrymple Hay presiding, the report, already noted in a previous issue, was adopted, a dividend of 5 per cent. declared, and a resolution of condolence with Baroness de Reuter on her bereavement was carried.

AUTOMATIC TELEPHONE COMPANY, LIMITED.

A meeting of the shareholders was held last Friday at Winchester House, Old Broad street, for the purpose of taking a poll on certain resolutions passed by a show of hands at the extraordinary general meeting of shareholders held on Friday, May 5, 1899. The resolutions referred to were as follows: "(1) That Max Margowski be removed from the office of the managing director of the Company. (2) That the articles of association of the Company be altered by cancelling Article 74 and substituting therefor the following: every member shall have one vote only on a show of hands; on a poll every member shall have one vote for every share up to 1,000; he shall have an additional vote for every 10 shares beyond the first thousand shares up to 5,000; an additional vote for every 100 shares beyond the first 5,000 shares up to 25,000 shares, and an additional vote for every thousand shares beyond the first 25,000. (3) That the articles of the Company be altered by omitting from Article 86 the words 'the said Max Margowski,' and substituting therefor the words 'the managing director for the time being.'"

The resolutions were declared lost. There was not one vote recorded in their favour, and 138,316 were recorded against the resolutions.

WEST INDIA AND PANAMA TELEGRAPH COMPANY, LIMITED.

The report shows an increase of £19,709 in the total receipts, chiefly arising from official and Press traffic consequent on the Spanish-American war. The expenses of repairing cables during the half-year were £9,037. Owing to the unfavourable financial condition of the Leeward Islands, the colonies of Antigua and St. Kitts have notified their intention of still further reducing their subsidies from £600 to £500 each per annum.

DUDLEY, STOURBRIDGE, AND DISTRICT ELECTRIC TRACTION COMPANY.

The seventeenth annual report to be presented at the ordinary general meeting of shareholders at 95, Colmore-row, Birmingham, on May 27, states: The total receipts on revenue account for the 12 months ended Dec. 31, 1898, amounted to £9,549. 8s. 8d., and the expenditure to £5,683. 5s. 6d., leaving a gross profit of £3,866. 3s. 2d., out of which the directors propose to pay a dividend of 5 per cent. per annum on the preference shares for the half-year ended December, 1898, and the rest is divided as follows: dividend at the rate of 3 per cent. per annum on the ordinary shares, £1.768. 7s.; depreciation fund, £1,000; preliminary expenses, £105. 5s.; carried forward, £919. 8s. 8d.—total, £3,866. 3s. 2d. The depreciation fund will then stand at £5,079. 8s. 8d. The directors have made an agreement with the British Electric Traction Company for the adoption of electric traction on the tramways, and for the transfer to this Company of the Dudley and District Light Railways Order, 1898, and agreements have been made with the various local authorities for extension of the tenure of the tramways. The tramways have now been reconstructed and are electrically equipped, and a power-house and new car depôt have been erected at Hart's-hill. It is expected that the tramways will be worked by electricity in the course of the summer.

Dr. BALANCE-SHEET, DEC 31, 1898.	£	s.	d.
Capital issued—11,789 ordinary shares of £5 each...	58 945	0	0
585 preference shares of £5 each.....	2,925	0	0
	61,870	0	0
Amount due to British Electric Traction Company on electric traction account.....	21,740	0	0
Sundry creditors.....	375	19	7
Depreciation fund—balance from last year, £4,322. 1s. 11d.; less cost of materials and renewals to engines, £243. 1s. 3d.....	4,079	0	8
Revenue account—surplus for 12 months ending Dec. 31, 1898	3,866	3	2
	£91,931	3	5
Cr.	£	s.	d.
Capital outlay—Permanent way	42,302	0	5
Buildings (on land held under a tenancy agreement)	3,405	9	6
Cost of orders	4,600	0	0
Engines	7,118	7	11
Cars.....	2,105	6	11
	£59,531	4	9
Electric traction account—amount paid and accrued under agreement with British Electric Traction Company	29,340	0	0
Office furniture.....	24	0	0
Machinery, tools, and stores.....	511	13	9
Debtors, including reserves for payments made on account of next year's revenue	165	17	11
Cash at bankers and in hand	2 253	2	0
Preliminary expenses	105	5	0
	£91,931	3	5

The accounts are certified by Messrs. Carter, Carter, and Martineau, chartered accountants, Birmingham.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Taunton.—The Corporation invite tenders for various plant by June 1.

Dudley.—Tenders are required for boilers, dynamos, cables, and lamps by June 17.

Madrid.—The Public Works Department invite tenders for electric tramways for Madrid. Tenders by June 14.

Sappemeer (Holland).—The Municipality invite tenders for the erection of central electric lighting station by June 1.

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Madrid.—The Post and Telegraph Department require 26,000 2in. cylinders for electric batteries. Tenders by June 13.

Lisbon.—The Mozambique Company will receive at their offices in Lisbon tenders for the erection of electricity works by July 10.

Southampton.—The Corporation invite tenders for motorcars and equipment and electrical equipment of lines. Tenders before noon on June 5.

Birkenhead.—The Corporation invite tenders for 100 electricity meters by 26th inst.; also a 225-kw. direct-current high-speed steam dynamo by June 9.

Medina Sidonia (Province of Cadiz, Spain).—The Municipal Authorities invite tenders for an electric light installation for public lighting by June 2.

Beira (East Africa).—The Colonial Office at Lisbon invites tenders for construction and working of electric lighting and telephones in Beira by July 8.

Carlisle.—The Town Council invite tenders for rewiring, etc., the public library, art gallery, etc., buildings for the purpose of lighting the same with electricity.

Hackney.—The Electric Lighting Committee of the Vestry invite tenders for trenching, troughing, cables, joint-boxes and jointing, and house services, by June 13.

Darlington.—The Corporation invite tenders for the supply and delivery of various plant, together with the fixing of the same at their electric generating station. Tenders by May 30.

Madrid.—The Post and Telegraph Department invite tenders for 16 tons of copper vitriol, estimated at 820 pesetas per ton (about £30 to £32). A deposit of 5 per cent. is required. Tenders by June 3.

London.—The Asylums Committee of the London County Council invite tenders for the installation of telephones, fire-alarms, tell-tale clocks, and call bells at the Heath Asylum, Bexley, Kent, by May 31.

Manchester.—The Art Gallery Committee invite tenders for an electric installation at the City Art Gallery, Mosley-street. Specification may be seen on application to the City Surveyor, Town Hall, Manchester. Tenders by 9 a.m. on June 3.

Knaresborough.—Tenders are invited for supplying an efficient searchlight, electric, acetylene, or other illuminant, for the Knaresborough Water Carnival, Aug. 17. Full particulars on application to Messrs. Wm. Bowler, jun., and Chas. F. Smith, hon. secs.

Wimbledon.—The Urban District Council invite tenders for 425 yards of 2ft. gauge tramlines and six tip wagons. Copy of plans can be had on application to Mr. H. C. Cooper, M.I.C.E., Council Offices, Wimbledon. Tenders by noon on 29th inst.

Tarifa (Spain).—Tenders are invited for public electric light installation, and working of the same for 20 years. The deposit required is 5 per cent. of the tender. Specifications, etc., are to be obtained from, and tenders addressed to, the Syndaco, Tarifa, Spain.

Brighton.—The Town Council invite tenders for the supply of auxiliary switchboards and switchboard gallery at the Corporation electricity works. Specifications, etc., may be obtained from Mr. Francis J. Tillstone, Town Hall, Brighton. Tenders by 10 a.m. on 29th inst.

Russia.—The Secretary of State for Foreign Affairs has received a dispatch from her Majesty's Consul at Taganrog, stating that tenders are invited by the Municipality of Kertch for the supply of materials for the construction of electric lighting plant and tramways in that town.

Teneriffe.—Tenders are invited for the erection and working of an electric tramway between Santa Cruz and San Cristobal. The deposit required is about 776,214 pesetas (about £350). Specifications, etc., are to be obtained from, and tenders addressed to, Public Works Department, Madrid, by 1 p.m. on June 14.

Halifax.—The Guardians invite tenders for the electric lighting of the workhouse and union offices from the Corporation mains. Plans and specifications may be obtained from Messrs. Shepherd and Watney, Greek-street-chambers, Leeds, on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders by noon on June 8.

Patricroft.—The Guardians of Barton-upon-Irwell Union invite tenders for the wiring, with lamps and fittings of their new infirmary buildings, Green-lane, Patricroft. Specifications, etc., can be obtained from Mr. G. R. Peers, A.I.E.E., 96, Deansgate, Manchester, upon deposit of a cheque for £3. 3s., which will be returned on receipt of a bona fide tender. Tenders by June 6.

Darlington.—The Corporation invite tenders for the various works required to be executed in the erection of buildings to be used as an electric lighting station in the borough. Specifications, etc., may be obtained on payment of £2. 2s. (which sum will be returned on receipt of a bona fide tender), from the Borough Surveyor, Town Hall, Darlington, on and after 15th inst. Tenders by 30th inst.

London.—The Guardians of St. Mary, Islington, invite tenders for works of installation of the electric light at the new infirmary for the parish at Highgate-hill, Upper Holloway. Specifications, etc., may be obtained from Mr. William Smith, architect, 65, Chancery-lane, W.C., up to 20th inst. upon depositing £5, which will be returned upon receipt of a bona fide tender. Tenders by 11 a.m. on June 1.

Sheffield.—The Health Committee invite tenders for the supply and erection of engines, electric lighting plant, pumps, shafting, pulleys, and other engineering work required at the destructor, Lumley-street, Attercliffe, Sheffield. Specifications, etc., may be obtained at the office of Mr. Charles F. Wike, C.E, city surveyor, Town Hall, Sheffield, on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders by June 5.

Crewe.—The Corporation invite tenders for supply of boilers and economisers, engines and dynamos, centrifugal pump and motor, mains, battery, switchboard, travelling crane. Specifications, etc., may be obtained from the Borough Engineer, Crewe, or from the engineers, Messrs. Hopkinson and Talbot, 26, Victoria-street, London, S.W., and 29, Princess-street, Manchester, on payment of £2. 2s., which will be returned on receipt of a bona fide tender. Tenders by June 1.

Wimbledon.—The Urban District Council will advertise for tenders for sufficient cable to meet the requirements for the next six months, and the following quantities are to be obtained in the first instance: Private lighting (armoured), 1,000 yards estimate, £100; public lighting, 1,000 yards estimate, £85; private lighting (unarmoured), 1,000 yards estimate, £85; high-tension, 100 yards estimate, £50—£320. Also for the supply of Welsh coal to March 31, 1900, the quantity not to be less than 1,000 tons.

York.—The North-Eastern Railway Company invite tenders for the following articles in such quantities as they may require during six months ending Dec. 31, 1899, delivered carriage paid at the company's telegraph stores at York: (1) telegraph apparatus; (2) telegraph wire and line stores. Payment for each month's delivery will be made at the end of three clear months, or in cash less 2½ per cent. discount. Forms of tender may be obtained on application to Mr. Graves, Telegraph Department, York. Tenders by noon on June 5.

Prestwich.—The Committee of Visitors of the Prestwich County Lunatic Asylum invite tenders for steam-pipes, condensers and cooling tower, steam dynamos for 274 kw., mains, switchboards, storage batteries, and wiring for an electric light installation. Firms desiring to tender are directed to send their names with a statement of the parts of the work they desire to quote for, to Mr. Charles Hopkinson, M.I.C.E., 29, Princess-street, Manchester: or to Messrs. Hopkinsons and Talbot, 26, Victoria-street, London, S.W. They will then be informed when the specifications are ready for issue.

London, S.W.—The Vestry of St. Mary, Battersea, invite tenders for the supply and erection and the carrying out of work in connection with the electric lighting of the parish to specifications as follows: (Specification No. 1) feeders, distributing mains, and arc light leads, including laying and jointing; (2) water-tube boilers; (3) steam dynamos and engines. Specifications, etc., may be obtained from the Vestry Clerk, at the Municipal Buildings, Lavender-hill, S.W., on payment of £3. 3s. for each specification, etc., which sum will be returned after the receipt of the specification, etc., accompanied by a bona fide tender. Specifications and drawings can also be seen at (but not obtained from) the office of Prof. Alex. B. W. Kennedy, 17, Victoria-street, Westminster. Tenders by 12 noon on June 7.

RESULTS OF TENDERS.

Sheffield.—The Electric Light Committee have decided to accept the tender of Messrs. Ferranti, Limited, of Hollinwood, for the delivery of a 1,000-kw. steam alternator for £9,500.

Wimbledon.—The following tenders for wiring have been accepted: Council offices, Donnison, Berlyn, and Co., £40; generating station, Whitehead Bros., £86; pumping station, Gerald Berners, £58. 7s. 6d.

Liverpool.—The Select Vestry have accepted the tender of Messrs. Pulford Bros., 15, Moorfields, Dale-street, Liverpool, for the renovation and extension of the telephonic and fire-alarm communications of the workhouse, Brownlow-hill.

Beckenham.—The following tenders for dust destructors have been received: Beaman and Deas, £1,685; Manlove, Alliott, and Co., £1,220; Goddard, Massey, and Warner, £1,154. 10s.; Horsfall Furnace Syndicate, £1,107 (recommended for acceptance); and W. F. Mason and Co., £768.

South Shields.—The Corporation have received the following tenders for the building of extensions to the engine-house and the boiler-house and bunkers at the electricity works, West Holborn:

T. Lumsden, Jarrow-on-Tyne (accepted)	£2,296	0	0
W. Christie, Commercial-road, South Shields	2,331	4	3
J. C. Nichol, Hyde-street, South Shields	2,380	0	0
J. Moore, Meldon-terrace, South Shields	2,389	0	0
W. J. Robertson, Mowbray-road, South Shields	2 400	8	11
S. Sheriff, Back Woodbine-street, South Shields	2 409	0	0
R. Allison, Whitburn, near Sunderland	2,622	12	2

Loughborough.—The Brush Electrical Engineering Company have received the following tenders for extensions to main shops and foundry at the Falcon Works, Loughborough:

To complete in 30 weeks.

A. G. Bell	£6,180

Dependent on supply of ironwork.

E. Orton	6,038

Twenty-five weeks.

Main, Kendall, and Main	5 895
Moss and Sons	5,750

Twenty-two weeks.

Faulks, Loughborough (accepted)	5,620

Derby.—The Guardians have decided to light the poor-law offices with electricity.

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BUSINESS NOTES.

Clontarf.—The preamble of the Electric Lighting Bill has been proved.

Reading.—The routes for the proposed tramway extension have been fixed upon.

Merthyr.—The Board of Trade have confirmed two Merthyr Tydfil light railway orders.

Buxton.—The Urban District Council have decided to obtain prices for the supply of tramway rails.

Burton-on-Trent.—A deputation of the Corporation on Friday visited Bradford for the purpose of inspecting the electric installation there.

Dublin.—The connecting link of the tramway system between Castlewood-avenue and Harold's Cross line was opened for traffic on Tuesday.

Clerkenwell.—The Electric Lighting Committee do not propose to go to Parliament for power at present to light the parish by electricity.

Blackpool and Garstang Electric Light Railway Company, Limited.—This Company has been registered with a capital of £10,000 in £5 shares.

Epsom.—The tenders received for the supply and erection of plant required for the electric light installation have been referred to the electrical engineer.

Limerick.—The Town Council have decided not to sell the gasworks, and to postpone the question of putting the electric lighting order in force for further consideration.

Hartlepool.—The Bill confirming the provisional order made by the Board of Trade under the Electric Lighting Acts with relation to Hartlepool has been ordered for third reading.

Newton.—The Caledonian Railway Company have introduced the electric light at their Newton yards and platforms. The entire plant has been fitted up by the company themselves.

Cardiff.—The Tramways Committee have decided to recommend the Council to approach the Penarth Harbour and District Tramways Company with a view of purchasing their lines.

Smithfield Markets Electric Supply Company, Limited. At an extraordinary general meeting on Wednesday the sanction of the shareholders to the raising of further capital was obtained.

Cape Copper Company, Limited.—The directors have declared an interim dividend of 5s. per share on the cumulative preference and ordinary shares, free of income tax, and payable on July 1.

Lee.—The Blackheath and Greenwich Electric Light Company have erected a transforming station at the entrance to Blackheath Park, behind the lodge, and are laying mains along the Lee-road.

Salford.—Colonel C. H. Luard, Local Government Board inspector, has held an enquiry into the application of the Corporation for permission to borrow £5,822 for electric lighting purposes.

Ham.—The District Council have adopted the proposals of Kingston as to electric lighting, subject to the Kingston authority agreeing to remove the wires if requested and to make good all roads.

Newcastle.—The Corporation's Tramway and Public Improvements Bill will come before the House of Commons on or about June 6. It will be opposed by the two electric lighting companies in the city.

Cradley Heath.—The British Electric Traction Company have entered into a contract for the construction of the Cradley Heath electric tramway with Mr. George Law, contractor, of Kidderminster.

Bradford.—A deputation from Derby inspected the Bradford electric tramways on Wednesday. They were shown over the system by Mr. J. H. Cox, the city surveyor, and Mr. C. J. Spencer, manager of the tramways.

Ilkeston.—The order authorising the Corporation to carry out a scheme of electric lighting for the borough has passed Mr. Lowther's Committee of the House of Commons, and will now be reported for third reading.

Wimbledon.—Mr. Casswell has been elected chairman of the Electric Lighting Committee until the next annual meeting of the Council. The resident engineer has been authorised to purchase tools for the repairing shop at £100.

Hough Green.—It is proposed to lay mains for the supply of public and private lighting in Hough Green and Curzon Park, and for the public lighting of Saltney main road (including 36 Jandus arc lamps), at an estimated cost of £3,500.

West London and Provincial Electric Supply Company, Limited.—This Company has been registered, with a capital of £150,000 in £1 shares, with the object to carry on the business of an electric light company in all its branches.

Leatherhead.—At their last meeting the Urban District Council resolved to canvass the persons living in the area to be covered by the electric lighting installation as to whether they would use the electric light if the Council carried out the work.

Ormskirk and Southport Light Railway.—Notices are published of intention to apply for an order for incorporating a company and authorising the construction of light railways from Ormskirk to Southport, in the county of Lancaster.

Dudley, Stourbridge, and District Electric Traction Company, Limited.—The traffic receipts for the week ending May 13, 1899, were £164. 18s. 4d.; corresponding week last year, £168. 10s. 2d. The total for this year is £3,095. 12s. 4d. (£3,041. 3s. 4d.).

Twickenham.—The Light Railway Commissioners will hold their enquiry into the application of the London United Tramways for an order authorising them to construct electric tramways through Twickenham at the town hall on June 12.

City (London).—At a special meeting of the Court of Common Council next week a report from the Streets Committee of the Public Health Department on the present position of the Corporation in regard to the future of electricity in the City will be discussed.

Middlesex Tramways.—Advertisements have been issued in the joint names of the Middlesex County Council and the North Metropolitan Tramways Company, giving notice of the intention of the Council and company to apply for power to construct and work light railways.

Southwark.—The City of London Electric Lighting Company, Limited, have published notice of intention to apply to the London County Council for its approval to alter the standard pressure of the supply to consumers from 100 volts to 200 volts in the company's distributing mains.

Automatic Electrical Advertising Syndicate, Limited.—This Company has been registered with a capital of £4,500 in £1 shares, and the object is to adopt an agreement with H. A. Phillips, and to acquire, own, and work an invention for the display of advertisements automatically by electric power.

Dining Table Lighting.—We are informed that Messrs. Drake and Gorham have reduced the price of their patent dining-table connector, the use of which obviates the necessity of cutting the table and cloth to 12s. 6d. for a connector to take four candlesticks, and to 17s. 6d. for those taking six candlesticks.

Ashton-under-Lyne.—The Board of Trade inspection of the electric tramways of Ashton was held on the 25th inst., and the opening of the line is to follow almost immediately. Mr. W. A. Ducat has held an enquiry into an application of the Town Council to borrow £352 for an installation of electric light at the public baths.

Buller's Telegraph Construction Company, Limited.—This Company has been registered with a capital of £400,000 in £10 shares, and the object is to carry on in Great Britain, Ireland, and elsewhere the businesses of telegraphic, electrical, mechanical, manufacturing, and general engineers and contractors, manufacturers, etc.

Cork Electric Tramways and Lighting Company, Limited.—Notice is now published of application to be made by the Cork Electric Tramways and Lighting Company, Limited, for an Order in Council authorising the company to make and maintain certain tramways in the county of Cork, to be worked by electrical or other mechanical power, or by horse power.

Darlington.—At a recent meeting of the Streets Committee of the Corporation the report of the Tramways Committee was adopted. The report recommended that a small deputation should visit the various towns where the electric tramway system had been adopted for the purpose of inspecting the mode of paving, the standard, lamp, and bracket used, etc.

Bordeaux Tramways and Omnibus Company, Limited.—The decree confirming the substitution of the Compagnie Française des Tramways Electriques et Omnibus de Bordeaux has been signed by the President. A final meeting to declare dividends and pass resolutions for winding up will be held shortly. The transfer books will be closed after the 23rd inst.

Stockport.—The Police and Sanitary Committee of the House of Commons (Sir Stafford Northcote's) have passed the Bill of the Stockport Corporation which deals with the purchase and working of the tramways in and out of the borough by the Corporation, the supply of electricity to adjoining neighbourhoods, and a number of clauses relating to police and sanitary matters. There was no opposition.

Chester.—The city electric light accounts for the year ended March 25 last show a net revenue from private lighting of £1,076, while the public lighting is estimated to have cost £1,777. There is a balance of £4 611, which it is proposed to distribute as follows: to interest on capital expended, £1.441; sinking fund, £1,317; preliminary expenses written off (balance), £1,052; reserve fund, £800.

Cleckheaton.—The District Council have received a letter from the Liversedge Council with regard to the application which has been made to the Light Railway Commissioners for an order empowering the Dewsbury Town Council and the Cleckheaton and Heckmondwike District Councils to construct an electric tramway between Cleckheaton and Dewsbury, asking to be admitted to the combination.

Birmingham Electric Supply Company, Limited.—An extraordinary general meeting of this Company will be held at the Company's registered offices, Dale-end, Birmingham, on Thursday next at 12.30 p.m., at which meeting will be submitted for approval a Bill proposed to be introduced in the present session into the House of Lords for the purpose of carrying into effect the terms of the sale of the Company's undertaking to the Corporation of Birmingham.

Hereford.—The Electric Lighting Committee are making arrangements for laying the cables in the principal streets, and they have asked intending consumers to apply at once in order to save expense by laying the wires connecting the mains with the various shops and residences at the same time as the mains. The price for the current will not exceed 6d. per unit, and the committee intend to make concessions as soon as financial considerations justify it.

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Inverness and Lochend Light Railway Scheme.—On Saturday the Light Railway Commissioners, the Earl of Jersey presiding, held an enquiry at Inverness in reference to an application for an order authorising the construction of a light railway between Inverness and Lochend, at the head of Loch Ness, seven miles and three furlongs in length. The Commissioners decided that sufficient public advantage had not been proved, and refused the order to construct the line.

West London and Provincial Electric Supply Company, Limited.—This Company has been registered with a capital of £150,000 in £1 shares, and the object is to carry on the business of an electric light company in all its branches; in particular to construct, lay down, establish, fix, and carry out all necessary cables, wires, lines, accumulators, lamps, and works, and to generate, accumulate, distribute, and supply electricity, and to light towns, streets, markets, theatres, shops, etc.

Dewsbury.—Colonel Marsh, Local Government Board inspector, held an enquiry on the 18th inst. into an application by the Corporation for a loan of £9,000 for electric lighting, including £1,400 for buildings and supply of extension mains and house service connections, the latter being chiefly in the Halifax and Oxford roads district. The borough electrician (Mr. Jonas) produced plans of work completed and intended to be done, and said the amount required was £9,060.

Islington.—At the meeting of the Vestry to-day the appointment of the Electric Lighting Committee will be recommended as follows: Messrs. L H. Wilkins, E. J. Chant, J. D. Moore, A. Walkley, W. Malins, G. T. Wilson, F. G. Watkinson, W. Beale, E. Fitzgerald, R. Gordon, W. W. Hann, J. H. Rollings, F. H. Varley, Geo. Wright. A. J. Fearnhead, H. W. Callender, S. Lambert, T. Andrew, R. S. Cufflin, T. W. Vine, C. Dearing, A. S. Dobite, A. Meyers, W. H Whadcoat, J. T. Ablett.

Eastbourne.—At a special meeting of the Town Council yesterday, a report was submitted recommending a modification of the proposed scheme of electric tramways for the borough. In consequence of the very strong opposition in the Upperton district, the suggested tramway through this neighbourhood has been abandoned, and the project has been reduced to the seaside tramway. At a public meeting held on Wednesday, resolutions were passed approving of the construction of tramways in the East-end.

Northfleet.—The District Council have sealed the agreements with respect to the proposed electric trams. The Clerk explained at last week's meeting that he had unsuccessfully endeavoured to get the Board of Trade to admit a clause whereby one of the three districts could buy the whole of the concern at a given time, provided the other two did not want to join in the purchase. There might be an alteration in the law, and he had induced the promoters to agree that in the event of this being done they would enter into a binding agreement to sell.

Brighton.—It is the intention of the Corporation after June 30 next, subject to the consent of the Board of Trade being first obtained, to increase the standard pressure of supply in the electricity mains in certain described districts from 115 to 230 volts. The Corporation will, free of expense to the consumer, provide new lamps in lieu of those now in use, and will, where necessary, repair the consumers' wiring, so that it shall pass the tests of their officers. Mains to the extent of 175 yards are to be laid in the upper part of Springfield-road at an estimated cost of £740.

Beckenham.—At a recent meeting of the Electric Lighting Committee the Clerk reported that at the local enquiry held by Colonel Slack, R.E., no opposition was offered to the Council's application for a loan of £37,100 for electric lighting purposes. The Council was recommended to advertise for tenders for the buildings, and the surveyor was authorised to invite applications for the post of clerk of the works at a salary not exceeding £4. 1s. per week. The report was adopted. A letter from the British Insulated Wire Company, Limited, to the effect that they had approached the Free Wiring Company, and that they were willing to enter into a contract with them, is before the Electric Lighting Committee.

Hackney.—In their report submitted to the Vestry on Wednesday, the Electric Lighting Committee asked for authority to purchase a site for the electric lighting and refuse destructor station, and stated that the arrangements for the electric lighting of the parish had so far advanced that, acting under the advice of the engineer (Mr. Hammond), the committee had resolved to commence to lay electricity cables in those streets which were most suitable from an electrical and commercial point of view, and they had invited tenders for electricity supply mains, trenching, troughing, cables, joint-boxes and jointing, and house services. These tenders will be submitted to the ordinary meeting of the Vestry on June 14, 1899.

Stock Exchange.—May 30 has been appointed the special settling day for: Aron Electricity Meter, Limited—125,000 6 per cent. cumulative preference shares of £1 each fully paid, Nos. 1 to 125,000; British Insulated Wire Company, Limited—29,935 vendors' ordinary shares of £5 each fully paid, Nos. 1 to 29,625 and 39,651 to 39,960; and a further issue of 40 ordinary shares of £5 each fully paid. Nos. 39,961 to 40,000; also Hiram S. Maxim Electrical Construction, Limited—200,000 vendors' £1 shares fully paid, Nos. 8 to 200,007. The City and South London Railway Company's further issue of 5,749 5 per cent. perpetual preference shares of £10 each fully paid, Nos. 9,252 to 15,000, and £50,000 4 per cent. perpetual debenture stock, is to be quoted in the official list.

Lowestoft.—The Light Railway Commissioners held an enquiry on Friday into the application of the East Anglian Light (Electric) Railway Company for powers to run from Southtown to Kessingland through Lowestoft. The Commissioners were the Earl of Jersey (chairman) and Colonel Boughey. The Hon. A. Lyttelton, for the Great Eastern Railway, contended that the Light Railways Act never meant two systems to run side by side; the application was one which should be referred by the Board of Trade to Parliament. A second bridge at Lowestoft Harbour would be dangerous to navigation. Lord Claud Hamilton, chairman of the Great Eastern Railway, said he considered that the line would compete with the Great Eastern Railway, but he principally objected to it on the ground that it would destroy the amenities of the country. Lord Jersey intimated that the points raised would be duly considered, and the enquiry ended.

The Ediswan Fittings.—We have received from the Edison and Swan United Electric Light Company, Limited, their latest copy of their supplementary electrolier list. This consists of 42 pages bound together, on which are illustrated a great variety of electroliers for various uses. Amongst them we particularly note those designed so that they can be made in wrought iron or copper. The design of these is exceedingly neat and artistic, and they will doubtless find a ready demand amongst the higher-class users of electric light. One electrolier in wrought iron, providing for six lights, is particularly handsome, and, considering the large amount of hand labour involved in its construction, the price is exceedingly reasonable. We also notice that the firm have standardised a wrought-iron gate fitting, constructed to bridge between two gate posts 12ft. apart, with electric lights in lanterns at the point of the arch and at either gate post.

Bradbury and Co., Limited.—We have received from this firm, which owns the Wellington Works at Oldham, an illustration of the six-capstan lathe, which is specially designed to reproduce in quantity small brassware, such as is so often required in the manufacture of electrical accessories—in fact, the lathe in question is specially designed with the object of manufacturing lampholders in quantity. The mandrel of the lathe is hollow, and will take tubing or solid bars up to 1¼in. in diameter. The working travel of the capstan slide is 3½in., which is amply sufficient for all lampholder-tube work. The turret is provided with six toolholders, and in addition to this an ordinary slide rest can be used to work on exterior while the turret is boring and screwing the interior work. We gather from the list that these lathes are being manufactured to stock, and we trust that this will enable Messrs. Bradbury and Co. to prevent numerous orders from going to America.

Hammersmith.—The Vestry have withdrawn their opposition to the London United Tramways Bill on certain conditions, under which they will consent to the working by the company of their lines in the parish. The clauses, in addition to those stipulated by the London County Council when giving consent, are: (1) that Clause 10 of the Bill be withdrawn so far as it proposed to take away the Vestry's power of veto; (2) that the tramway portions of the roads in Glenthorne-road and Studland-street (including the 18in. margins) when the lines shall have been reconstructed and the whole of the Beadon-road from kerb to kerb be paved with hardwood at the entire expense of the company and to the satisfaction of the Vestry; (3) that the company bear all expense consequent on reconstructing the lines and roads, and the expense of shifting the electric lighting standards, and place the Vestry's electric lights on their poles where considered necessary by the Vestry; (4) that protective clauses be inserted in the Bill on the lines to be acquired by the London County Council; (5) that the company pay the Vestry's costs in connection with the company's Bills last year and this year.

Liverpool.—At a meeting of the Tramways Committee of the Corporation on Wednesday, a report on the subject of advertising on the tramcars was received from the general manager. The present system was considered by the manager to be objectionable, but he thought that if the system exhibited at the Advertisers' Exhibition, Niagara Hall (used in the Leeds cars), which consists of photographic and other transparencies on glass, were adopted, a sum of about £10,000 per annum might be realised. The general manager was authorised to prepare specifications for outside and inside advertisements, together and separately, with the view to a contract being entered into from July 1 next. The matter will be decided when the specifications have been prepared and the tenders received. To fill the vacancy caused by the death of Mr. T. J. Flynn, it was decided to recommend to the Council the appointment of Mr. Charles Petrie, who is chairman of the Electric Lighting Committee. A question was raised as to the powers of the Corporation to work tramways in districts outside the city, and the Town Clerk stated that there would be no difficulty about obtaining powers so long as the consent of the local authorities was secured. The general manager (Mr. Bellamy) was instructed to prepare a plan of feasible extensions beyond the city boundaries with the view of a conference with the local authorities that might be concerned. At a meeting of the Tramway Committee of the Corporation the report of the city engineer as to construction of certain junctions and temporary lines in connection with the Walton route was adopted. The city engineer and general manager are also to report as to the extension of the electric system to Aintree and Fazakerley.

Ross.—At a special meeting of the Urban District Council last week the Chairman reported that he had visited Cheltenham electrical works, and had ascertained that since the erection of the works commenced in 1895, £75,000 had been expended, and a profit of 3 per cent. had since been made. The committee thought works could be erected and plant laid in Ross, which was one-tenth the size of Cheltenham, at a corresponding expenditure,

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The cost of gas in Cheltenham was 2s. 4d. per 1,000ft. and 4s. 2d. in Ross. The experience of Cheltenham was that since the electric light was installed, gas had been laid on to a large number of the smaller houses and the price reduced. The committee anticipated a similar result on the installation of electric light at Ross. They thought electric light corresponding in quantity to the 4s. 2d. in gas could be supplied for 3s. 3d. The committee decided to engage Mr. Kilgour, electrical engineer of Cheltenham, to prepare plans and specifications, with an approximate estimate of the expenditure.

Croydon.—The report and accounts of the Electric Lighting Committee adopted by the County Council last week show a gross profit on the year's working of £5,340; £4,092. 2s. 8d. has been transferred to interest and sinking fund on loans, leaving a net revenue for the year of £1,247. 17s. 4d. In consequence of the refusal of the Local Government Board to sanction a loan for the payment of the premium to the British Thomson-Houston Company, £1,000 has been allocated to pay off this sum, leaving a balance of £247. 17s. 4d. to carry forward. The committee point out that a considerable portion of the works upon which capital has been expended during the year, and on which sinking fund and interest have been paid during the same period, had not been fully productive during the year. For instance, in some cases cables had just been laid for extensions which were included in the capital expenditure of the year, but the full revenue from connections to these cables would not be received until the current year. The committee recommended that the charge for current be made at the option of the consumer upon the maximum demand system at the price of 7d. per unit for the first hour's average demand, and 2d. per unit for the remainder of the supply.

Aston Manor.—The destructor which was erected in 1892 having proved insufficient for the work, the Urban District Council now propose to add four cells on the Beaman and Deas pattern, and to make other alterations by which its capacity will be improved to 108 tons daily. The steam will be obtained entirely from the heat generated in the destruction of refuse, but should the cells be allowed to go out or cooled down for cleaning or repairs, the steam can again be started by means of auxiliary grates. The power will be distributed electrically by means of cables carried from one central generator or motors fixed wherever required. Separate motors will be fixed to work (1) the fans for the air blast in the cells, (2) the elevator, (3) mortar mills, (4) well pumps; a small one will be set up in the stables for chaffcutting. The present boiler will be used for heating the fire station with steam. The wharf and premises will be lighted throughout with electric light, and the disinfecting apparatus will be worked by steam from the boilers. The estimates have increased from £11,500 to £14,000. The estimated cost is as follows: one 130-h.p. multipolar generator, £430; one 25-h.p. motor for grinding mills, £150; one 10-h.p. motor for elevator and conveyor, £90; one motor for fan, £100; one 10-h.p. motor for well pumps, £98; one 5 h.p. motor for chaffcutting, £70; cable and electric motors, £100; electric lighting, 22 arc lamps and 68 incandescent, £365; main switchboard, £65—making a total of £1.468. It is proposed that the works be divided as follows: (Contract No. 1) the destructor cells, flues, boilers, etc.; (2) engines, generator, and electrical plant, pumps, and storage tank; (3) elevator and conveyor; (4) buildings and paving; (5) well and boring; (6) disinfector. Also that the Local Government Board be applied to for a loan for £14,000, and that the committee be empowered to advertise for tenders for the works as above. These recommendations have been adopted by the Urban District Council. Permission has been given for the laying of trunk lines in Witton-lane and Alma-street, subject to the National Telephone Company paying an acknowledgment therefor in proportion to the sum paid by them under the existing agreement.

Hastings.—The Council have adopted the minutes of the Public Lighting Committee containing a report from the electrical engineer (Mr. Leonard Andrews) in connection with the proposed extension to West Marina, stating the cost of running a 0·05 square inch low-tension three-wire cable laid in earthenware troughing, and run up solid with bitumen from the Sussex Hotel, Marina, to a sub-station in the Corporation yard at West Marina, as £461; 0·035 square inch high-tension cable, laid as above, for feeding the proposed sub-station, £261; 0·025 square inch low-tension three-wire service up Grosvenor-gardens, £45; 0·05 square inch low-tension three-wire cable from Bopeep Hotel to the Victoria Hotel, *via* West Hill-road, £633; building a sub-station in the Corporation store yard, and equipping same with necessary transformers, switch gear, etc., £350—total cost, £1,750. The engineer does not recommend that the whole of the above extensions should be carried out at once, but only that provision should be made for any probable future demand to avoid the expense of opening up the roads a second time. As a basis for determining in what directions extensions of mains should be carried out, he suggests that no extension should be made unless there appears to be a reasonable prospect of earning 20 per cent. per annum upon the total cost of making the extension. At 6d. per unit each 8-c.p. lamp connected will earn about 8s. Thus to earn £280 about 700 lamps will have to be connected. As the cost of interest, sinking fund, and maintenance of mains will not amount to more than about 8¼ per cent. per annum, the 20 per cent. mentioned will leave a very fair margin. As space will not be available at the Corporation yard at West Marina for the proposed sub-station, a site for the station is to be obtained in some other suitable position in the vicinity, and, subject to the sanction of the Local Government Board to the borrowing of the estimated cost of the works specified in the report being obtained, the whole of such works are to be carried out as and when requisite. A resolution has been passed to apply to the Local Government Board for the necessary sanction. The Public Lighting Committee have made an agreement with the proprietors of the Empire Theatre of Varieties by which they obtain facilities for the laying and maintaining of two pipes for carrying electric light wires under the passage at the east end of the theatre, to connect with the sub-station constructed on adjoining land belonging to the Corporation, and for the user of such passage as a means of access to such sub-station. The proprietors have consented to grant the required rights on a yearly tenancy at the rent of 1s. per annum, and otherwise subject to the usual incidental conditions. In view of the collapse of the Corporation Tramways Bill, Mr. Murphy's scheme, now pending before the Light Railway Commissioners for tramways in the borough of Hastings, and from West Marina to Bexhill, is being revived. A recent letter from the promoter has been referred to Council in committee for early consideration and report.

PROVISIONAL PATENTS, 1899.

MAY 15.

10183. A removable combination magnet and coil for electric generators and motors. Charles H. Cutting and George H. Cutting, Parliament Works, Parliament-street, Derby.

10205. Liquid feed devices for electrolytic and kindred apparatus. Raoul Girouard, 55, Chancery-lane, London. (Complete specification.)

10215. Improvements in electrolytic apparatus. Max Haas, 77, Chancery-lane, London. (Complete specification.)

10219. Improvements in or relating to the regulation of electric motors. Martin T. A. Kubierschky, 111, Hatton-garden, London.

10228. Improvements in or relating to electric controllers. Alfred Julius Boult, 111, Hatton-garden, London. (Thorsten von Zweigbergk, United States.)

10238. Improvements in coin-operated mechanism specially applicable for electric and other meters. Edward du Bois and the Mutual Electric Trust, Limited, Norfolk House, Norfolk street, Strand, London.

10241. Improvements in electrical incandescence lamps with osmium filaments. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Oesterreichische Gasglühlicht und Elektricitäts-Gesellschaft, Austria-Hungary.)

10243. Improvements relating to electrical fuseholders. Thomas Duncan Dundas, 8, Rastell-avenue, Streatham-hill, London.

10246. Improvement in portable telephones. Lars Magnus Ericsson, Clun House, Surrey-street, Strand, London.

MAY 16.

10301. Improvements in or relating to overhead systems for electrical transmission of energy, William Routledge, 73, St. Stephen's-road, Upton Park, London.

10303. An improved system or arrangement of apparatus designed for the production of electrical pressure or intensity. Gordon Earl Adams, 55, Chancery-lane, London.

10320. Improvements in electrodes and electrode connections in liquid feed devices for electrolytic apparatus and in the construction of enclosing vessels for electrolytic and kindred apparatus. Henry Carmichael, 55, Chancery-lane, London. (Complete specification.)

10336. Improvements in controllers for electric motors. Reginald Belfield, 322, High Holborn, London. (Harry Phillips Davis, Gilbert Wright, and Alexander Jay Wurts, United States.)

10340. Improvements in electric meters. Hans Otto Swoboda, 18, Buckingham-street, Strand, London. (Complete specification.)

MAY 17.

10357. An improved electric alarm clock for awakening sleepers. Arthur Henry Arnold, 204, Woolwich-road, Charlton, London.

10374. Improvements in and relating to the junction-boxes and other similar joints of pipes used in connection with the conducting wires of electric lighting. Sam Fielden, 12, Standish-street, Burnley.

10393. Improvements in or relating to electro-mechanical impulse devices. Henry Campiche, 111, Hatton-garden, London.

10403. A new or improved electric switch. James Joseph Goodbury, 55, Chancery-lane, London.

10406. Improvements in wireless telegraphy. Leslie Bradley Miller, 93, Hatton-garden, London.

10413. An improvement in dynamo machines. Coleman de Kandó, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

10416. Improvements in incandescent electric lamps. William Mengarini, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

10442. Improvements in or connected with alternating-current electric arc lamps. William James Davy, 40, Chancery-lane, London.

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MAY 18.

10476. Improvements in the mountings and reflectors of electric lamps. Jean Houbois, 100, Wellington-street, Glasgow. (Complete specification.)

10489. Improved mounting or holder for reflectors of incandescent electric lamps. Carl Wolffhardt, 53, Chancery-lane, London.

10527. Improvements in coin-freed electrical apparatus. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (F. G. Lochmann und Cie., Germany.)

10535. Improvements in arc lamps. Henry Stansfield Dodd and Robert Ironside Bagnall, jun., Norfolk House, Norfolk-street, Strand, London.

10536. Improvements in and relating to electrical contact devices for explosion engines fired by electricity. James George Accles, 45, Southampton-buildings, Chancery-lane, London.

MAY 19.

10561. Improvements in electrical igniters for gas lamps. Ridley James Urquhart, 57, Barton-arcade, Manchester. (The firm of Eckel und Glinicke, Germany.)

10590. Improvements in the combination of electric motors with centrifugal fans or pumps. Samuel Cleland Davidson and Louis John Steele, 55, Chancery-lane, London.

10596. Electrical apparatus by means of which a prize is automatically delivered when a target is hit. Julius Dömjén and Carl Schrötter, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

10606. Improvements in thermostatic regulators. Albert Richardson Shattuck, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

10608. Improvements in the manufacture of conduits for electrical conductors and other purposes and in apparatus therefor. Harry Scott Morrison, 24, Southampton-buildings, Chancery-lane, London.

MAY 20.

10647. Improvements in electric switches. Alfred William Cramp, 23, Coleman-street, London.

10669. Improvements in or relating to incandescent electric lamps. Max Rudolph Heide, 322, High Holborn, London.

10682. Improvements in telephones. Joseph Devonport Finney Andrews, 45, Fulham Park-gardens, Fulham, London.

SPECIFICATIONS PUBLISHED.

1898.

9475. Electric arc lamps. Boardman.

9511. Rheostats for the graduated control of electrical resistance, particularly applicable to the production of theatrical luminous effects. Clémançon.

10616. Enclosed arc lamps. Thomas-Davies.

11609. Electrical fuses and cut-outs chiefly applicable to the bridge fuse. Sowry and Munslow.

11962. Automatic prepayment mechanism for controlling the supply of electricity or gas. Hughes.

12667. Device for fitting reflectors, shades, globes, or the like to electric incandescent and other lamps. Bartenstein.

13116. Illuminating conductors for incandescent electric lamps. Imray. (Von Welsbach.)

13999. Electric stop motions employed in machinery or apparatus for elongating or drawing strands of cotton and other fibres. Tunstall and Crabtree.

14217. Electric miners' lamps. Wood.

14293. Systems of electrical distribution. Belfield. (Scott and Lamme.)

14294. Regulation of rotary transformer direct-current E.M.F. Lamme. (Date applied for under International Convention, Feb. 10, 1898.)

14761. Electrical safety fuses or cut-outs. Langdon.

24404. Insulating and supporting electric conductors. Hackethal.

1899.

1627. Insulators for fastening electric wires. Treleaven.

4119. Mode and means for operating the poles or masts of electrical cars or vehicles for tramways. Rutherford.

5576 Automatic systems of preventing collisions on electric railways. Bancroft and Sullivan.

5619. Galvanic batteries. Singer.

5868. Sheathing or casing of thermo-electric elements. Johnson. (Hartman and Braun.)

6067. Electrical drying apparatus for treating textile fabrics. Vignon-Danto.

6269. Electric lampholders. Hall.

6270. Combined electrical switches and lampholders. Hall.

6443. Pocket galvanometer. Beez.

6562. Current regulators for electric batteries. Fuld.

6647. Wall plugs for electric lighting and heating. Lundberg and Lundberg.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1899.	Corresponding week 1898.	Increase or decrease.	Total receipts for half-year. 1899.	1898.
		£	£	£	£	£
Birmingham Tramway Co.	May 20	4 184	3,600	+ 584	77,754	71,256
Blackpool and Fleetwood Tramroad	,, 20	324	—	—	5,047	—
Bradford City Trams	Feb. 5	145	—	—	6,733‡	—
Bristol Tramways and Carriage Co.	May 19	2,863	2,696	+ 167	—	—
City and South London Railway	,, 21	1,079	987	+ 92	22 358	21,666
Dover Tramways	,, 20	160	127	+ 33	3,046	2,345
Dublin U.T., elec. cars	,, 19	1,064	899†	+ 165	18,816	15,162†
Dublin S.D. Electric Tramways	,, 19	744	556	+ 188	13,637	8,989
Halifax Corporation Tramways	Mar. 29	312	—	—	10,712*	—
Liverpool Overhead Railway	May 21	1,395	1,416	- 21	28,314	29,300
South Staffordshire Tramways	,, 19	596	576	+ 20	12,316	11,844

* Since June 30, 1898. † Including horse cars. ‡ Since July, 1898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	23½-24½
Bournemouth and Poole Electric Supply, Limited, Ord.	10	13½-13¾
—— 4½ per cent. Cum. Pref.	10	10½-11½
British Electric Traction, Limited, Ordinary, Nos. 1-80,000	10	18-19
—— 6 per cent. Cm. Pf., 80,001-40,000 (all paid)	10	13¾-14½
—— 6 per cent. Cm. Pf., 40,001-60,000	10	13½-14
—— 5 per cent. Perpetual Debenture Stock	100	126-129
Brush Electrical Engineering, Limited, Ordinary	2	1½-2½
—— Non. Cum., 6 per cent. Pref.	2	2½-2¾
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	102-106
Callender's Cable Company, Debentures	100	114-117
—— Ordinary	5	12½-13½
Central London Railway, Ordinary	10	11-11½
——	3	9-9½
—— Pref. Half-Shares	3	3½-3¾
—— ,, ,,	5	5½-6½
Charing Cross and Strand	5	11-12
—— 4½ per cent. Cum. Pref.	5	5½-6½
Chelsea Electricity Company	5	8-9
—— 4½ per cent. Debentures	100	114-116
City of London, Ordinary	10	16-17
—— 6 per cent. Cumulative Pref.	10	15-16
—— 5 per cent. Debenture Stock	100	125-130
City and South London Railway, Consolidated Ordinary	100	68-70
—— Ordinary	3	4½-5½
—— 4 per cent. Debenture Stock	100	132-134
—— 5 per cent. Pref. Shares	10	14½-15½
—— ,, ,, '96	10	14-15
County of London and Brush Prov. Elec. Light Co., Ord.	10	11-12
—— 6 per cent. Cum. Pref.	10	14-15
—— 4½ per cent. Prov. Certs.	—	54-56
Crompton and Co.	3	3¾ 4¼
—— 5 per cent. Debentures	—	98-101
Crystal Palace District, Ordinary 5 per cent. Stock	100	130-135
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2-2½
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	96-98
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5½-5¾
Electric Construction, Limited	2	2½-2¾
—— 7 per cent. Cumulative Pref.	2	3-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	103-106
W. T. Henley's Telegraph Works, Ordinary	10	25-26
—— 7 per cent. Preference	10	18-20
—— 4½ per cent. Debentures	100	113-115
House-to-House Company, Ordinary	5	8-9
—— 7 per cent. Preference	5	9-10
Imperial Tramways, Limited	6	24½-25½
India Rubber, Gutta Percha, and Telegraph Works	10	21-22
—— 4 per cent. Debentures	100	101-105
Kensington and Knightsbridge Ordinary	5	12-13
London Electric Supply, Ordinary	3	3½-3¾
—— 6 per cent. Pref.	5	6½-7
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	106-108
Metropolitan Electric Supply, Limited, Ord., No. 1-62,500	10	16½-17½
—— ,, ,, No. 62,501-85,000	10	15½-16½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-12[illegible]
National Telephone, Ordinary	5	4½-5
—— 6 per cent. Cum. First Pref.	10	11-13
—— 6 per cent. Cum. Second Pref.	10	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	4½-5½
—— 3½ per cent. Deb. Stock, Red.	100	99-102
Notting Hill Electric Lighting Company, Limited	10	16½-17½
Oriental, Limited, 1879	1	1½-1¾
—— £5 Shares	5	7½-7¾
—— £4½ Shares, New	4½	6½-6¾
Oriental Telephone and Electric Company	1	¾-1
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6¼-7
Royal Electrical Company of Montreal	[illegible]	165-185
—— 4½ per cent. First Shares Mortgage Debentures	100	105-107
South London Electric Supply, Ordinary	3	4½ 4¾
St. James's and Pall Mall, Limited, Ordinary	5	17-18
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	37-41
—— 5 per cent. Bonds	100	106-108
Waterloo and City Railway, Ordinary	100	107-110
Westminster Electric Supply, Ordinary	5	14½-15½

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NOTES.

London Chamber of Commerce.—A special general meeting of this organisation was called for last (Thursday) night, to consider certain proposed alterations in the by-laws.

Electricite a la Maison.—The Brussels Exhibition with the above name is to be opened by Prince Albert of Belgium on Saturday next, at 2 p.m. A Press view of the exhibition is being held to-day.

Institution of Junior Engineers.—Arrangements have been made for the members of this institution to visit at 6.30 p.m. next Friday (the 9th inst.) the Bankside works of the City of London Electric Lighting Company.

Royal Institution.—The special meetings of the Royal Institution to commemorate the centenary of the first meeting of members in 1799 will be held on the first three days of next week. The programme of the meetings was given in a recent issue.

Biological Electricity.—A prize of £50 is offered by the Economic Society of Mohringen, near Königsberg, for the best work on the relations of electricity to living organisms. The work must discuss new phenomena in biological electricity, or the sources of it, from a physical point of view.

Institution of Civil Engineers.—We would remind our readers of the conference to be held next week at Westminster in connection with the Institution of Civil Engineers. The conference will be opened on Wednesday, June 7, at 10.15 a.m, by an address by Mr. W. H. Preece, C.B., F.R.S., and the various sections will meet afterwards as announced last week. A conversazione will be held on Thursday evening and also on Friday.

Physical Society.—At the ordinary meeting of this society last Friday, Mr. T. H. Blakesley, vice-president, in the chair, a paper was read on "The Thermal Properties of Normal Pentane" (Part 2), by Prof. S. Young and Mr. Rose Innes. A lengthy discussion followed, with the result that the reading of a paper on "The Distribution of Magnetic Induction in a Long Iron Bar," by Mr. C. G. Lamb, was postponed until the next meeting.

City and Guilds Exhibition.—On Friday next, June 9, the Duke of Devonshire, K.G., will open an exhibition of practical work executed by the candidates at the 1899 examinations of the City and Guilds of London Institute. The exhibition will be held in the North Gallery of the Imperial Institute, and will be opened at 3.30 p.m. precisely. The advantage of these practical tests in connection with an examination which combines practical and theoretical questions is most apparent. The exhibition will be of great interest to employers of labour in ascertaining the quality of the work the rising generation are capable of turning out.

The Southampton Accident.—We understand that the secretary to the Board of Trade has refused to accept the explanation of the Southamption Corporation that the Corporation should be released from responsibility with respect to the workman who was killed while making alterations to the mains. The Corporation wished to be relieved from responsibility because the work was not completed, but the secretary to the Board of Trade reminded the Corporation that as they ordered the supply to be given to the main in question they could not afterwards refuse to accept the responsibility for an accident arising out of the fulfilment of their order.

The Electric Horse.—An interesting libel case has been occupying the Queen's Bench Division this week, a Mr. J. J. Inger having been suing the *Star* Newspaper Company to recover damages for libel. The libel arises out of a comment on the Electric Horse Promotion Syndicate. This syndicate was supposed to be formed for the ultimate promotion of the Electric Horse Company, Limited, with £80,000 worth of capital. We have read carefully the reports of the matter before the Court, but up to the present we have not found any connection between electricity and the horse which the plaintiff was exploiting. We hope, however, to glean further details as the case proceeds.

Accumulator Exhibition.—We see from the columns of our French contemporary *L'Electricien* that the list of entries for the international exhibition of accumulators organised by the Automobile Club of France, has been closed. Nineteen firms which undertake the manufacture of accumulators have entered their names, and will submit their work for public trial. It will be remembered from one of our previous notes that these trials are made with the object of determining the most suitable type of accumulator for automobile work. We are glad to note that amongst the list of entries are two English firms, and we trust that their accumulators will obtain a high position in the comparative tests.

Tramway Bargains.—Now that the London County Council are buying up the whole of the tramway undertakings in Greater London, it is interesting to see that the smaller municipal authorities do not propose to relax the methods by which they have exacted blackmail from other tramway promoters. For instance, the Wandsworth District Board of Works have laid down the following conditions, which have to be complied with before they will consent to the extension of the tramways in the parishes of Clapham, Streatham, Tooting, Wandsworth, and Putney by the London County Council—*i.e.*, "The roads to be widened to the width required by the Board at the County Council's expense; the lines to be doubled, and the route to have the Board's approval."

American Cabs.—We have seen in a number of the daily papers accounts as to what Lord Charles Beresford thought of the electric cab he used in New York, but the statement in our contemporary the *Electrical Review* of that city goes rather beyond all these. In that journal Lord Charles Beresford is credited with saying that "while I was in New York I was supplied with a motor-cab which had the appearance of a cab and the manners of a kangaroo, but it always got me safely to my destination." Our contemporary takes this as a great compliment to the cab, but we would point out that the manners of a kangaroo would make a cab much more objectionable than a horse would. Personally, we much prefer that the cab should run smoothly and noiselessly.

Patents in United States Colonies.—According to particulars recently received from Washington, and furnished to the *Journal* of the Society of Arts by Mr. R. W. Barker, of Ludgate-hill, owners of patents in territory subject to military government by the United States will receive the same protection as is accorded in the States themselves. These patents include design patents which have been issued, or which may hereafter be issued, and trade marks, prints, and labels duly registered in the United States Patent Office. The rights of property in patents and trade marks secured in the islands of Cuba, Porto Rico, the Philippines, and other ceded territory to persons under the previous Spanish laws, will be respected the same as if such laws were in full force and effect.

Institution of Electrical Engineers.—The annual meeting of this Institution was held on Thursday week, when the award was announced of the premiums for papers read during the past session as follows: the Institution premium

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to Mr. P. V. McMahon; the Paris Electrical Exhibition premium to Messrs. Duddell and Marchant; the Fahie premiums to Prof. Oliver Lodge and Mr. G. Marconi; and extra premiums to Mrs. Hertha Ayrton and Mr. J. Elton Young. Students' premiums for papers read before the students' section were awarded to W. G. Royal-Dawson and M. R. Gardner, E. P. Howgrave-Graham, Leonard Wilson, I. R. Morshead, and Mr. H. M. Dowsett. The Salomons scholarship was awarded to Mr. H. J. Thomson, a student of the Central Institution. The premiums and scholarship cheque will be presented at the first meeting of the next session in November.

Personal.—Mr. H. Scholey, who for the last 10 years has acted as assistant-editor to our contemporary, the *Electrical Review*, informs us that he has now severed his connection with that journal in order to take up commercial work. Mr. Scholey will in future have offices at 14, Victoria-street, Westminster, and act as the representative in London and the South of England of the well-known firm of Messrs. Mather and Platt, of Manchester. In wishing Mr. Scholey every success in his new sphere, we cannot but pay a tribute to the pleasure it has been to meet him as the representative of the *Electrical Review* at the scientific meetings in different parts of the country. The intimate knowledge which he has gained of the electrical profession generally should serve him in good stead, and make him a valuable representative of the firm with which he has just become associated.

Aluminium Feeders.—According to the *Railway and Engineering Review* of Chicago, the North-Western Elevated Railway of Chicago has entered into a contract for 150,000lb. of aluminium feeders. Three sizes of bare cables will be used—785,000, 1,000,000, and 1,300,000 circular mils in area respectively. The largest feeder will be about 1½in. in diameter. Of the two larger sizes there is to be two cables of more than 10 miles in length each. The feeders will be placed in a wooden box or trough covered by a board walk between the tracks, and they will be supported on vitrified clay blocks of umbrella shape, placed 9ft. apart. The contract was made on the basis that 47lb. of aluminium are equal in conductive capacity to 100lb. of copper. Experiments carried out by the electrical engineering department of the road have demonstrated that 157 circular mils of aluminium are equivalent in carrying capacity to 100 circular mils of copper.

Connection between the Ionisation Coefficients and the Depression of the Freezing Point of Solutions containing Potassium and Sodium Sulphates. We have received a copy of an interesting paper on the above subject, by Mr. E. H. Archibald, from the *Transactions* of the Nova Scotian Institute of Science. The object of the experiments was to find the ionisation coefficients of solutions of potassium and sodium sulphates from the conductivities of these solutions. The ionisation coefficient of a solution containing a mixture of these salts was then calculated from a formula due to Prof. MacGregor. The depression of the freezing point in such mixed solutions was then determined experimentally, and the results obtained were compared with those anticipated from Prof. MacGregor's formula. A satisfactory agreement was found, though it is admitted that the test was not a very severe one. It is hard to understand why, at the present time, when accurate standard ohm coils can so easily be obtained, the author should give his results in terms of the conductivity of mercury. Some laxity may also be remarked in the use of a non-calibrated thermometer for delicate thermometric measurements.

Electrolysis.—An engineer representing the State Railway Commissioners has recently presented a report to the authorities of New York City with respect to the damage being done to Brooklyn Bridge through earth currents set up by the Manhattan Railway Company's system. The tests on which the report was founded were made during the period from Jan. 24 up to April 20 this year. During the whole time the ground was frozen. Full figures are given in the report of the voltages to earth of the various parts of the structure. These show that the maximum difference of potential between the elevated structure and the waterpipe near it at the Manhattan end of Brooklyn Bridge was 2½ volts. At one other point the voltage at times rose to 3 and averaged 1½ volts. The expert recommends that the railway company should be instructed to immediately put its structure in proper order, so that the voltage of those parts should never be more than one volt greater than that of the earth. We take it that the company will do this by means of additional return feeders and negative boosters.

The Electric Tramways of Europe.—We gather from the columns of the *Elektrotechnische Zeitschrift* the following particulars, showing the growth of electric tramways and railways in Europe for the past three years. Our contemporary has collected a great deal of useful information, both as to the lengths of line equipped, the generating machinery used, and the system by which the current is conveyed to the car. As an example of the increase of length, at the beginning of 1897 there were about 900 miles of electric tramways in the whole of Europe. This figure was increased to 1,400 for last year, and to 1,700 miles at the beginning of 1899. For the working of these lines there is now required generating plant having a total capacity of about 86,000 kw. Some 5,700 motorcars are in use on the various tracks. In the subdivision of the new lines into various systems, the overhead trolley continues to hold its own. For example, there are some 206 equipped with this system, while there are only eight conduit lines and 10 railways or tramways using the third-rail system. Accumulators have been employed for providing power for the cars on some 14 systems, and on eight others a combination of accumulators with overhead trolley is adopted.

Electric Railways in France.—We notice in a recent number of *L'Energie Electrique* a good description of a complete tramway system which has been put down in Haute-Silésie. The lines in question were worked by steam up to 1898, but the great proportion of them have now been converted to electric traction. They connect the following places, forming a complete system of interurban tramways, with a total length of about 62 miles: Gleiwitz, Zabrze, Kœnigshütte, Laurahütte, Kattowitz, Autonienhütte, and Bobrek. The rolling-stock consists of some 84 motorcars, of which 50 are in regular work, and some 200 trailers will also be provided. As a rule, one motorcar and one trailer will be employed, but the motors are provided with sufficient power to draw two trailers as required on Sundays and fête days. The organisation of the line is more like that of a railway, as three different classes of passengers are provided for. The average running speed of the cars will be 15 miles per hour, but this may be increased, when occasion requires it, to 25. The rolling-stock is of the Walker type, and consists of long cars carried on two bogies, every axle being driven. This necessitates the use of four motors for every motorcar. Two central stations are used to generate current—one being situated at Zabrze, and the other at Chorzow.

Cutting Steel Girders.—Some interesting work was recently done in Chicago by the Moulton Starratt Contracting Company, who were engaged on the reconstruction of the New York Life Building in that city. It was found necessary to cut through six steel I-beams, each 15in. high,

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with a ½in. web and 6in. flange, varying in thickness from ½in. at the outside to 1in. at the centre. The point at which the cut was to be made was located in such a position that it would be necessary to have special saws made, and as three I-beams of this size side by side could not be cut very easily. It was estimated that in addition to the time required to make the special saws it would take two men at least two weeks to saw them off. It was accordingly suggested that these girders might be cut by electricity, as a smooth end was not necessary. The work was placed in the hands of Mr. Clyde J. Coleman, who has had considerable experience in such matters. The six beams were actually cut through in 12 hours, and some four or five hours were spent on the mechanical work connected with getting at the girders and removing those which had been burned through. A current at 110 volts was used, and at times as much as 350 amperes passed through the arc. The positive side of the circuit was connected to the steel girders, and the negative pole consisted of a carbon 1½in. in diameter.

Article Club Exhibition.—On Tuesday last His Royal Highness the Duke of Connaught opened the exhibition of the Article Club at the Crystal Palace. A large number of invitations were issued for the opening ceremony, and liberally responded to by the various sections of the Press. Apart from the opening ceremony itself, the exhibition is at present hardly ripe for description. By the constitution of the Article Club, only one firm in a particular industry is admitted to membership, the aim of the club being to secure the best firms as members. We notice that the electrical industry is represented as follows: Messrs. Siemens Bros. are at the head as the electrical firm, while Messrs. W. T. Glover and Co., Limited, exhibit electric lighting cables. The Chloride Electrical Storage Syndicate, Limited, are exhibiting samples of their well-known make of accumulators and stands. An indirect representation is obtained by Messrs. Greenwood and Batley, who are showing some of their make of the Laval steam-turbine driving dynamos. Another firm, however, intimately connected with electric lighting, is that of Messrs. Willans and Robinson, of Rugby, who exhibit some of their high-speed engines driving Siemens dynamos. As soon as these firms have their exhibits put in order, we hope to give a fuller description of their essential features.

Institution of Mining Engineers.—At the meeting last week of the Institution of Mining Engineers, held at the Geological Society's Rooms, Piccadilly (Mr. J. A. Longden, the president, in the chair), a number of interesting papers were read, most of which were confined to subjects alone of interest to mining engineers. On the last day of the meeting an interesting paper was read by Mr. H. B. Baillie-M'Cower on a new process of seasoning and preserving timber and other fibrous substances by means of electricity. From the description we have seen of the paper, we think that the author refers to the process being developed by Messrs. Johnson and Phillips at Charlton. He claimed that the process in question removed all the sap out of the wood, and prevented the same warping afterwards. It also enabled cheap classes of timber to be rendered exceedingly serviceable for commercial work. At the same meeting a report on mechanical ventilators was made by the joint committee of the North of England Institute of Mining and Mechanical Engineers and the Midland Institute of Mining, Civil, and Mechanical Engineers. The committee had tested the Guibal, Waddle, and Schiele fans used in collieries, and considered the Guibal fan superior to the others. At the same time, their experiments indicated that the choice of an engine very materially affected the useful effect of a ventilator. The Secretary announced that the autumn meeting would be held in Sheffield on Sept. 19, 20, and 21 next, and that in 1900 they would meet in London in May and the week afterwards in Paris.

Magnetic Moments of Permanent Magnets.—In the *American Journal of Science* for November, 1896, Prof. B. O. Peirce gave an account of experimental determination of the magnetic moments of a number of magnets of hard tool steel which had been aged by boiling for some time in water at 100deg. C. A number of samples of commercial steel were used, and full tables of results were given. In the *American Journal of Science*, vol. v., 1898, Mr. A. Durward gives an account of experiments carried out with magnets made from ordinary and self-hardening steel, particularly in connection with their temperature coefficients. He concludes that when a seasoned magnet is exposed to constantly higher and higher temperatures it attains at each stage, in a fraction of a minute, a state which it would keep sensibly unchanged if exposed for hours to that temperature. The magnetic moment is invariably diminished as the temperature increases, but the original value is regained on cooling. In the *American Journal of Science*, vol. v., May, 1898, Prof. B. O. Peirce describes some experiments made with permanent magnets made from self-hardening steel. He found that these magnets have slightly lower temperature coefficients than those made from tool steel, but that the original moment is not always regained directly after heating has been discontinued. Long magnets appear to be preferable to short ones.

Home Truths.—It is interesting to read in the *Scientific American* the opinion which that journal holds with reference to the scientific news appearing in the daily Press of the United States. We ourselves have had to find fault with these scare reports at various times. Our own daily Press is sometimes a sinner in this respect, but not to the extent to which matters are carried the other side of the Atlantic. Our contemporary says that the average American daily Press reporter, excepting a few gentlemen engaged on high class daily journals, approach a scientific question "caring very little whether his dishing up of science belongs to the 'is so' or 'not so' class, provided it is sufficiently lurid and sensational and amenable to the artistic requirements of 'scare head' type and the broad blotches of ink which answer for the illustration end of yellow journalism. To him science is nothing if it is not sensational; it is, indeed, a vast and fruitful hunting ground where game of the 'three to ten' variety is the object of his diligent and only too successful quest. The idea of investigating a scientific subject for the purpose of separating the true from the false and giving the public the facts for which they pay is so subversive of the first principles of yellow journalism as to be to its average reporter absolutely unthinkable." Of course, the writer for a popular magazine always tries to bring his science down to the understanding of his readers, and in this respect the art of clearly expressing in common language the discoveries of science is not an easy matter. Our great scientist Tyndall possessed the power to do this in a remarkable way, and his book, "Heat a Mode of Motion," is a brilliant example for the popular technical writer to follow.

Electrical Association.—The *N. S. W. Railway Budget* furnishes a report of the first general meeting of the Electrical Association which has been formed at Sydney, New South Wales. From it we learn that Mr. A. C. F. Webb, M.I.E.E., in his presidential address, briefly outlined the progress of the electrical industry in the colony during the past year. It appears that 16

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electrical supply stations exist, eight of these being in Sydney. The total number of 8-c.p. incandescent lamps now connected to the eight metropolitan stations is 25,542, the total capacity of these stations being about 696 h.p. In addition to the supply stations there are about 70 isolated electric plants equal to 1,500 h.p., scattered throughout the colony. Mr. Webb drew attention to the fact that since the Sydney Municipal Electric Lighting Bill was passed three new electric supply stations have been erected throughout the city, and plant installed equal to 15,000 8-c.p. incandescent lamps. Reference was made to the increased use of electric traction, and to the determination of the Railway Commissioners to convert the whole of the steam tramways for this use. During last year five miles of single line were equipped for electric traction, making a total of nine miles three chains now open for traffic. The total number of electric cars have increased from 5 to 17. The electric car mileage for the month of February, 1898, was 10,634, and the car mileage for the corresponding month, 1899, 24,431. Additional generating power of 400 kw. capacity and large storage batteries have been installed both on the North Shore and Rose Bay lines. Mr. Webb proceeded to discuss in detail the best method of wiring and fitting up freezing and chilling chambers, breweries, meat-preserving works, etc., and advocated a special construction of watertight fittings.

Electric Traction on Tramways.—On Monday last, Mr. J. Clifton Robinson, M.I.E.E, read a most interesting paper before the Cleveland Institute of Engineers, on "The History, Position, and Prospects of Electric Traction on Tramways." Mr. Robinson's experience in electric traction, and his still wider experience on tramways as a whole, entitle him to speak with great authority on this matter. The paper, which we have before us, after giving a brief *résumé* of the history of electric traction, furnishes full descriptions of the tramways with which the author has been connected. Amongst these are the Bristol Tramways, the Dublin Tramways, the Middlesbrough, Stockton, and Thornaby Tramways, and the London United Tramways. This last line, as our readers are aware, is now under course of conversion, and on it the whole of the electrical conductors will be kept insulated overhead, so that two trolleys will be required for each car. This is in order that the magnetic instruments at Kew may not be affected by earth currents from the tramway. The author then proceeds to review the various systems of electric traction. He points out that while there is no doubt that the accumulator system is the ideal method of electric traction, the great dead weight to be carried by the cars and the cost of upkeep of the accumulators renders it almost prohibitive. The Hanover system is referred to, and also the experimental lines which have been made in Paris. Of underground systems the conduit obtains most praise from the author, who objects to the complication of the surface contact systems. In his conclusion, Mr. Clifton Robinson has some strong remarks to make about a certain report presented to the Newcastle-on-Tyne Town Council, and ridicules the fact that the Corporation should send a deputation to America to see what is being done there when there are now so many electric lines successfully working in England. As regards the accidents caused by electric tramways, Mr. Clifton Robinson points out that in spite of the scare head lines, "Accident on an Electric Railway," he knows of no case in the United Kingdom where an accident was caused by the fact that the cars are driven electrically. We hope in a future issue to make still further use of some of the valuable information given in the paper.

A Lay of the Mains.—

The boilers take their toll of care; in steam-pipes there are joints;
The engines need an overhaul at times;
The dynamos, the darlings, have their awkward little points;
And the switchboard is not innocent of crimes.
But the chaps that take the biscuit, O! the boys that take the bun,
Are the cables that lie buried in the street;
For you never know the moment when they'll have their bit of fun;
You never know what's brewing 'neath your feet.

The boilers are in duplicate, the steam-pipes are a ring;
The engines, you may read their souls aright;
The dynamos—God bless them!—can't complete their little fling,
Like the switchboard, you have got them all in sight.
But the feeders near the station and the mains that spread for miles
They are free to have their little bit of sport.
Who thinks he knows his mains by heart, he recks not *all* their wiles,
And Heaven only knows what caused the short.

Sometimes a boiler bursts a tube; a steam-pipe joint will blow;
An errant nut will give a piston pause;
An armature conductor will a drunken winder show;
And a wrench behind the switchboard be the cause
Of hairpins on the circuit till the spares have turned the tide.
But let the spider's web begin its game—
An acre is the station, to a few square leagues outside;
And the difference in effect is just the same.

A cable may be perfect, and a careful laid one, too;
Its jointer may be all he claims, and more;
But the man who runs the cable, be it old or be it new,
Will learn to dread the hurried knock at door.
So, till the joyful time arrives when navvies work with care,
And angels heal the spot that wants to arc,
O! let the harassed mains-man have your morn and evening prayer,
That consumers mayn't be swearing in the dark.

J. H. C. B.

Measurement of Power Factors.—The measurement of the quantities required to determine the power factor of an alternator, transformer, or other electrical apparatus used on an alternating-current system, are not conducive to an accurate determination of the power factor. A slight error in the ammeter or voltmeter, even if the wattmeter is reading correctly, will often cause a variation in the power factor of 20 per cent. Our contemporary the *Electrical World*, in calling attention to this fact, points out the great need there is for an indicator of the wattless component which can be used commercially. The inherent inaccuracy of determining the lagging output by the comparison of volt-amperes with watts, even where the two quantities are measured by instruments of the same type and comparatively calibrated, may be shown by the following numerical examples: If the volt-amperes exceed the watts by only 1 per cent., it means that there is upon the line a wattless or magnetising current with a strength fully 14 per cent. of that of the energy current. If the excess is 2 per cent., the magnetising current is some 20 per cent. as great as the energy current. Thus it is pointed out that very great variations of the wattless output, having a disastrous effect upon the regulation, affect but slightly the indicated volt-amperes. In the same issue, an apparatus for measuring phase differences devised by Lord Rayleigh is described by Mr. Edwin Place. The instrument consists of an ordinary

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galvanometer with a soft-iron needle instead of one of magnetised steel. The needle is suspended by means of a glass fibre between two coils in such a way that at rest it takes up a position of 45deg. with the common axis of the coil. When an alternating current is sent through either coil of such an instrument the needle is turned towards parallelism with the axis, an amount depending on the strength of current and the distance apart of the coil and needle. If the deflection is small, and a mirror and scale be used to magnify and measure it, the scale deflections may be used to determine the current strength. When the instrument is used to measure phase angle between two currents, the deflection is observed when the current in each coil acts separately, each giving a separate scale reading, and also that deflection when both are acting at the same time. From these three deflections, the author states, can be deduced the phase angle. The author proceeds to describe the experiments made with the instrument, and to the difficulties arising in obtaining accurate reading by it when the waves were not pure sine waves. From the remarks we gather that it is not suitable for commercial working.

Terrestrial Magnetism.—We have received the May number of the *Wisconsin Engineer*, which, it will be remembered, is published semi-annually by the University of the Wisconsin Engineering Journal Association. The present number is a most excellent one, and contains a large number of articles which are of interest to electrical engineers. The one on terrestrial magnetism by Prof. John E. Davies is a most excellent *résumé* of the subject. In tracing the history of the use of the mariner's compass, the author goes back to the early days, and recalls the fact that it was only after the voyage of Columbus in 1492 that it was fully established that the compass needle did not point to the north star, nor even to the true pole of the heavens, as some had supposed. Tracing the deviation in the compass, the author goes on to state that the first careful measurements of this quantity were made by Burroughs, the controller of Queen Elizabeth's navy in 1580. At that time the needle pointed 11° 15′ east of the true north at London. The author proceeds to deal with the early measurements made to ascertain the dip of the needle, and the observations from which it has been adduced that the magnetic north and south poles do not lie on a diameter of the earth. Referring to the careful records on electrical magnetism which are now being regularly made, the author concludes that there can hardly be a doubt that the diurnal variations of the needle are caused by influences outside the body of the earth. When he proceeds to discuss the intricate question of the deviation of compasses on board ship, he gives information which is of the utmost value to both the practical man and the student. The casual reader will be impressed with the vast number of causes which may alter the indication of a ship's compass on an iron vessel. As an example of this the author instances the effect of lightning, the firing of heavy guns, and the shock of very heavy waves. In one case on record this last cause has been known to change the deviation of a compass by as much as four compass points. Again, the induction of the earth's field on the iron carcase of a ship accumulates slowly when the vessel is kept for a long time on one particular course. The magnetism so induced is lost equally slowly, and Prof. Davies mentions one case in which the induced magnetism was apparent even when the ship's course had been reversed, and she had gone 800 miles in an opposite direction. The author emphasises the precaution which should be taken that no magnetic material liable to removal should ever be placed nearer the compass than 15ft. or 20ft. The conclusion of the whole matter is that eternal vigilance is the only price of safety, as an error of less than half a compass point in a day's run will bring a steamer to the right or left of her true course by more than 28 miles. After reading the article in question in the light of the recent disasters at the Manacles, the not unreasonable conclusion is that the magnetic condition of vessels themselves, or of their cargo, may have led to the wrong course steered.

Calculations on Electrolysis.—We have received from Prof. J. G. MacGregor two interesting articles he has written. The first is "On the Calculability of the Results of Electrolysis in Solutions containing Two Electrolytes with one ior in common." The author treats this interesting subject from both the theoretical and the practical side, and compares the results of calculation with those obtained in actual practice. His calculations on the whole matter are ably expressed in the following summary, which is given at the end of the paper: "In the case of solutions containing sodium and hydrogen chlorides, the only case in which the test can be quite satisfactorily made, it has been shown to be possible, by the aid of the dissociation theory, to make, at least approximately, and probably within the limits of observational error, a complete calculation of the transference ratio—*i.e.*, the ratio of the numbers of equivalent gramme-cations of the two electrolytes transferred across a section of the cell by the current, and as complete a calculation as the data will admit, of the total amount of the two cations appearing primarily at the cathode, and it has been shown to be possible to make these calculations on either of two assumptions as to the velocities of the cations—viz. (*a*) that they are the same in the case of each electrolyte as they would be in a simple solution with a concentration equal to the concentration of the complex solution with respect to such electrolyte, and (*b*) that they are the same as they would be in a simple solution with a concentration of ions equal to the concentration of the complex solution with respect to the ions of such electrolyte, the latter assumption giving slightly better results than the former. In addition, the differences between observed and calculated values are such as to rouse a suspicion of a mutual interaction between the cations of the respective electrolytes by which the cation with the greater velocity is somewhat retarded, and the cation with the smaller velocity is somewhat accelerated. Hopfgartner's observations on solutions containing barium and hydrogen chlorides have been shown to be consistent with, though not demonstrative of, the calculability of the transference ratio and the total number of equivalent gramme-ions appearing at the cathode. Schrader's observations on solutions containing potassium iodide and chloride have been shown to be consistent with, though not demonstrative of, the caculability, of the transference ratio, the total number of gramme-ions separating out, and the conductivity. Schrader's observations on solutions containing sulphuric acid and copper sulphate have been shown to be inconsistent with the calculability of the transference ratio, the total quantity of the ions separating out, and the conductivity, on the assumption that the solutions contain only electrolytes with a common ion; but the differences between the observed values and those calculated on that assumption have been shown to be capable of being accounted for, both as to sign and as to relative magnitude, on the assumption of the existence of the acid sulphate of copper in the solutions." The author has a reprint of an article which appeared in the March number of the *Physical Review*: "On the Applicability of the Dissociation Theory to the Electrolysis of Aqueous Solutions containing Two Electrolytes with a common ion." We have already referred to this paper in a previous issue.

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BARKING ELECTRICITY WORKS.

The history of the introduction of electric lighting at Barking is instructive, coming about through the failure of the Barking Gas Company to come to reasonable terms with the Council for the lighting of the district, which for some years has been done by means of oil lamps. In October, 1896, the Council decided to obtain a report on the possibility of lighting the district by electricity, and called in Mr. W. C. C. Hawtayne, who presented a report on Nov. 9 of the same year, the result being that the Council applied for a provisional order. The report advised the putting down of a plant to deal with about 4,000 8-c.p. lamps for a commencement, including public lighting. The provisional order was granted, and in the usual course of events tenders were invited, and when it was found that the work could be done at about £1,000 less than the estimates, the Council decided to apply to the Local Government Board for sanction to borrow the necessary money. Some extensions of mains were also decided upon at the same time, so that the total amount applied for to the Local Government Board was £15,000.

Mr. Denniss further stated that the Council had prepared a careful estimate showing the relative costs of lighting by oil, gas, and electricity. The Council had approached the Barking Gas Company in the January preceding the enquiry, to know if they would again make them an offer for lighting the whole of the district by gas, and if so at what price, but the gas company replied that owing to their having to lay some further mains in order to take in the whole of the district, their lowest offer would be £4. 2s. per lamp per annum. From the estimates which the Council had made, it appeared that the cost of oil lighting came out at £3. 0s. 1d. per lamp per annum; gas, £4. 2s. per lamp per annum; electricity, £2. 13s. 10d. per lamp per annum. The expert evidence brought forward by the gas company was not able to find any fault with these figures, but at a later period of the enquiry the Barking Gas Company, no doubt thinking that the ground was slipping from under their feet, came out with the startling offer that they would be prepared to carry out the public lighting at £2. 15s. per lamp per annum, a reduction of £1. 7s. per lamp on about 400 lamps. Mr. Bartley Denniss was quick to take advantage of this in pointing out that, supposing nothing more happened with regard to the electric lighting scheme

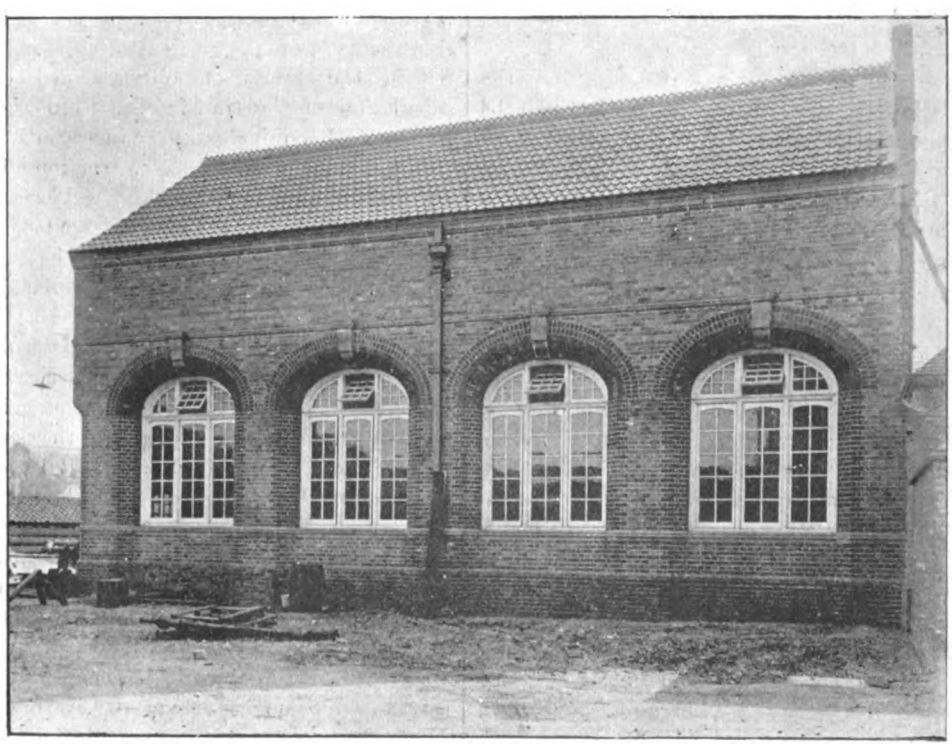

FIG. 1.—View of the Engine House at Barking.

The enquiry was held by Mr. W. O. E. Meade-King, M.I.C.E., one of the inspectors to the Local Government Board, on April 21, 1898, and owing to the strenuous opposition of the Gaslight and Coke Company and the Barking Gas Company lasted for two days. The Gaslight and Coke Company, it appears, represent half the ratable value of Barking, and some of their employés had got up a petition, which was largely signed in the town, against the introduction of electric light. Mr. E. R. Bartley-Denniss, who represented the District Council at the enquiry, was, however, able to make short work of this petition, and convinced the inspector that it did not need to be taken very seriously. Mr. Bartley-Denniss brought out the fact that the price of gas in the town was 4s. 6d. per 1,000 cubic feet, which price was maintained until March 1 preceding the enquiry, when it was reduced to 4s. At that time the Council were paying £1,270 a year for lighting the district by oil. They had already received applications from private householders for electric light to the equivalent of over 2,000 lamps of 8 c.p., and in addition to these, one well-known local builder, who attended the meeting, stated that he was prepared to put in electricity throughout a large estate of working-men's cottages that he was building in the district, and he estimated that he would require at least 1,000 lights for the purpose.

at Barking, the Council had been amply justified in the position they had taken up by this move on the part of the gas company, and that as a matter of fact one would think that an offer of the sort, forced out of the company at the last moment, was about the worst step they could have taken, and certainly tended to show to the inspector that it was quite time that some other system of lighting was introduced.

The Barking Gas Company's experts stated in cross-examination that this price, which included cleaning, lighting, and maintenance, would only allow them a bare 1s. 3d. to 1s. 6d. per 1,000 cubic feet for their gas, whereas the Gaslight and Coke Company, who are also in the same district, were just about to raise their price from 3s. to 3s. 3d. per 1,000ft. for London; the Barking Gas Company themselves had stated that they could not possibly reduce the price to the ordinary consumer below 4s. per 1,000 cubic feet.

Mr. E. H. Lister, the clerk to the Urban District Council, came in for severe cross-examination, but his evidence only strengthened the case for the Council.

Mr. W. K. Marriott, the late chairman of the Council, who was largely instrumental in getting the undertaking started, also gave valuable evidence. The engineer naturally came in for a severe cross-examination, expert evidence being brought on the other side, which—unfortunately for

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the other side—broke down rather badly, the expert, as a matter of fact, saying that from the figures he had heard he believed that the scheme would be a profitable one.

The demand for electric light has grown at such a rate that already the Council have made considerable extensions in the mains, and have now concluded a contract with the Sunderland Forge Company for a second 80-kw. set similar in every respect to the one already installed. The station buildings have been made much larger than is necessary for lighting only, as a light railway scheme is in hand for connecting Barking with the Beckton gasworks. It may be mentioned that this is the only scheme which has been granted under the Light Railways Act to a local authority. The Board of Trade have sanctioned the expenditure of some £34,000 in connection with the light railway scheme. Mr. Hawtayne has the specifications practically ready, and the scheme will be proceeded with but little delay.

The Barking Council have since also applied for powers under the Tramways Act, and have the approval of the Board of Trade to a very large system of tramways, extending from Creeksmouth on the south up to the Ilford boundary on the north, where they will join up to the proposed Ilford tramways, which have also received the Board of Trade sanction, and on the west with the East Ham Urban District Council's tramway scheme. Mr. Hawtayne has the tramways for Barking and Ilford in hand at the present time. At Creeksmouth are situated Messrs. Law's chemical manure works and several other large works, who have jointly guaranteed an annual consumption of electricity to the amount of £350 for seven years to induce the Barking Council to lay a large main down to them. This it has been decided to do, and motor-generators will shortly be put in. The Council at their last meeting decided also to apply to the Local Government Board for a further loan of £18,000 to meet the extensions proposed to be carried out. The Council have also erected public baths adjoining the electricity supply works, and arrangements are being made to employ the exhaust steam from the latter for heating purposes.

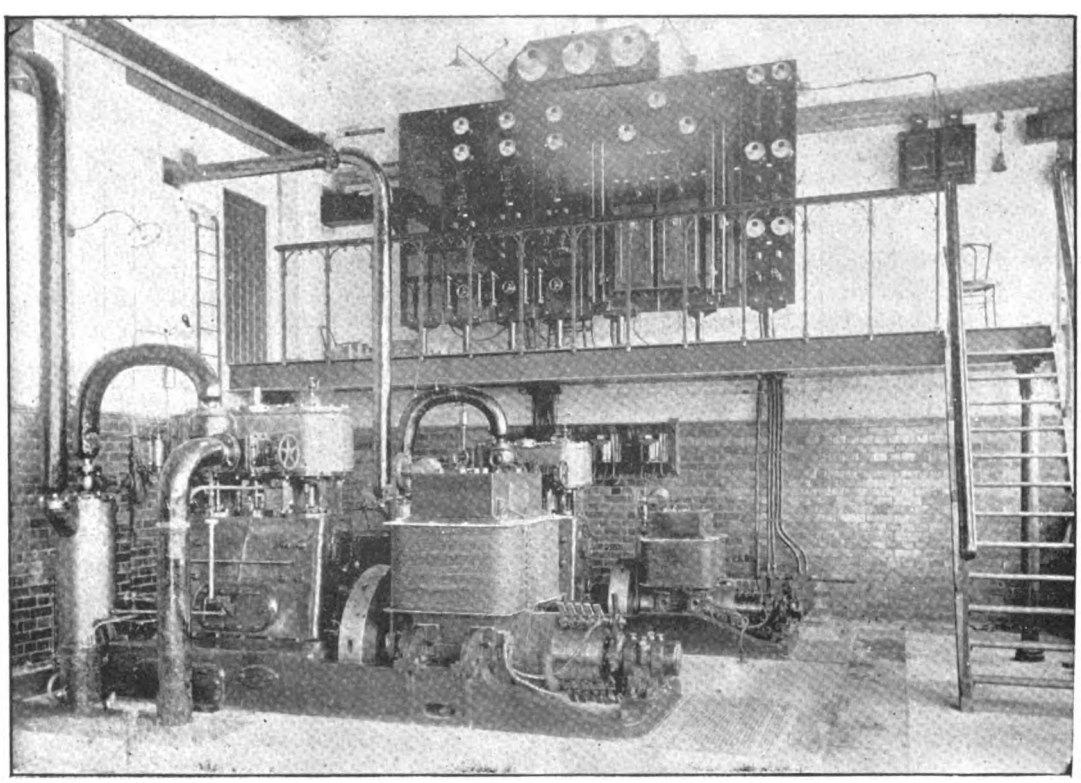

FIG. 2.—General View of the Engine-Room at Barking.

THE WORKS.

A stranger visiting the electricity works at Barking is at once impressed with the municipal spirit shown by the Council. The municipal buildings themselves are a great credit to the district, and behind them are ranged the new public baths and the free library. The electricity works also stand on an adjacent site. The buildings for these works were designed by Mr. C. J. Dawson, the Council's surveyor. A general view of the exterior of the engine-room is shown in Fig. 1, and further details of the buildings will be gathered from an inspection of the other illustrations. The buildings are conveniently arranged and well built, the contractor for the work being Mr. George Sharpe, of Stratford. The most novel feature from our point of view is the woodwork in the engine-room roof, which, although handsome, is not a usual adjunct to an electric lighting works. The buildings now erected provide ample room for the extensions which the rapidly growing demand for light in Barking will necessitate. In this respect the Council have done well to take the advice of their consulting engineer, as it is now an easy matter to put down more machinery as required. Fig. 2 shows a general view of the engine-room, from which the interior finish of the building can be seen.

The contract for the whole of the generating plant was placed with the Sunderland Forge and Engineering Company. This firm, which has only comparatively recently taken up the manufacture of electrical plant, has made a good job of their first central station, and that Mr. Hawtayne is pleased with their work is evidenced by the order for another generating set already placed with them. The two boilers are of the well-known Babcock-Wilcox type, each capable of evaporating 3,000lb. of water per hour at a pressure of 160lb. per square inch. They have each some 1,100 square feet of heating surface and 23ft. of grate area. The boiler mountings are of the Hopkinson type. The two pumps for boiler feed service are of the Worthington Pumping Engine Company's make, and are capable of delivering 600 gallons of water per hour. These are placed near the boilers, as shown in the plan (Fig. 3) and elevation (Fig. 4). There is a Green's patent fuel economiser, placed in the main flue, consisting of 72 tubes 9ft. long The scrapers of this machine are driven by a small "Pallion" two-pole open-type motor, manufactured by the Sunderland Forge and Engineering Company. The speed of the motor is reduced first by spur gear and then by belting between the motor and the scraping gear. The motor is controlled from the boiler-room by a regulator placed over the main flue, where it can be easily reached from the switch gallery. The steam and exhaust piping arrangement is well thought out, and executed in marine engineering style. The main

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steam-ring is placed in the boiler-room, from which copper bends lead to the various engines and dynamos.

speed of 450 and 500 revolutions per minute respectively, with a steam pressure of 160lb. per square inch. The general

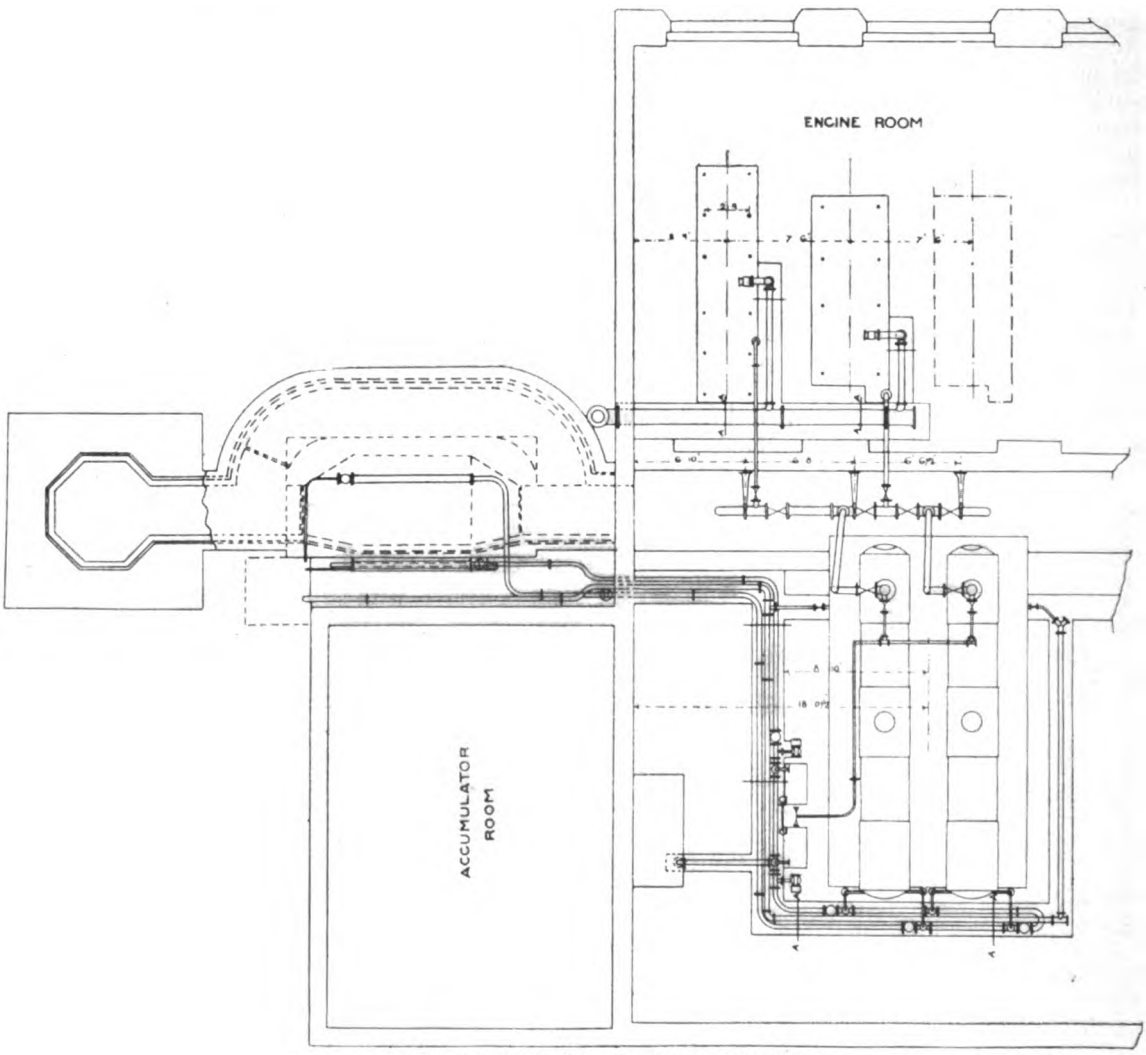

FIG. 3.—Plan of the Electricity Works at Barking.

There are two steam generating plants at present fixed, one of 80 kw. (Fig. 5) output, and the other a double-ended plant, with one engine and two dynamos (Fig. 6),

design of the engine can be seen from the illustration, and we hope to get a section of the parts to publish shortly. The valve gear is placed between the high and low pressure

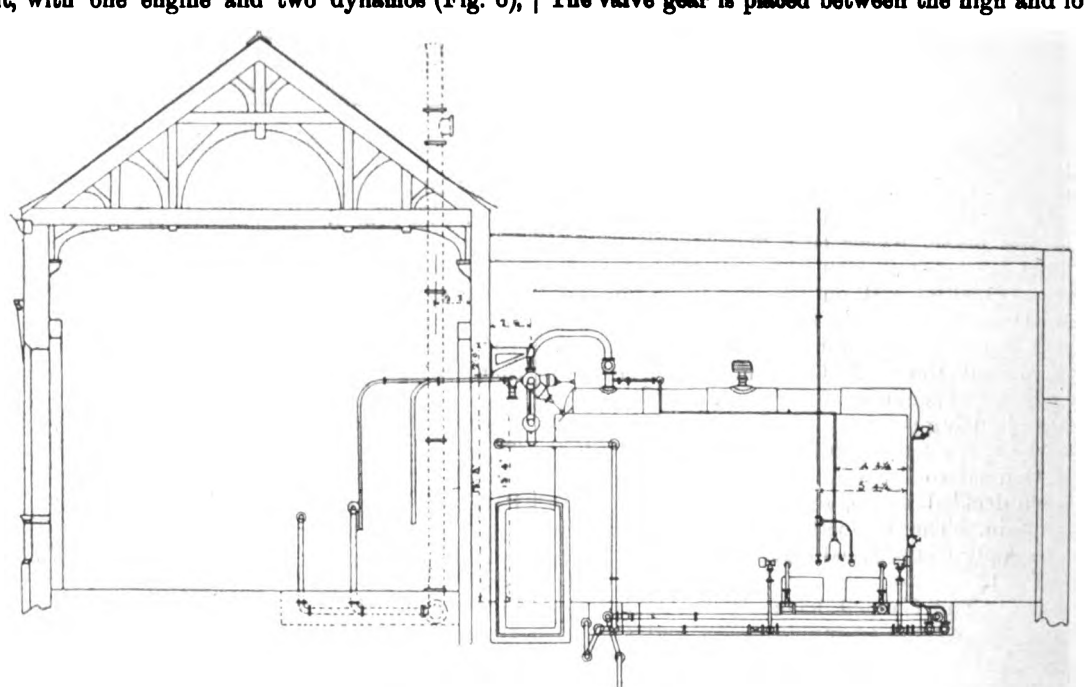

FIG. 4.—Section of the Electricity Works.

each dynamo being capable of developing 20 kw. All these were made by the contracting firm. The engines in both cases are of their improved enclosed self-lubricating compound double-acting central-valve type, running at a

cylinders. The engines govern wonderfully well, and easily comply with Mr. Hawtayne's requirements in this respect.

The dynamos are shunt wound, and mounted on the same bed-plate as the engine. The armatures are of the

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slotted drum type, and in the case of the 80-kw. plant the end connections consist of copper spirals. The commutators are built up of drawn-copper segments, and each connecting lug is dovetailed, sweated, and riveted into its segment. The field coils are wound on metal spools, which are made of aluminium, and have a liberal amount of wire upon them. The temperature of the coils after the official test was well within the specified amount. The bearings of each dynamo are large in diameter, and the length is about four times the diameter of the shaft. They are of the self-oiling type, being automatically lubricated by rings revolving slowly on the shaft, the lower portion of each ring dipping into a reservoir of oil in the usual way. In fact, these generating sets are a credit to the Sunderland Forge Company, and should be the means of bringing many orders to that firm.

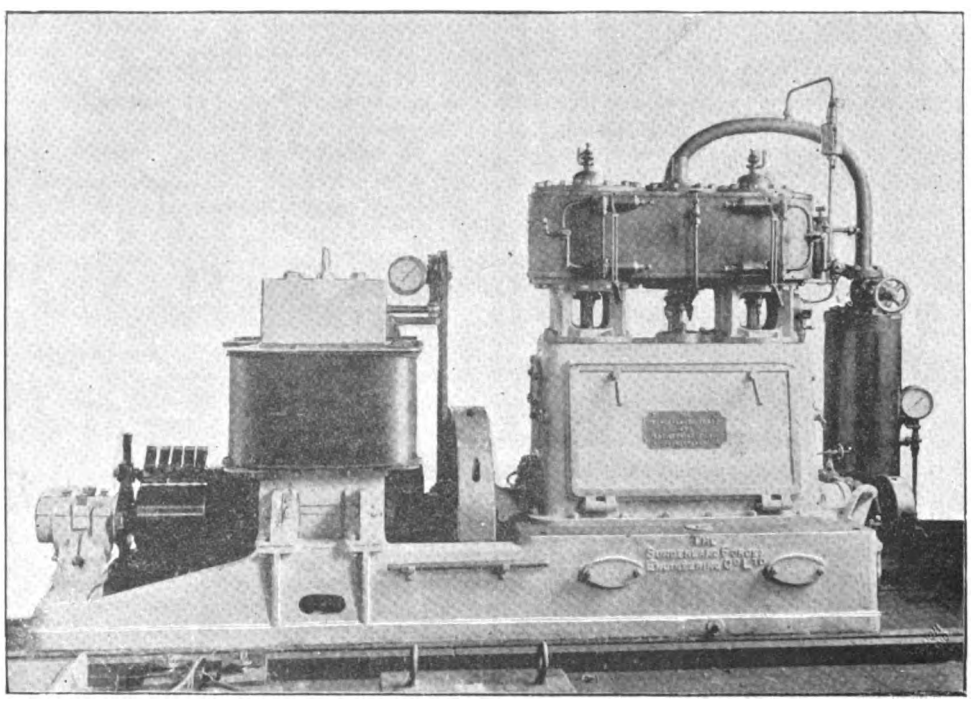

FIG. 5.—The Large Generating Set at Barking.

The accumulators used at Barking were supplied by the Chloride Electrical Storage Syndicate, Limited. The cells are of the R 13 type, containing six positive and seven negative plates. The battery is divided into two halves, one for each side of the three-wire system. The stillage and the connections to the switchboard show careful forethought. The cables are all lead-covered to prevent the acid fumes acting on the insulation. The switchboard was manufactured and supplied by Messrs. Laing, Wharton, and Down. It contains the necessary instruments and switches for three feeders, and for the generating plant at present installed. The arrangement of this board can be seen from the general view of the engine-room (Fig. 2). The feeder panels are at the right-hand side and the machine panels on the left. As the station is at present worked, the accumulators supply the demand through the day. At night both the generating sets are run, and the smaller engine, which is coupled to the two dynamos, charges the accumulators. The larger set then supplies the light, and any balancing current is taken from the accumulators. The regulation is made easy by treating the station as a consumer. Thus the station is supplied from the public mains, and not from the machines direct. In this way the pressure on the mains is regulated by voltmeters reading the voltage in the station.

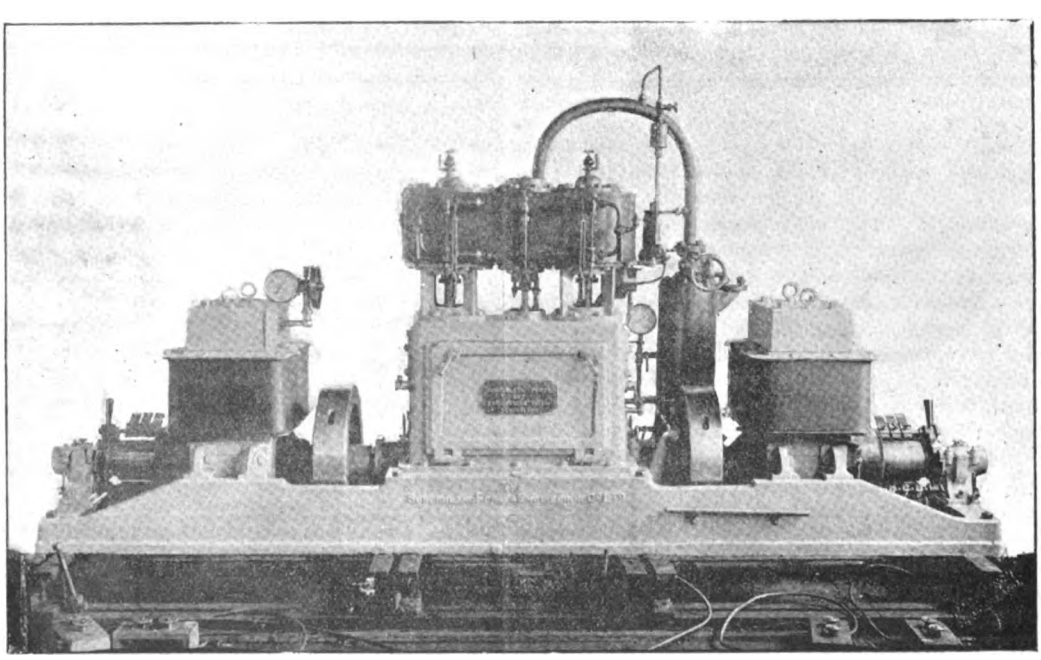

FIG. 6.—The Balancing Engine and Dynamos at Barking.

The contract for the mains was placed with the Callender Construction and Cable Company. The mains have been laid on the three-wire low-pressure system, with a pressure

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of 460 volts between the outers. A drawing-in system has been adopted, and for this purpose the well-known Callender-Webber conduit has been used. In the most important streets (Fig. 7) five-way conduits have been used, and in the by-streets three-way conduits. Into these conduits are drawn feeders and distributors. At present there are two

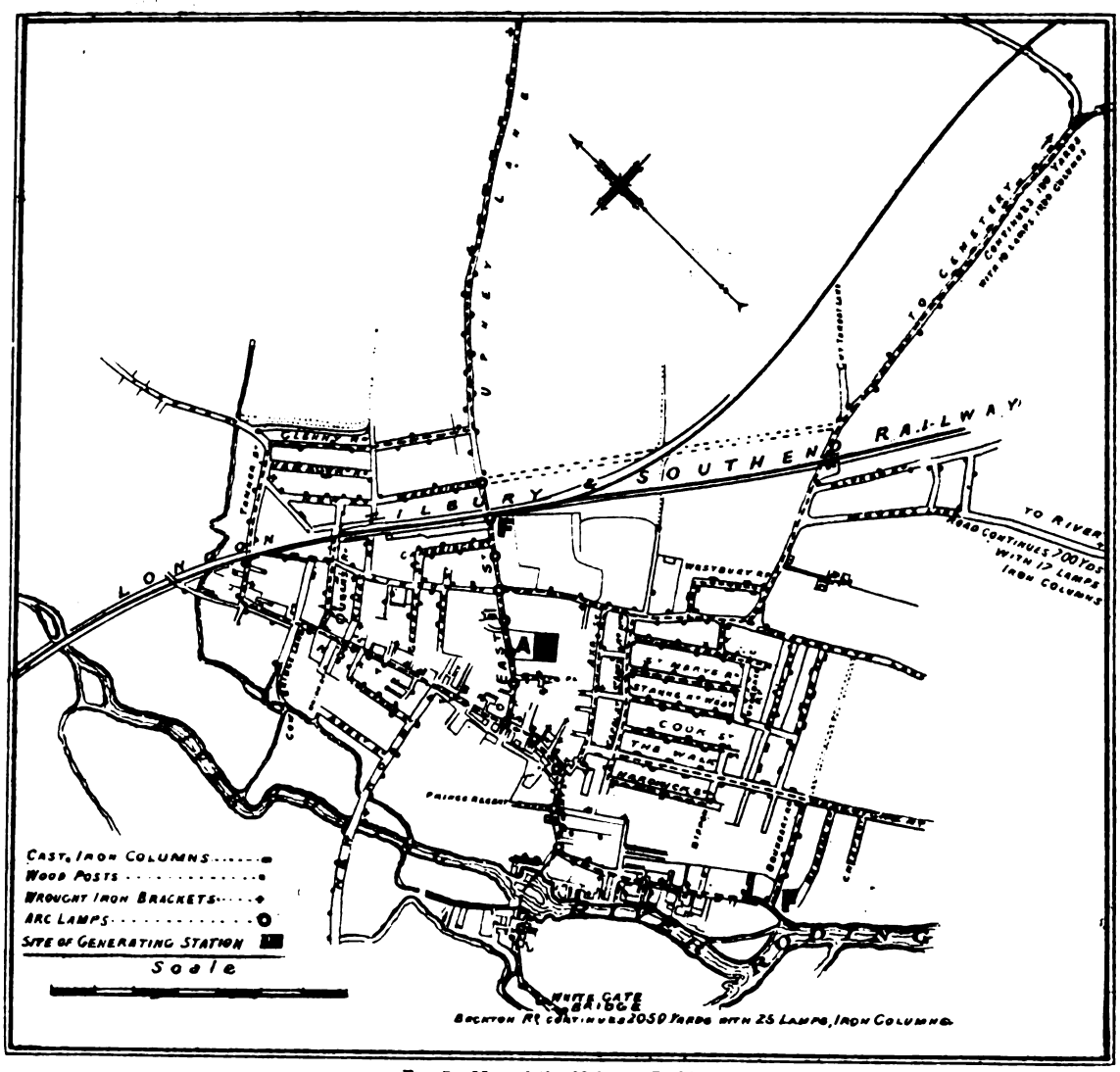

FIG 7.—Map of the Mains at Barking.

main feeders, each consisting of ·2 square inch concentric vulcanised bitumen cables. No. 1 feeder runs from the generating station (behind the public offices) to the corner of Axe-street and the Broadway, marked F, and No. 2 feeder runs from the generating station to a point in East-street, just outside the London, Tilbury, and Southend Railway Station. The total length of feeder cables is 840 yards. A third feeder is about to be laid. The distributors consist of vulcanised bitumen single cables drawn into the Callender-Webber cases. Two sizes of distributing mains are used, being respectively $\frac{1}{8}$, $\frac{1}{16}$, $\frac{1}{8}$ and $\frac{1}{16}$, $\frac{1}{32}$, $\frac{1}{16}$. From the nearest point of the network to the generating station three cables, ·25 square inch in section, are drawn in, connecting the network to the station. The total length of three-wire distributing mains laid up to the present is 9,500 yards. Two feeder boxes and seven network boxes of Callender's standard type for three-wire work have been fixed at suitable points. In addition to the mains for private lighting, provision has been made for lighting the whole area by arc and incandescent lamps. In the compulsory area this has been done by means of tappings of the distributing mains, consisting of vulcanised bitumen twin cable, lead covered and armoured. In the outside area, twin cables have been laid for this purpose of ·028 square inch and ·008 square inch sectional area, as occasion demanded. These cables are insulated with a dielectric of bitumenised fibre, lead covered, protected with an armouring of two steel tapes and yarned over all. The total number of arc lamps at present arranged for is 14, and of incandescent, 365. The whole of the excavation, conduit laying, cable laying, and lamp connection work has been carried out by the Callender Company, under the general supervision of Mr. F. E. Proctor, and executed on the spot by Mr. J. H. Preedy.

The arc lamps are of the Crompton-Pochin enclosed type, combined two in series on the supply mains. The incandescent lamp fittings were supplied by the Reason Manufacturing Company, of Brighton. They are of this firm's most recent type, in which the two lamps are placed under the apex of the double reflector, instead of one on each side, as in the earlier patterns.

MR. E. E. HOADLEY, RESIDENT ELECTRICAL ENGINEER AT BARKING.

The resident engineer now in charge of the Barking works is Mr. E. E. Hoadley, and he has taken an active part in superintending, under Mr. W. C. C. Hawtayne, the erection of the machinery. Mr. Hoadley's career is briefly as follows: After leaving school he was articled for a year

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to the chief engineer of the Chatham Electric Light Company. At that time the company were laying down their machinery and mains. After this he took a two years' course at the Finsbury Technical College, where he gained the diploma, and also was awarded the Salomons Scholarship. After this course, Mr. Hoadley returned to Chatham as junior assistant. Since then he has held an appointment at Eastbourne, and in 1896 was selected as one of the engineers in charge at Islington out of over 100 candidates. In July, 1897, he left Islington to take up the position of chief assistant engineer to the Worcester Corporation, where he gained good experience in superintending the putting down of extension plant, etc. Last October he was an applicant, together with 72 others, for the post of resident engineer to the Barking Urban District Council, and was selected as the most suitable for the post.

In conclusion, we must express our thanks to Mr. Hawtayne for kindly giving us information about this plant. Congratulations are due to him for its practical character, and no doubt these will be rendered at the opening ceremony on Thursday next.

WATFORD ELECTRICITY WORKS.

Another municipal electricity supply undertaking to be opened next week is that at Watford. Here again Mr. W. C. C. Hawtayne is the consulting engineer. The history of the electric lighting scheme at Watford is, briefly, as follows: The question of electric lighting had been before the Council on several occasions, but it was not till June of 1896 that any serious move was made, and it was then decided to advertise for a consulting engineer to advise the Council generally on the matter. As a result the Council placed the drawing up of a report in the hands of Mr. W. C. C. Hawtayne, who presented a long report in October of the same year, in which he advised the Council that the establishment of municipal electricity supply works should prove remunerative. The Council desired that the scheme presented should be one to embrace the complete public lighting of the town. Mr. Hawtayne's scheme dealt with this, and, of course, the laying of mains in a considerable portion of the town for supplying private customers as well as public lamps.

The system recommended was the high-tension alternating-current transformer system, with distribution at low pressure, and the scheme was estimated to cost approximately £19,000, if the buildings could be combined with the new sewage works that the Council were about to construct at the old sites, which are distant about 1¼ miles from the centre of the town, or about £21,000 if the two undertakings were not combined. Mr. Hawtayne's scheme was adopted by the Council, and a provisional order was applied for. This order was obtained in the following year, and specifications were then prepared on which tenders were invited, the total amount of the tenders accepted coming to something under the amount estimated.

As soon as the Council had satisfied themselves from the tenders received that the work could be carried out for the amount estimated, tenders were accepted, and a loan of £21,000 was applied for. As a result, Colonel W. L. Coke, C.E., Local Government Board inspector, held an enquiry at the Council Offices on May 27, 1898, at which the engineer gave the details of the scheme, and as there was no opposition the loan was in due course sanctioned, and the work put in hand. But pending the completion of the undertaking, the Council erected a temporary dynamo, run by an old sewage works engine, to supply current to a large estate which was in urgent need of the electric light. This temporary installation has done duty up to the present time, but the supply is now given from the permanent plant.

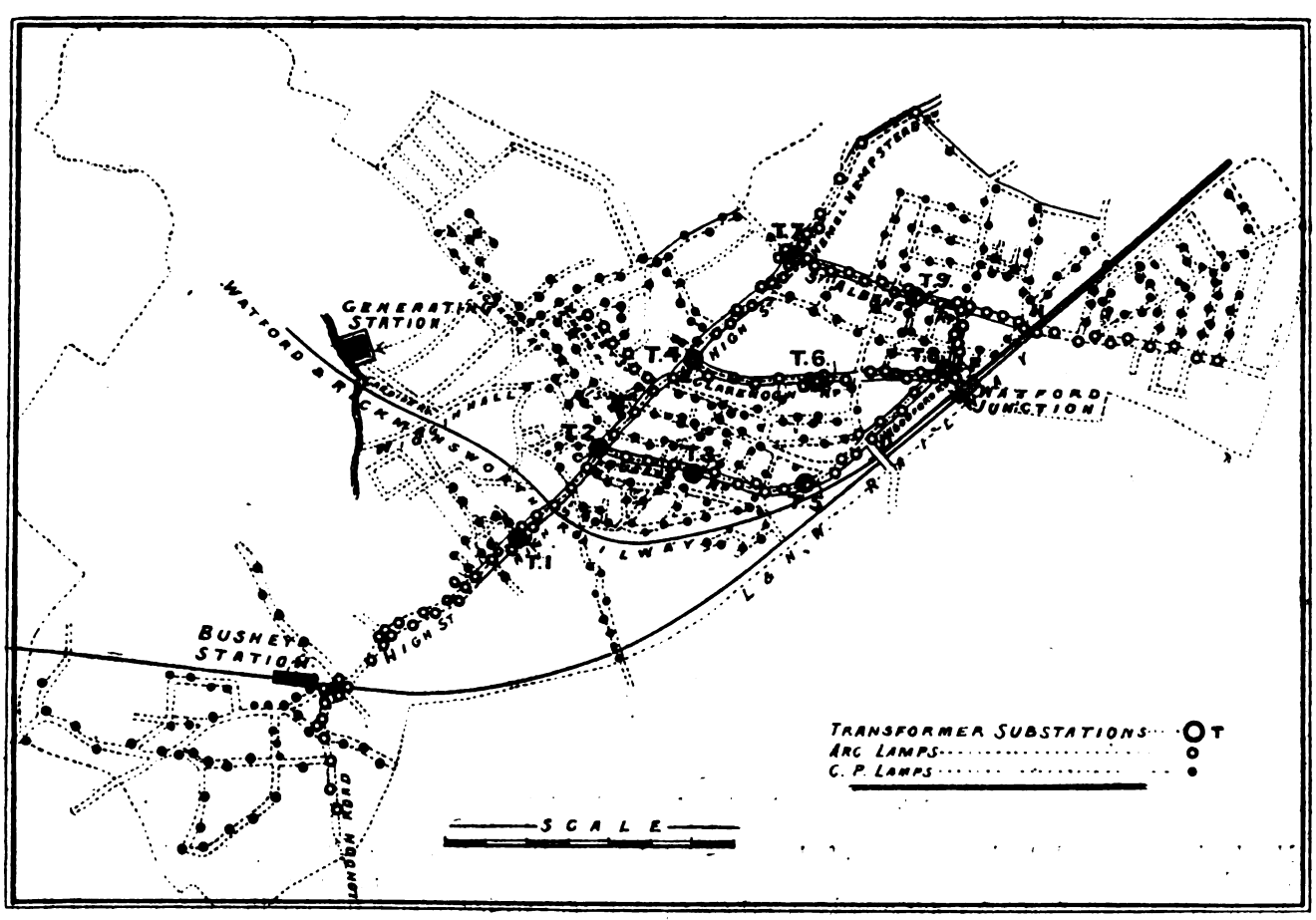

FIG. 1.—The Map of the Mains and Lamps at Watford.

The electricity supply station buildings have been put down adjoining the sewage works, and connected by a flue to the common chimney shaft. Some slight modifications were made in the scheme originally prepared, larger plant having been installed than was at first intended. The plan (Fig. 1) shows the arrangement of the public and private lighting at the time at which tenders were invited, but as an indication of the rapid growth of Watford it may be mentioned that, whereas the number of public lamps set out on the plan is 414, the actual number now being connected to the mains is exactly 800. The contract for the cables for both public and private lighting was placed with Messrs. Henley's, who have carried out the work in

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a very thorough manner. It was originally intended that a number of arc lamps should be placed in High-street and Queen's-road, but the Council afterwards decided that they would go in for incandescent lighting throughout, except in the Market-place, where three arc lamps are installed, and in the Railway Station Approach, where there is one. Separate mains are laid throughout for the public lighting, which is controlled from six switching-on points. The high-tension mains are connected to transformers at a ratio of 2,000 volts to 400 volts, from which the low-tension mains run to the groups of street lamps; each lamp-post being fitted with two 200-volt 8-c.p. or two 16-c.p. lamps in series across the 400 volts in all the streets, with the exception of a few in the centre of the town, where two 20-c.p. lamps are placed in each lamp-post. Existing posts are being adapted in the majority of cases, but in the centre of the town new lamp-posts are being erected.

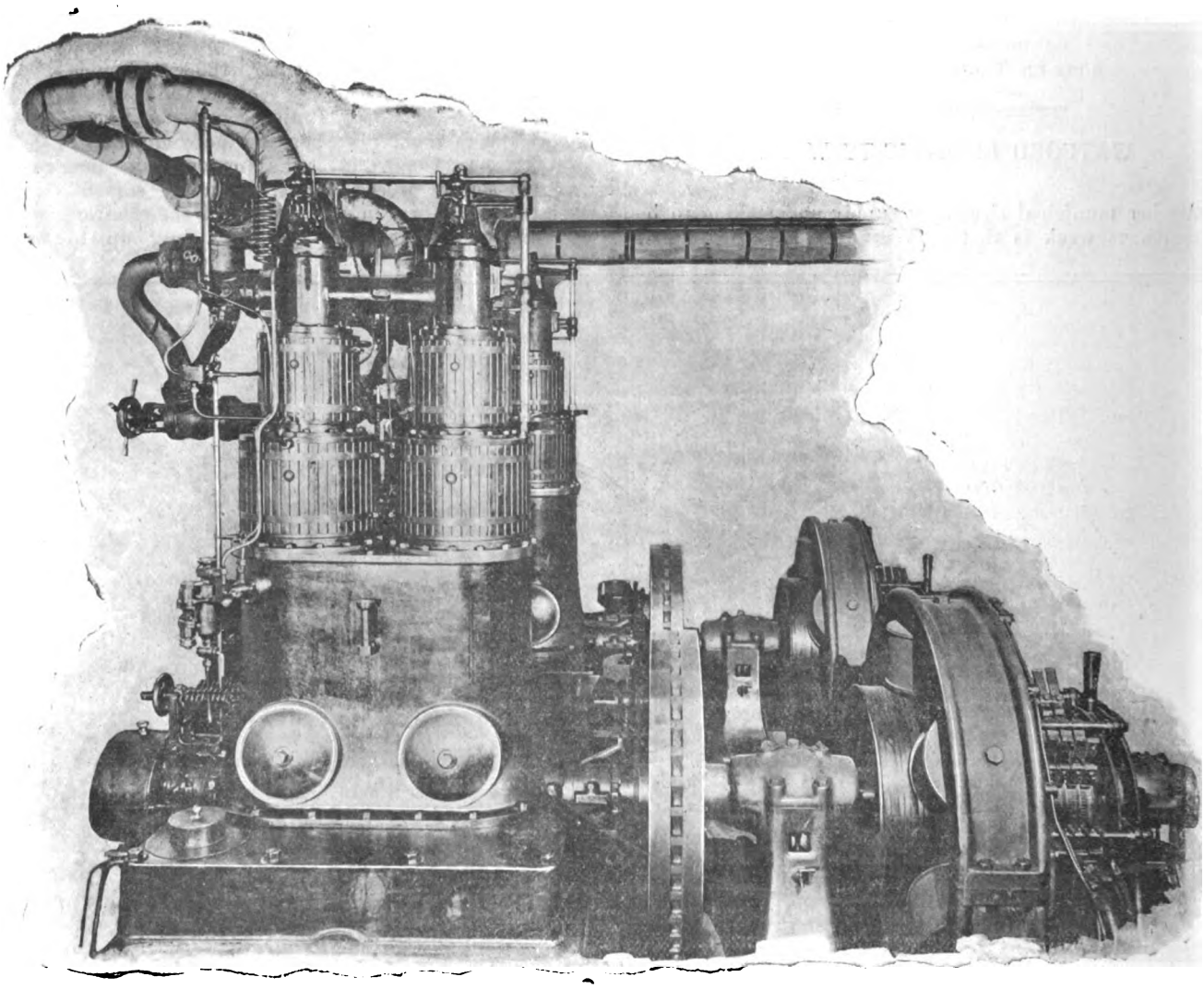

FIG. 1.—The Generating Plant of the London Electric Cab Company

Mr. A. E. Pridmore, J.P., the chairman of the Council, has also been chairman of the Electric Lighting Committee from the very commencement of the undertaking. He was largely instrumental in starting the undertaking, and has, during the erection of the works, been unsparing in his efforts to popularise the light.

The contract for the plant was placed with the Brush Electrical Engineering Company, who have supplied two Babcock-Wilcox boilers (each capable of evaporating 600lb. of steam per hour) and the necessary feed pumps, tanks, etc. The generating plant consists of two 100-kw. sets, and one of 30 kw. for day load. The engines used are of the Universal type manufactured by the Brush Company, and the alternators are of the Mordey inductor type. The speed of the large sets is 300 revolutions per minute, while that of the smaller sets is 370. The transformer boxes, which are placed under the streets, are also of the Brush type. Each box contains a double-pole switch and fuse on both high and low tension sides. The switches are united and arranged to be operated from the street-level by a single key after removing a small plug in the centre of the outer cover. Of the transformers at present supplied, there are nine of 30 kw. and two of 12 kw., which are used for the private lighting, and transform from 2,000 to 200 volts. In addition to this, there are three transformers with the transforming ratio of 2,000 to 400 volts, used for street-lighting. The main switchboard is of the Cowan-Still new type, manufactured by Messrs. Cowans, Limited, of Salford. It is arranged to control three generators and two feeders. The special feature of this type of board consists in its compactness, combined with easy accessibility to every part. There is no passage behind the board, but by the removal of a couple of set screws each panel can be swung back on its lower edge, and its self-contained connections are then accessible. When a panel is swung back all its fittings are necessarily "dead," and are therefore safe to handle. The 'bus bars are mounted on porcelain insulators at the back of the board, while the exciting rheostats are manipulated by hand-wheels mounted on a desk running the full length of the board. On this desk the exciting ammeters are also fixed. Front, top, sides, etc., are all of enamelled slate, giving a good general appearance, and as metal, slate, and porcelain are the only materials used in its construction, it is necessarily fireproof. As is usual with all Messrs. Cowan's high-tension fittings, they are absolutely protected, so that accidental contact with any part carrying high-tension current is not possible. The whole of the cable work was done by the Henley's Telegraph Works Company, Limited. Both the high-tension and the low-tension cables are concentric lead covered and steel armoured; the insulation of these cables is impregnated paper.

We are informed by Mr. W. C. C. Hawtayne that the works at Watford are to be opened on Friday, the 9th inst. Mr. Hawtayne's plan of street-lighting by electricity

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is an exceedingly advantageous one for such a small place as Watford, as it induces the Council to lay cables on all streets, so that stray consumers can be connected in any part of the town. In this way a good load will be soon obtained.

LONDON ELECTRIC CAB COMPANY.

Through the kindness of Mr. W. C. Bersey we have been privileged to again visit the works and cab yard of the London Electric Cab Company, which is situated in Juxton-street, Lambeth. The working of this undertaking up to the present time has not resulted in a profit to the shareholders, but, as we stated at the time the annual accounts were presented, the pioneer nature of the work is largely responsible for the financial results. Until the cab company started work there was no firm either in England or abroad which had had practical experience in running a large number of electrically-driven vehicles on the public roads. The experience gained by the London Electric Cab Company has hence been of great value to other undertakings of a similar nature, and we trust that, with the alterations now made at their works, the company will enter into a dividend-earning stage. The first cost of the electrical energy was the one striking feature in their report. The supply was formerly taken from the mains of the London Electric Supply Company, and paid for at the rate of 2¾d. per unit during the day and 4d. per unit during the evening. The energy had to be transformed by means of a motor-generator. In this case the losses were not inconsiderable, and this, together with the accumulator losses, made the prime cost of the electrical energy as used in the motors very high. The company is now working its own generating plant, by which the first cost is kept down to 1d. per unit delivered at the switchboard. The plant consists of two Babcock-Wilcox boilers, two Willans engines, and two dynamos (as shown in Fig. 1), manufactured by the General Electric Company of America. These are of the six-pole type, and capable of giving 100 kw. at 350 revolutions. The voltage of the machines is about 110, but this varies according to the state of the cells which are being charged. As the batteries come in from the cabs, their voltage at normal discharge rate is measured before they are put on to the charging berths, which are in the gallery over the cab yard. The length of charge to be given is determined from this reading, but Mr. Bersey is trying a new method of estimating the charge required by the number of miles the cabs have been run. This is ascertained from a cyclometer, placed on each cab, which was demanded by the accumulator makers in order that they might guarantee the batteries. One hundred new sets of accumulators have been obtained from the Electrical Power Storage Company, each set of which is guaranteed to run a cab for 32 miles under ordinary conditions. But in order to keep on the safe side, an average run of 25 miles with one set of accumulators has to be observed. Besides this, some 20 sets of Tudor cells are being tried. This makes a total of 120 sets of accumulators, which will have to work 80 cabs. From this it will be seen that there are ample spare sets to enable each cab to have the accumulators changed as required. The electric cabs of the new type contain a number of radical departures, which tend towards smooth and more economical running. In the first place, the electric motors have been increased in power from 2½ h.p. to 3½ h.p. The motors are mounted on a hinged tray at the back of the cab, and, by means of indiarubber studs, jar on the motor and gearing is largely prevented. The driving gear is of the same general type as of the older cabs, and chain driving is still used. The chains are now of the Brampton type. In order to reduce the wear on the driving tyres, the brake has been made to act on the band wheel, instead of on the rubber tyre itself. Two of these band brakes are provided, one for each of the driving wheels, and in this way the life of the tyres will be very largely increased. In addition to this, an electric brake is obtained by means of an additional step on the controller, which provides for five

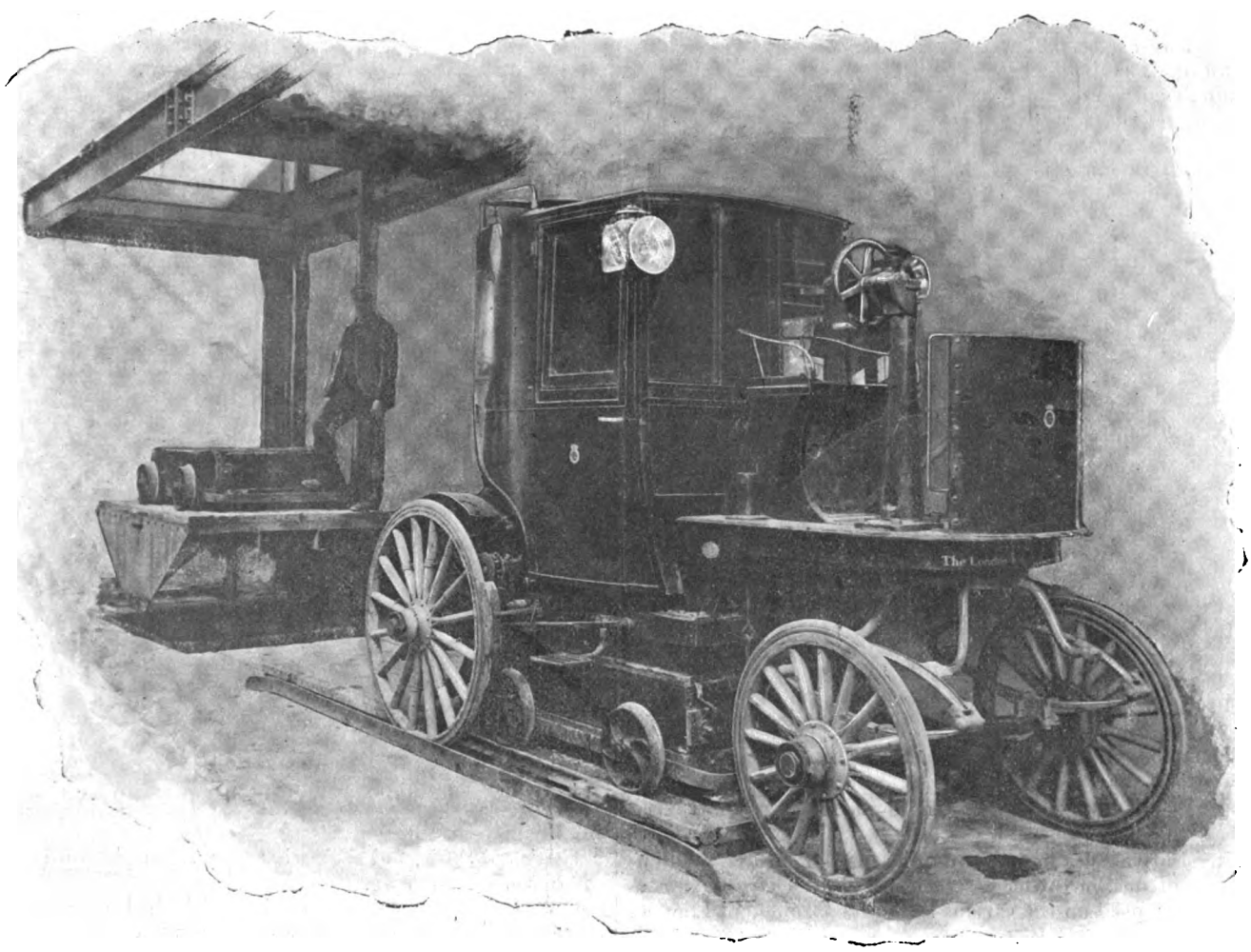

FIG. 2.—The New Type of Electric Cab.

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forward speeds, and one reversing step in addition. The general finish of the new cabs can be seen in Fig. 2, in the background of which the lift for elevating the accumulators to the charging floor is shown. In this figure, however, the old rim brakes have not been removed. Fig. 3 shows the electric brougham which the cab company are now supplying for private purposes, and from which, from a personal trial, we can testify to be a most comfortable conveyance. We were glad to find Mr. Bersey confident of the success of the new vehicles, the chief point in which still requiring alteration being that essential addition, the driver. In this respect the company has had a great deal of trouble in common with other employers of labour, and we do not doubt that Mr. Bersey will be pleased to arrange to provide carriage exercise for any electrical engineer who wishes to spend a fortnight in cab-driving. In passing, we may mention that Mr. Bersey's idea of the ultimate development of self-propelled electrical vehicles lies towards the use of lighter accumulators of smaller capacity, which would be charged at constant potential on the various cab ranks throughout London.

FIG. 3.—The Electric Brougham as Supplied by the London Electric Cab Company.

THE BIOGRAPHY OF AN ELECTRIC LIGHTING ENGINE.

BY A. D. MARKLAND.

Whence came this old engine, few could say. It is believed that she had been built by an "eminent firm" of engineers, famous in their day for making a type of engine with a big beam which is known to go up in the morning and come down at night. They were not exactly then what we should term high-speed engineers. Such was, in fact, the pedigree of that piece of mechanism known under the cognomen of old "Susie." She was the firm's only adventure in this particular line, and I have no doubt she was the last. Her power not being accurately known it is useless to define it, but, to be generous for good intentions, I had better say she tried to drive a 50-kw. alternator.

I come now to the specification of her in detail. In design she was a marvel—a perfect maze of old levers and cogwheels; and to build her it is thought heavy requisitions must have been made from various scrap heaps. The particular class she belonged to is difficult to name, so we had better leave her in a class "all her own." Besides possessing the modern-sounding word of "compound," etc., she was high speed, for she ran at 180 more or less. I fear it was more of the less. She was "half open" and "half enclosed." The most fascinating part of old Susie was her valve gear. It was a caution. Various parts of it probably belonged to some old weaving machinery of a former generation, but having been discarded they had since risen, as it were, in the social scale, and were now doing duty on the above relic. The average diameter of the low-pressure cylinder was said to be 15in.—that is, about 15 at the top, or a little less, and $15\frac{1}{16}$ at the bottom, or a little more. It was a treat to see the way that old piston rod whipped about, especially when it came to that part of the cylinder which did not possess the "average" diameter. The nominal stroke was 12in. at light load, and a "bit" more at heavy loads owing to the "knock." Many times when visitors came to see the station they asked with an enquiring air "What is that?" referring, of course, to the engine. "That's old Susie, and she's what they call a phenomenon," the driver would reply.

Old Susie was always troubled with bad coughs and rheumatics in her limbs. It was a great feat if she could run a day without the glands blowing hard, but the rheumatics, otherwise the "knock," were always there. Any variation in the "knock" was a sure sign of bad things. "She'll pull't steam-piping down, else knock herself to death," was a favourite prediction of the driver. The noise of her running, or, to be more genteel, her "silent running," as used by high-speed engineers of to-day, was quite a treat for variety of sound. A mild idea of the row could be obtained by imagining a load of brick and old iron hoops falling from a top storey, with interludes of guzzling steam from the glands, and the awful bump! bump! every time the crank swept over the centres.

The setting and altering of old Susie's valve gear was a "corker," as the Yorkshiremen say. "Experts" appeared to differ as to what would improve her running abilities. One "gaffer" advocated less lead, as it "warn't economical" to let the steam get in the cylinder too early to "waste itself," while the piston "warn't going in the right direction." Having done this to his satisfaction, old Susie went at it "hammer and tongs," as the saying goes, but the frightful crash every time the piston came to the end of the cylinder was positively deafening. Accordingly, the "lead" was increased again by shifting the eccentric, but

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the valve blocks were now said to be too small, so Susie had a rest while new valves were made. Having got the new valves, it took the "gaffer" and his mate three days to set them. During this time the "short but pithy" remarks which are so commonly used by angry workmen were never more feelingly spoken. They were uttered with great emphasis, and no wonder the moon turned pale. The valves being set, she ran a little better, but there was still room for improvement. Every few days a piece of sheet iron, etc., would be put in or taken out from between the eccentric rod and valve spindle. For some time old Susie toiled on as of yore, but in an indifferent state of health with her asthmatic and rheumatic attacks, till the time came for her dissolution. Although with a highly-strung mechanism as compared with her ancestors, yet, like them, she followed their inevitable course. *Mors omnibus communis.*

Whilst running on the midnight shift she evidently decided to "chuck up," for she tried to dissolve partnership by flinging the top half of one of her eccentrics into the rope race. At the time the eccentric was renewed, the valves were once again reset, but when steam was turned into her she ran half a revolution and stopped dead with a terrible groan. Even when given full steam, with a rush back she wouldn't budge. On opening the valve chest, *mirabile dictu!* a few odd nuts and cotters were found wedged between the valve blocks. Having cleared the obstructions, she ran on a little longer, but one day her crank-pin bolts broke, and she made a record for herself by sending the piston aloft to admit daylight through the cylinder top. *Facilis est descensus*, and the piston was no exception, for it came down with the connecting-rod end free, and made record number two by driving a 2ft. ventilating hole in the cast-iron column. Alas! it was all over now, for the flywheel, which in its sunny days was never known to run *in equilibrio*, now jammed itself against the foundation bed, and in a few more strokes she pulled up with a howling shriek midst the roar of the escaping steam.

Ah! the old tale over again—"'tis the pace that kills." Thus passed away the soul of old Susie. As it was in the beginning, is now, etc. No attempt was made to repair her, as she was in such a frightful hash that by the time taken to repair her she would have been too small for the load, and she was therefore abandoned. The "gaffer" chalked on her columns, in bold type, "N.D.U."—the initials of a short text much used by marine engineers when things go the wrong way and become useless. The exact literal translation I should blush to divulge. A little longer and the place thereof knew her no more, for a broker bought up old Susie, and she was taken home to the place where she came from—*i.e.*, the scrap heap.

MUSSELBURGH LIGHT RAILWAY ENQUIRY.

The Light Railway Commissioners held an enquiry on the 24th ult. in connection with the promotion of the electrical light railway between Joppa and Levenhall and elsewhere in Musselburgh, the proceedings of which are of unusual interest on account of the far-reaching effect of the Light Railway Commissioners' decision. This was a case of a tramway line which was partly (in fact, mainly) in the town and partly in the county. The promoters had a sealed agreement with the Town Council, and the line was held to come under the Light Railways Act because (1) the eastern portion of it acted as a feeder to the existing railway company; and (2) the western portion served a district which could not be served by the existing railway. Both portions really feed the North British Railway Company on account of the geographical situation of the station. The railway company opposed on two grounds—viz., (*a*) competition, and (*b*) that the line was a tramway and not a light railway. Practically, the only competition which was really proved was against the railway company's omnibus, which runs from their station to the Levenhall district at the eastern extremity of the Musselburgh boundary.

The Commissioners were the Earl of Jersey (chairman), Mr. Gerald A. R. Fitzgerald, Colonel Boughey, and Mr. Henry Allan Steward (secretary). For the promoters (the Drake and Gorham Electric (Pioneer) Power Syndicate) appeared Mr. E. F. Vesey-Knox, instructed by Mr. L. H. Browning (of Messrs. Ashwell, Browning, and Tutin), and Mr. Guild (of Messrs. Reid and Guild). The North British Railway Company (opposing) was represented by Mr. James Watson, and the Midlothian County Council by Mr. M'Clure. The Gas Commissioners of Edinburgh and Leith were represented *pro forma* by their clerks to secure the insertion of a clause in the order to preserve their gas-mains where the lines of the scheme passed over them. These clauses had been accepted by the promoters.

Mr. KNOX stated that the purpose of the light railway was to serve Musselburgh and the surrounding district and to bring Portobello into connection with Musselburgh, which was now becoming a suburb and pleasure resort of the city of Edinburgh, and in the past five years it had increased its population by between 25 and 30 per cent. The line would bring passengers from Portobello, who in the ordinary course would not have continued the through journey, and thus it could not be said that such passengers would be abstracted from the North British Railway Company. They asked for compulsory powers to acquire ground for a suitable power station where there was no objection to be taken, and they abandoned their request for such compulsory powers in regard to another proposed station (in Campie district). The great object of the line, so far as connected with through traffic with Edinburgh, was to bring the people to and from the station of the North British Railway Company. No complaint was made as to the service of the trains of the North British Railway Company, but the fact of the station being at the outskirts of the town presented a great deal of hindrance to the rapid development of Musselburgh as a suburban resort. The railway company had done something to develop the district by a coach route to Levenhall. One omnibus ran backwards and forwards along the road 12 times, but he contended that enough was not done, as Levenhall was a rising suburb with something like 1,000 inhabitants. The local authorities were unanimously in favour of the scheme going on.

Mr. W. A. CARTER, C.E., engineer for the promoters, said a single line was proposed with 17 passing-places. There were no engineering difficulties to the scheme, and the steepest gradient was 1 in 34. The cost was £32,437. The road of part of the route would have to be made up at a cost of between £800 and £1,000. He proposed that the promoters should do this work and be recouped within, say, five years, during which the road would naturally have had to be kept by the Council. In cross-examination, Mr. Carter stated that the Edinburgh Corporation had powers to change their tramway cable power to electric power, and the promoters of this scheme reserved the right to change to cable traction. He did not consider it would be a serious competition with the North British Railway Company.

Mr. R. W. HOGARTH, electrical engineer, consulting engineer for the promoters, and Mr. JAMES MORE, C.E., chief engineer of Messrs. Dick, Kerr, and Co., gave technical evidence as to the sufficiency of the plans.

Provost KEIR, of Musselburgh, stated that the Town Council were unanimous in desiring the railway.

Treasurer SIMPSON, Musselburgh, corroborated as to the local unanimity of desire that the scheme should go on, as did also Councillors DAVID WHITELAW and JOHN ANDERSON.

Mr. ALLBRIGHT, C.E., managing director of the promoting company, said if the district was so be served it must be by some cheaper method than cable service. Their receipts would be derived (1) from passengers requiring to be brought from the outlying district of Levenhall into the railway station of the North British Railway; (2) from the west portion of the town of Fisherrow to the railway; (3) a considerable "pick-up" traffic along the line of route between different parts of the town; (4) holiday and excursionist traffic from the termination of the tramway line at Joppa. With the exception of the traffic at Levenhall, it was a traffic of which, on account of the geographical position of its station, the railway could have no part, and which would therefore not compete with the latter's interests.

Mr. CONACHER, general manager of the North British Railway Company, stated that he considered the train service between Edinburgh and Musselburgh ample, and then gave details as to the number of trains per day, passengers carried, etc. The car service between Edinburgh and Portobello competed very strongly with them, and equally so would such a scheme as was being promoted. He admitted, under cross-examination, that since the opening of the tramway service to Portobello the railway receipts on the line between the places had not diminished but increased, but he accounted for this by the natural expansion of the city.

After hearing counsel for the promoters, the EARL of JERSEY said they must consider each case on its merits. The Commissioners were of opinion that the scheme would affect the undertaking of the North British Railway Company, and therefore they were not prepared to give an order.

We learn that this decision of the Light Railway Commissioners is a decidedly unpopular one in the district, and that the promoters may approach Parliament in the matter next year.

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THE CITY AND ITS LIGHTING.

With the exception of a rider which may mean anything or nothing, the Court of Common Council at its special meeting on Monday adopted a resolution that fairly meets the merits of the case. Of course, the Court of Common Council is too honest to adopt the flabby, invertebrate action of "expediency" *versus* consistency and honesty suggested by a contemporary. Expediency is too often another name for swindling and all that is blackguardly; hence those who make much of it can only be characterised as unprincipled. There can be no two honest views of the proper course of action of the City Fathers. The negotiations for electric lighting agreements extended over many years. Every point was thoroughly discussed and fought out, and, with the exception of a few enthusiasts, nobody believed in the early days in the commercial success of any scheme of electric lighting in the City. The labours of Hercules were comparatively mild to those of the pioneers in electrically lighting the City. They were met with the parrot cries of "In its infancy," "No demand," "Warehouses and offices closed when artificial light is required," with all the claptrap arguments of ignorance, bias, and interest. The opponents who knew more of the truth were devoted to gas. They knew the large and increasing consumption in the City. They knew that all day long the load was considerable, and likely to become greater. They, of course, held their tongues as to facts, but fought the electrical child tooth and nail. As we say, it took many years to overcome opposition or make headway. The men who supported the introduction of the new illuminant were looked upon as having more money than brains, and were told on every side that there was no hope of return for their investments. The agreements made under such circumstances could not be perfect. Investors with all this weight of opinion against them naturally introduced all the protective and productive clauses possible. Can we blame them? The result has been an eye opener to those who cavilled and doubted. The business has been successful; a fair dividend upon the capital is paid, but not an extraordinary one. The success has been achieved in the face of difficulties, not only of the nature above referred to, but also of other kinds too technical to be dealt with now. The natural rule follows the wake of success: envious eyes are directed towards the monopolised ground, and envious hands would take hold of a part of it. They hoped to upset agreements, and after others had done the hard work to have come in and reaped part of the benefit. A few gentlemen connected with the Corporation had been pecuniarily interested in the matter, and this, according to counsels' opinion, made the agreements illegal. Upon this decision some members hastened to make the Council repudiate the engagements, and for a time it seemed that they would have been successful in their endeavours. The Streets Committee considered the question and reported to the Council, recommending that though the legal opinion was against the agreements, the Council did not wish to repudiate obliga-

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tions entered into, and were willing to continue as heretofore if the company interested would meet private consumers in the question of price. That is the position at the present moment—namely, counsel say the agreement is illegal owing to pecuniary interests of some members of the Corporation at the time of making the agreements; the price charged is said to be high, and private consumers want a reduction, hence the Corporation says, "We do not desire change, but meet us in the question of price." We congratulate the Corporation upon not being led away by the cry of "expediency," or by loud-mouthed agitators. If better terms are possible, by all means try to get them; but get them honestly, not by the repudiation of solemn covenants.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

OZONE.

SIR,—I have not the slightest intention to raise in the *Electrical Engineer* another question about my ozonisers, but I must tell you that the criticisms made by M. Otto in the beginning of *1897* were refuted in *l'Eclairage Electrique* and in *l'Electricien* and some other papers, and that M. Otto had nothing to say in reply.

He found that his apparatus gave 200 grm. per horse-power hour. I have shown that this is because the more acid you put into the iodide of potassium solution traversed by a stream of ozone, the more ozone you have apparently; and M. Otto's solution is highly acidulated.

Ask Prof. W. Ramsay what he thinks of the action of acid in the determinations of ozone!—Yours, etc.,

E. ANDREOLI.

The Acacias, Cold Harbour-lane, S.E., May 27, 1899.

ANNUAL REPORT OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

The report presented at the annual general meeting of this Institution, held on May 26, states that in accordance with No. 57 of the new articles of association the date of the annual general meeting has been changed from December to the end of the session, and no annual meeting was held in December, 1898, in conformity with No. 1 of the articles of association. The report, therefore, covers a period of 17 months, commencing Dec. 9, 1897. The Council, who are empowered to elect one hon. member annually, had in 1898 the satisfaction of announcing that Mr. Henry Wilde had been elected for that year. Under the articles of association in force prior to 1899 continuance in professional practice was a disqualification for hon. membership, but with the new articles this ceased to exist, and Lord Kelvin, senior past-president, was nominated first hon. member under the new rules.

A new professional class, that of associate members, has been created this year, and elections and transfers to this class are for the first time recorded in the annual report. The total additions during the period covered by the report has been 667, comprising 2 hon. members, 37 members, 29 associate members, 11 foreign members, 354 associates, and 234 students, and 36 candidates were balloted for on May 25. One hundred and four associates have been transferred to the class of members, and 109 students to the class of associates. The death-roll has been very heavy during the recent months, 41 of those who were on the last register having died. Of these 2 were past-presidents, 3 were former members of the Council, 1 local hon. secretary, and 11 members, 4 foreign members, 18 associates, and 2 students. The Council received with pleasure, on the occasion of the death of Dr. John Hopkinson, a telegram expressing the sympathy of the Associazione Elettrotecnica Italiana, and from the American Institution of Electrical Engineers and the South African Society of Electrical Engineers, letters conveying similar messages. Seven members, 4 foreign members, 30 associates, and 10 students have resigned during the period under review.

The report having given a list of the papers read during the period, goes on to state that the average attendance at the meetings has been much larger than usual. The number of members and visitors on March 2 was so great as to necessitate a repetition of the paper and demonstration. A special feature of the proceedings of the last session has been the illustration of papers by experiments. A separate volume of abstracts has been issued to members entitled to receive the publications without extra charge, and these have consequently been omitted from the *Journal*. The following awards have been made for the session 1898-9, and the premiums will be presented in November at the first meeting of the coming session—viz.:

The Institution premium, value £25, to Mr. P. V. McMahon (member) for his paper on "Electric Locomotives in Practice, and Tractive Resistance in Tunnels, and Notes on Locomotive Design."

The Paris Electrical Exhibition premium, value raised to £20, to Mr. W. Duddell and Mr. E. W. Marchant, associates, for their paper, "Experiments on Alternate-Current Arcs by aid of Oscillographs."

Two Fahie premiums, none having been awarded in 1898, of £10 each, one to Prof. O. Lodge, F.R.S., member, and one to Mr. G. Marconi, member, for their papers entitled respectively "Improvements in Magnetic Space Telegraphy" and "Wireless Telegraphy."

Two extra premiums of £10 each, one to Mrs. Ayrton for her paper on "The Hissing of the Electric Arc"; the other to Mr. J. Elton Young, member, for his paper on "Capacity Measurements of Long Submarine Cables."

The Senior Students' premium, value £10, to Mr. W. G. Royal-Dawson, student, for his paper on "Alternating Currents of very High Frequency."

The Second Students' premium, increased in value to £10, to Messrs. M. R. Gardner and W. P. Howgrave Graham for their paper on "The Synchronising of Alternators."

The Third Students' premium, value £5, to Mr. Leonard Wilson, student, for his paper on "The Effect of Governors on the Parallel Running of Alternators."

Extra Students' premium, value £4, to Mr. L. R. Morshead for his paper on "Enclosed Arc Lamps"; and an extra Students' premium, value £3, to Mr. H. M. Dowsett, student, for his paper on "Electricity Meters."

The Salomons scholarship for 1899-1900, value £50, was awarded to Mr. H. J. Thomson, a student of the Central Technical College.

The character of papers read at the students' meetings has been higher than during the last few sessions. Visits to the following stations, works, etc., were organised: St. Pancras lighting station, Shoreditch station, Metropolitan Electric Supply station, City of London Electric Lighting Company's station at Bankside, the works of Messrs. Easton, Anderson, and Goolden, Electric Welding Company, Incandescent Electric Lamp Company, Langdon Davies Motor Company, Central London Railway, Siemens Bros. and Co., W. T. Henley's Telegraph Works, and the Davy-Faraday laboratory of the Royal Institution.

The annual dinner was held at the Hotel Cecil on Dec. 7, the number present being in excess of that of the annual dinner of 1897. The attendance at the annual conversazione was also a record.

The new articles making the end of the financial year fall on Dec. 31 instead of Sept. 30, the period covered is 15 months instead of 12, and it is thus difficult to compare the position with that of the last published accounts. The sum of £725 has been invested on account of life compositions, leaving on Dec. 31 a balance of £173, which has since been invested. The Council, taking everything into consideration, have every reason to be satisfied with the financial position of the Institution. The Council have again transferred £500 to the building fund, this bringing the amount up to £5,277 on Dec. 31, 1898. In the place of the late Mr. P. Christian Dresing, local hon. secretary for Denmark, Mr. J. L. W. V. Jensen has been appointed; Mr. Hartley Gisborne has replaced Prof. Carus-Wilson as local hon. secretary for Canada; and Mr. M. G. Simpson has succeeded Mr. J. J. Allen in a similar position in India.

The following address was offered to her Majesty the

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Queen on the occasion of her eightieth birthday by the Institution of Electrical Engineers:

To the Queen's Most Excellent Majesty.

May it please your Majesty—We, your Majesty's loyal and faithful subjects, the president, past-presidents, vice-presidents, Council, and members of the Institution of Electrical Engineers, desire humbly to offer to your Majesty our heartfelt congratulation on the completion of the eightieth year of your Majesty's great and glorious life, and we earnestly pray that your Majesty may long be preserved to reign over these realms, which for 62 years have been blessed under your Majesty's beneficent sway.

(Signed) J. WILSON SWAN, President, 1898-1899.
SILVANUS P. THOMPSON, President, 1899-1900.
WALTER G. MCMILLAN, Secretary.

The desirability of making certain changes in the articles of association had been under discussion for some time, and a committee and two sub-committees were formed to consider the matter. They presented their reports, and special general meetings were held on Nov. 3 and Nov. 18, when the members approved of the alterations suggested in the rules. A special resolution was passed, and the articles came into operation on Jan. 1, 1899. A few special details of these rules demand notice: first, as to the qualifications of members. The council being desirous to raise the standard of membership, a clause in the new articles was so drafted as to make it clear that high professional qualifications were required for candidates for admission to this class. On account of the higher qualifications required for this class of members a new class was formed intermediate between members and associates, which enabled those associates who are qualified to do so to join a class intended to include only electrical engineers and electricians. The new class of associate members was therefore created, and the number of elections and transfers to this class during the first five months of 1899 amounts to 441.

With the expansion of the work of the Institution there has, of course, been an increased expenditure to provide for, and concurrently there has been a diminution in the interest obtainable on capital to be invested. The fees payable for life composition no longer yielded a return commensurate with the expenditure incurred per member, and it was found necessary to raise the fee to 40 guineas, but the positions those who had already compounded were left undisturbed. Similarly the subscription for students has been raised from 10s. 6d. to £1. 1s. per annum.

Provision is now made for the holding of meetings at populous centres outside London. Mr. Webb having resigned the secretaryship, Mr. McMillan took over the duties of the office on Feb. 12, 1898. The accessions to the library during the year were 82, all of which were presented. An arrangement has now been made by which specifications of all electrical patents published during any week are placed on the library table every Monday morning. The number of visitors in the 17 months has been 1,132, of whom 95 were non-members.

ELECTRIC LOCOMOTIVES IN PRACTICE, AND TRACTIVE RESISTANCE IN TUNNELS, WITH NOTES ON ELECTRIC LOCOMOTIVE DESIGN.*

BY PETER MCMAHON, MEMBER.

(Continued from page 662.)

Locomotive Losses and Draw-Bar Pull at Starting.—In order to arrive at the value of the draw-bar pull exerted by the locomotive on the level at starting, the starting periods at Kennington with 100 and 120 amperes, and Elephant and Castle with the same currents, will be considered; these stations are chosen to avoid the errors (or uncertainties) introduced in the dynamometer readings by a quick down grade. In each of the four cases the values of the dynamometer reading, the tractive force due to gravity, and the tractive force due to acceleration, were taken from the plotted curves, at five-second intervals, and reduced to the level at a constant speed. Thus at Kennington (curve Fig. 11), at five seconds after starting the draw-bar pull, as shown by the dynamometer, was 1,075lb., the tractive force due to acceleration, plus or minus gravity, was 201lb., and as this force did not appear at the draw-bar, but was given out by the locomotive at the tread of the wheel, it must be added to the draw-bar pull, consequently the total tractive effort which should appear at the draw-bar at a constant speed on the level would be 1,276lb. for a current of 105 amperes. In the same manner at the tenth second interval the draw-bar pull was 1,075lb., the tractive force due to acceleration, plus or minus gravity, was 345lb., giving 1,420lb. at the draw-bar at a constant speed on the level for a current of 100 amperes. In the same way the tractive efforts at the draw-bar at the fifteenth and twentieth second intervals were 1,467lb., and 1,596lb. for a current of 100 amperes. To facilitate the analyses of these curves during the starting periods, both as regards locomotive losses and tractive effort per ton of train at starting, the curves, Figs. 11 and 12 (from the Kennington and from the Oval curves) are plotted by the author to a distance scale. The value of gravity for half a coach on the level and half on the grade could then easily be allowed for

Locomotive Losses and Draw-Bar Pull when Running.—To arrive at the draw-bar pull on the level exerted by the locomotive for speeds of nine miles per hour and upwards for various currents, the experimental runs between Stockwell and the Elephant, and the Elephant and Stockwell, were analysed, but in this case the area of the speed, current, draw-bar pull, and the tractive force due to gravity and acceleration curves (Figs. 10, 11, and 12) were measured, and from these the average values were obtained as follows: between Stockwell and the Oval the average draw-bar pull was 268lb. for an average current of 36·8 amperes at an average speed of 18·4 miles per hour (during the running period). The average tractive force due to acceleration, plus or minus gravity, was 8·36lb., leaving 259·7lb. as the tractive force at the draw-bar of the locomotive on the level at a constant speed. From the Prony brake test the tractive force at the tread of the wheel for a current of 36·8 amperes was 340lb., leaving 80lb. as the locomotive losses, in which are included journal and rail friction and air resistance. The author treats in a similar manner seven other experiments with currents ranging from 34·2 to 60 amperes, and tabulates the results.

Having obtained in this way a series of curves, the author proceeds to analyse them and to obtain the average traction resistance per car mile at various speeds. The curve shown in Fig. 29 was deducted from the experiments with No. 12 locomotive. To arrive at the additional resistance offered by the curves on the line, the observations from which the tractive force per ton was obtained were further analysed in the following manner. The position of the curve in the section being known, the exact time when the train was passing over the curve was found as already explained, for the gradient, the draw-bar pull, tractive effort due to gravity and acceleration were taken from the respective plottings for the second with a two-coach train. Although there are several sharp curves their length is small, and it was difficult to get accurate results, as in some cases the length of curve was not greater than that of the locomotive and train. The most consistent results were obtained on the curves between the Borough and Elephant Stations, and between the Elephant and Kennington Stations. The first curve has a radius of 390ft., and the average of three sets of observations gave 27·9lb. per ton at 16·5 miles per hour, the tractive force per ton on the straight and level road being 12·75, leaving 15·15lb. per ton due to the curve alone. The next curve has 540ft. radius, and the average of six sets of observations gave 22·6lb. per ton at 13·5 miles per hour, that on the level straight road being 11·3lb., leaving 11·3lb. due to the curve. There is a guard rail on each of these curves, which, although in good condition, no doubt adds to the resistance.

Electric Locomotive Design.—From the experience gained by the foregoing locomotive tests, and knowing exactly the tractive force required at the draw-bar of the train from the curve (Fig. 29), a further set of investigations was gone into. It was thought that an improvement might be made in No. 12 locomotive by winding the motors to give a higher tractive effort per ampere. This would solve the "starting period" part of the problem, but at the expense of the "running period," if the existing switching arrange-

* Paper read before the Institution of Electrical Engineers.

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ments were employed. The switching arrangement gave very good results in the past, and the cost of repairs was exceedingly small, so that it was with a certain amount of reluctance that it was decided to try the series-parallel

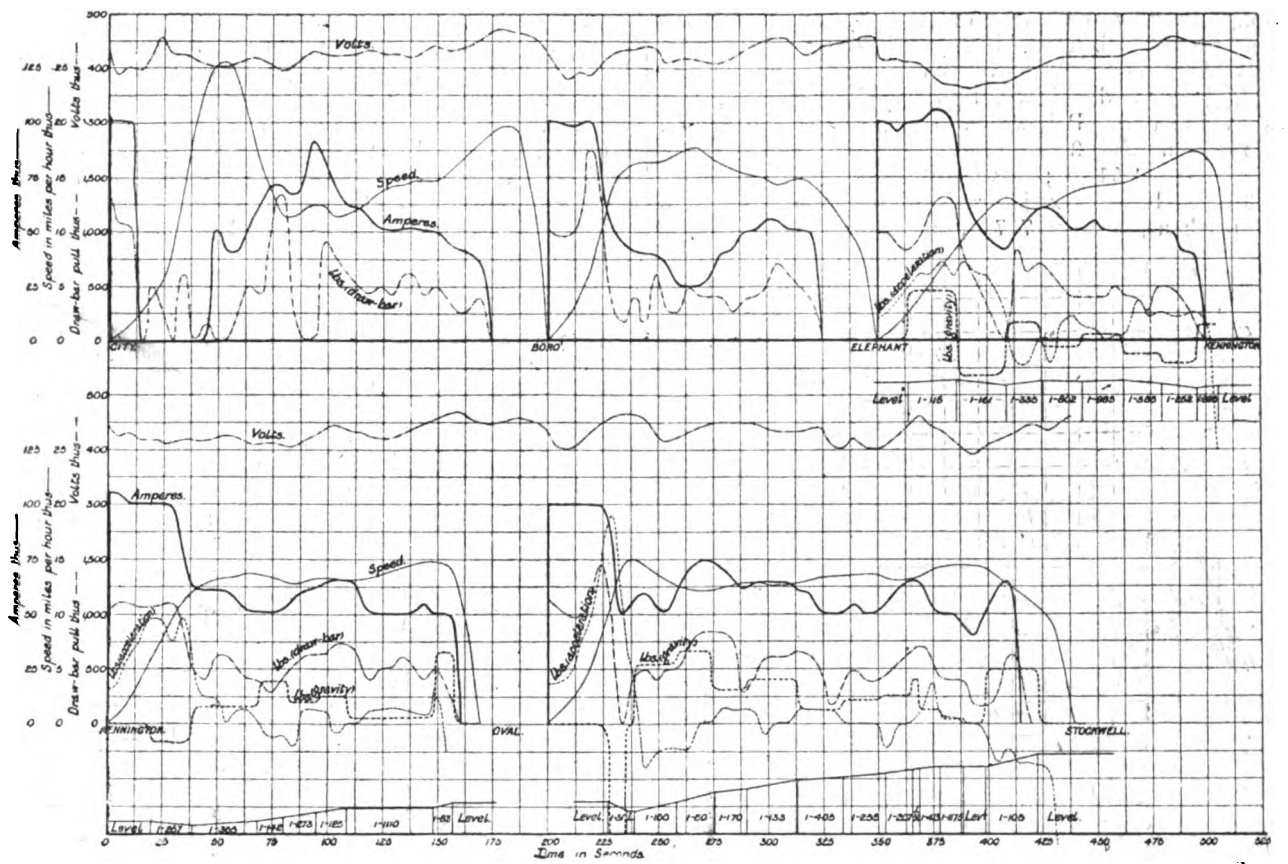

FIG. 11.

method. The necessary calculations were made for altering the armature and field-magnet winding, utilising the same carcase. The original number of conductors on the armature was 540. It was decided to increase this by

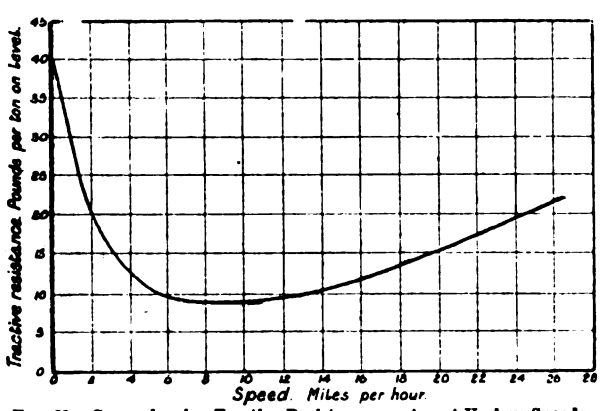

FIG. 29.—Curve showing Tractive Resistance per ton at Various Speeds.

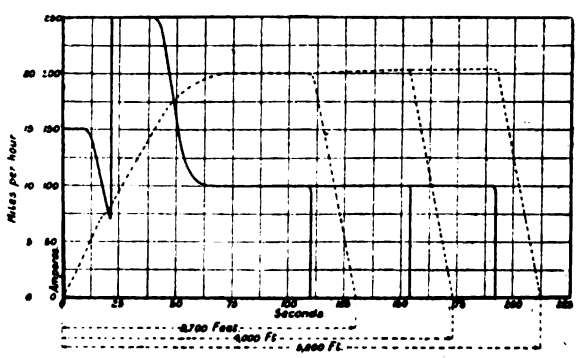

FIG. 31.—Motor No. 1, Performance Diagram.

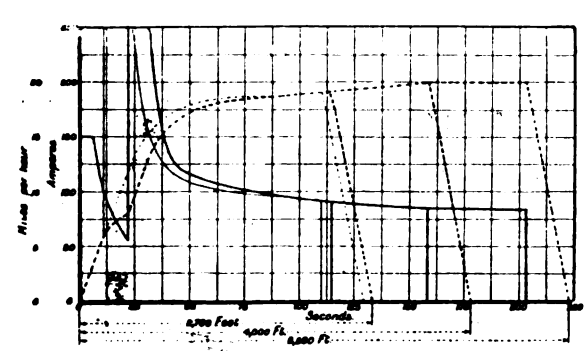

FIG. 37.—Motor No. 2, Performance Diagram.

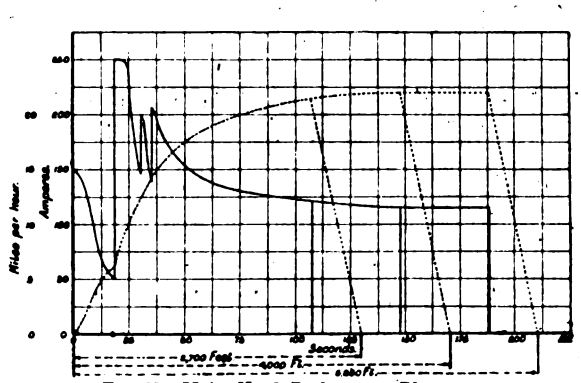

FIG. 38.—Motor No. 3, Performance Diagram.

50 per cent., or to rewind with 810 conductors. The characteristic curves of the rewound motors were then calculated and plotted (Fig. 30). It will be seen that the tractive force at the tread of the wheel (27in. diameter)

was 1,595lb. for 150 amperes, falling to 415 at 50 amperes. The speed in miles per hour at average voltage (430 volts) was 15·5 with 150 amperes, and 22·75 miles per hour with 50 amperes, with a pressure of 215 volts (corresponding to the series position) the speeds were 5·5 miles per hour at 150 amperes and 9·3 at 70 amperes. With the above curves it is possible to show the performance of this motor in actual work on the rails. The length between the start-ing and stopping point is taken as 2,700ft. This is about the average length between stations or short sections on the City and South London Railway, and in some of the proposed new schemes. To simplify calculations, the

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section is assumed level and free from curves. This assumption will not, of course, affect the general result, as the same section is considered in each case.

The weight of the locomotive and four-coach train now under consideration is 49 tons. From the curve (Fig. 29) giving the tractive resistance per ton at various speeds, a table was compiled, from which could be found the total tractive force necessary to overcome the resistance due to the locomotive and train at all speeds within the limits of this investigation. Points were taken at every two miles: thus between 0 and 2 miles per hour the average tractive resistance was 1,640lb.; between 2 and 4 miles per hour it was 906lb. In the next interval, that is, between 4 and 6 miles per hour, it fell to 707lb., and so on.

this by the average force of 2,374lb. gives 18·4ft. as the space traversed in the interval, the time occupied being 4·2 seconds. In the same manner, between four and six miles per hour the resistance is 707lb., the tractive force begins to fall at 5·5 miles on account of the current falling, so that the average tractive force in the interval is 3,060lb. for a current of 140 amperes, the space travelled is 32ft., and the time is 4·39 seconds. In the next interval the current has an average value of 100 amperes, giving a tractive force of 2,100lb., the resistance is 660lb., and the kinetic energy is 101,500 foot-pounds; working out as before, we find that a space of 70·5ft. is travelled through in 6·91 seconds.

It will be seen that the train and locomotive have now

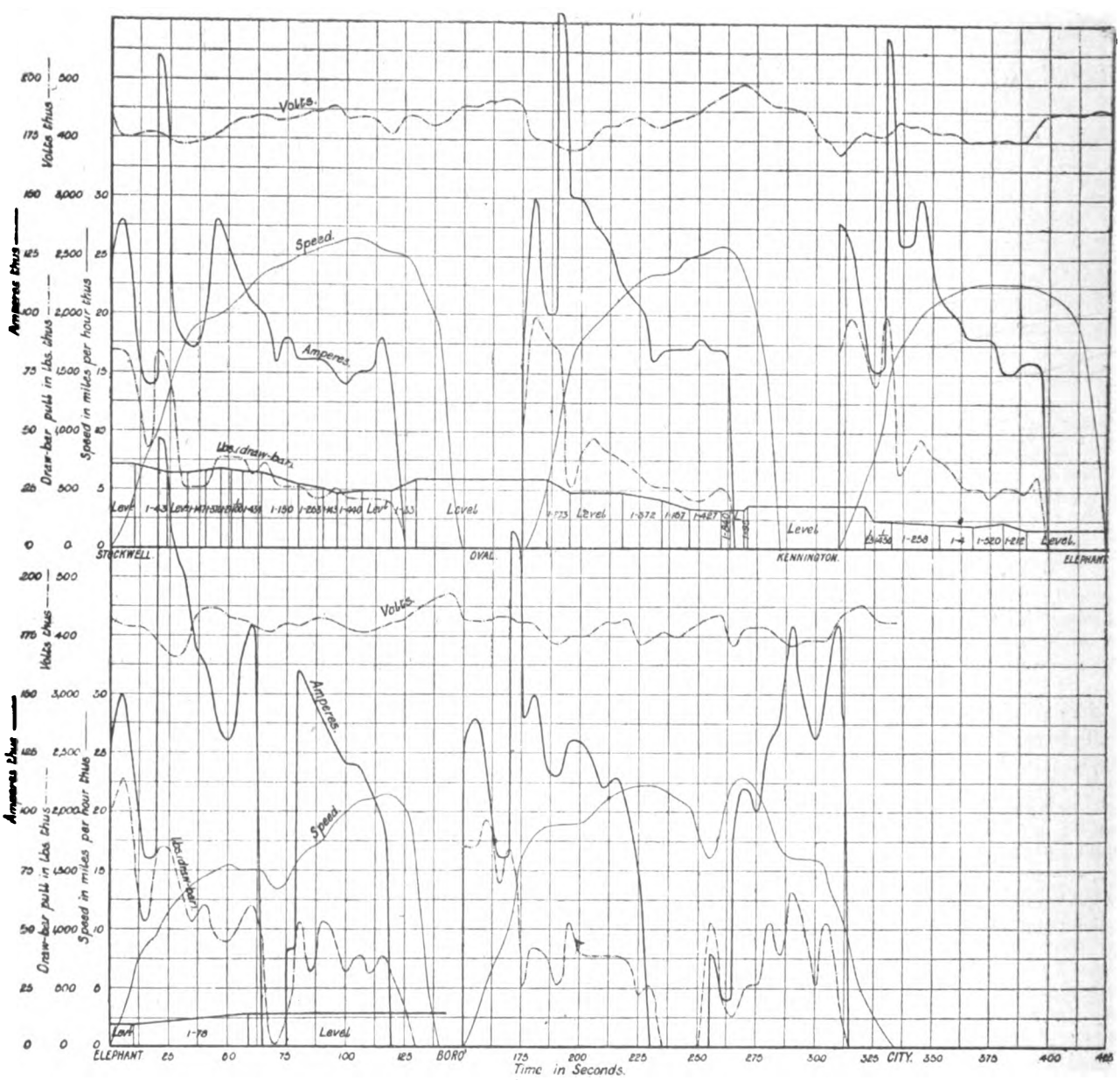

FIG. 48.

Turning now to the characteristic curves of the locomotive (Fig. 30), and limiting the starting current to 150 amperes, the tractive force at the head of the wheel is 3,280lb. for two motors, and this can be maintained until a speed of 5·5 miles per hour has been reached by the locomotive. In the interval between 0 and 2 miles per hour we have a tractive force of 3,280lb., of which 1,640lb. is absorbed by train resistance, etc., leaving a force of 1,640lb. available for accelerating the train and locomotive. The kinetic energy stored up at two miles per hour is 14,500 foot-pounds, and as the average force acting in the interval was 1,640lb., the space passed through must be 8·87ft., and the time taken 6·06 seconds. In the interval between two and four miles per hour the tractive resistance is 906lb., leaving 2,374lb. for accelerating the train and locomotive: the kinetic energy stored up between two and four miles per hour is 43,700 foot-pounds; and dividing

attained a speed of eight miles per hour, and have passed through a space of $8·87 + 18·4 + 32 + 70·5 = 129·7$ft. in $6·0 + 4·2 + 4·39 + 6·91 = 21·5$ seconds. At this point it is convenient to put the motors into parallel. They can, of course, remain in series until 10 or 12 miles per hour has been attained; a saving is thereby effected in current consumption, but at the expense of tractive force, and, as will appear later, at considerable sacrifice in the total efficiency of the locomotive.

When the motors are placed in parallel the current is limited to 125 amperes per motor or 250 amperes for the locomotive. The proper limit of current when the motors are placed in parallel is fully considered later on. This current of 250 amperes will begin to fall at 17·0 miles per hour, and is prevented from exceeding that amount by external resistance, when the motors are placed in parallel. The tractive resistance in this interval (eight to ten miles

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per hour) is 660lb., and the tractive force is 2,580lb., leaving 1,920lb. for acceleration; the kinetic energy is 131,000 foot-pounds, with the result that 68·2ft. is passed through in 5·21 seconds. The author proceeds in a similar manner for speed, gradually increasing by two miles per hour, and plots the results in a table. Plotting these results, he obtains the two curves shown on Fig. 31. The solid line represents the amperes at 430 volts, and the dotted curve the speed in miles per hour.

(To be continued.)

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. Questions may be sent at any time. Answers must be written on one side of the paper only, and should be kept as concise as possible.

QUESTIONS.

171. Discuss the best practical method of calculating the size of cables required for transmitting energy to any specified distance by means of three-phase alternating currents, the voltage at the generating end of line being known, and the maximum percentage loss of voltage allowable on the line being a fixed quantity.—G. J. F.

172. Describe, with sketches, some simple, accurate, and easily made form of frequency meter.—H. R. M.

ANSWERS.

Question No. 165.—Describe any commercial method of ascertaining the E.M.F. curve of an alternator.

Best Answer to No. 165 (*awarded* 10*s.*).—If an oscillograph is obtainable similar to those shown recently by Mr. Duddell at the Institution of Electrical Engineers, there is no doubt that it would give the best commercial method of finding the E.M.F. curve. Not only does it show the average form of the E.M.F. wave by means of a spot of light moving on a piece of tracing paper, but it is also possible, as Messrs. Duddell and Marchant showed, to obtain the shapes of the instantaneous waves by means of a rapidly moving photographic plate. None of the other methods will enable us to do this. The best known method of delineating alternating E.M.F.'s is Joubert's, and this is the method used in nearly all electrical engineering laboratories. We attach a revolving contact piece to the shaft of the alternator in such a manner that a circuit is closed for a very small fraction of a second at an assigned position of the armature, and the E.M.F. at this position is measured. We then alter the position at which contact is made, and take a new reading. Proceeding in this manner we get points on the curve step by step, and so we can draw the curve on squared paper. Dr. Fleming, Prof. Rosa, and M. Blondel have greatly improved this point-by-point method. As Dr. Fleming's arrangement is the simplest to set up in practice, and requires no special apparatus, we shall describe it. He uses a small alternating-current motor of the synchronous type. On the shaft of this motor a contact arrangement is fixed, and this can be varied in position so that it can make contact at any assigned instant during the phase cycle. This contact puts into connection the source of the alternating E.M.F. and a non-inductive resistance. The fall of potential down this non-inductive resistance can be measured by using any electrostatic voltmeter, and hence, as in Joubert's method, we can construct the wave curve. In using this method care must be taken to have the armature of the motor running very freely, as even a small load will throw it out of synchronism. Prof. Rosa and M. Blondel's methods are perhaps better, but they need complicated and special apparatus, and if money is to be spent most electricians would prefer an oscillograph.—J. C. R.

Answer to No. 165 (*awarded* 5*s.*).—The wave form of the E.M.F. of an alternator can be obtained commercially (which I take to mean that the method must be simple and the results merely accurate enough for practical use) in the following manner by the use of what is called an "instantaneous contact breaker." The action of this device will be understood by reference to Fig. 1, which shows the

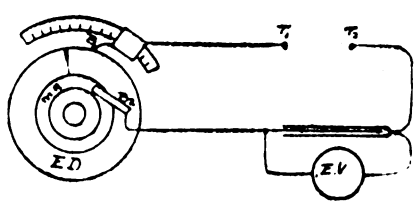

FIG. 1.

arrangement of apparatus required for determining values in the curve. T_1 and T_2 are the terminals of the alternator; E D is an ebonite disc which is fixed on the end of the alternator shaft. This disc has fixed on it a flat metallic ring, M R, and from the ring a connection is taken to a narrow strip of brass, which is let into the periphery of the disc as shown. Two brushes, B_1 and B_2, bear, one on the ring the other on the edge of the disc. The tip of brush B_1 must be narrow, in order that the period of contact with the brass strip should be as short as possible. This brush slides on a graduated scale, which should be long enough to allow the brush to move at least through one complete period of the E.M.F. curve. The brush B_2 is connected to one terminal of a condenser, the other terminal being connected to one of the alternator terminals, and the remaining alternator terminal to brush B_1, thus completing the circuit. Across the terminals of the condenser is placed an electrostatic voltmeter.

As the alternator revolves the condenser is connected through the contact maker to the alternator terminals. As explained, the contact is of brief duration, and by rapid succession of these contacts the condenser becomes charged to and maintained at the potential difference equal to that between the alternator terminals at the instant of contact. After contact is broken the condenser discharges into the voltmeter, thereby indicating the instantaneous E.M.F. for that particular point in the period. Incidentally I may say that it would be well to set the zero line of the graduated scale so as to correspond to either the maximum or minimum E.M.F. values at "no load." The effect on the resultant E.M.F. caused by self-induction can then be readily observed, both as regards value and phase, when a load is switched on. If the brush B_1 be now moved through equal distances on the scale for a whole period, and a reading taken of the respective E.M.F. values on the meter, ordinates (the lengths of which are made proportionate to the several values) can be set out (Fig. 2) on a

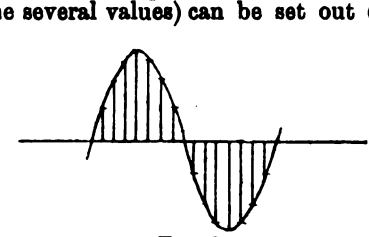

FIG 2.

horizontal line at equal distances from each other. The curve is now obtained by drawing a line through the extremities of the ordinates.

The condenser is used in connection with the static voltmeter in order to minimise any leakage which would otherwise introduce an error in the readings. As this leakage varies with the time which elapses between two successive contacts, a great improvement is effected if a number of brass strips (say equal to the number of coils) is inserted in the disc and connected to the ring. In placing the additional brass strips, care should be taken that each one is in the same position relative to phase.—ED. EVANS.

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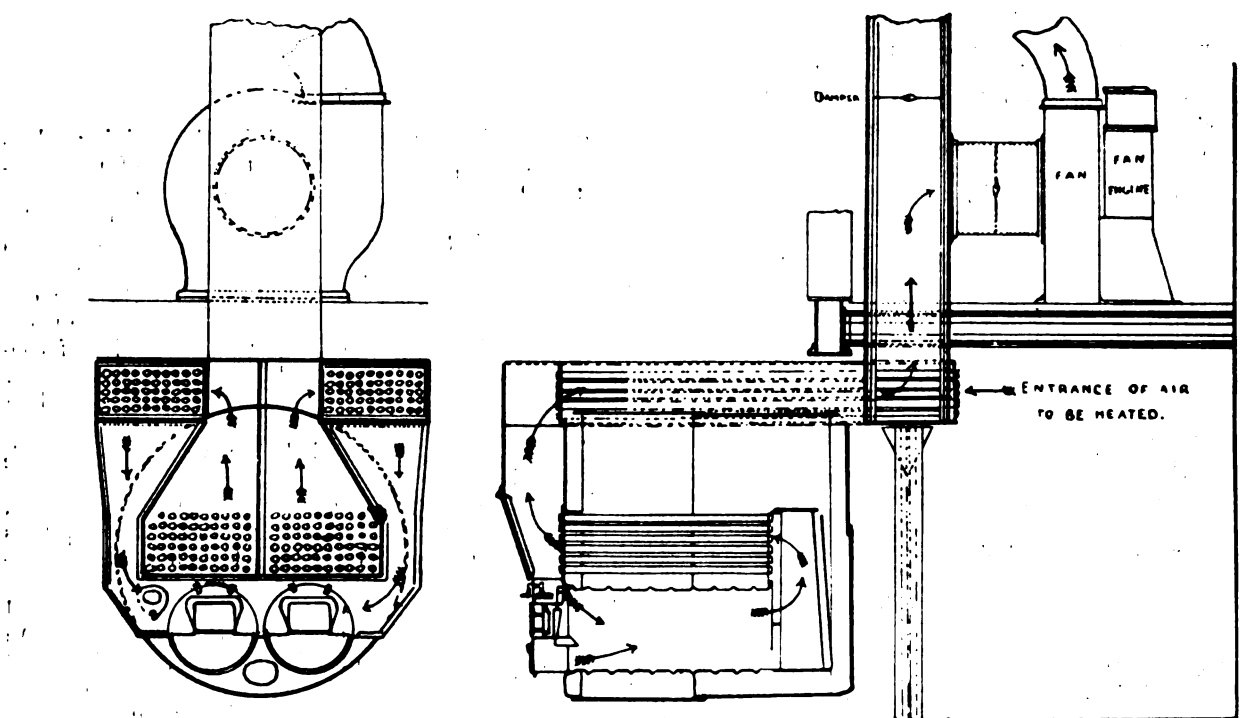
Question No. 166.—What is meant by a system of induced draught for boilers? Describe one such system.

Best Answer to No. 166 (*awarded* 10*s.*).—Boilers may be worked under the following different conditions: (1) natural draught; (2) induced draught; (3) forced draught.

Natural draught, which is really one form of induced draught, is generally obtained by a chimney, and when we speak of natural draught we infer that no mechanical means are adopted for its generation. Natural draught arises from the difference in elastic pressure existing between the atmosphere and the column of hot gases in the chimney due to the less specific density of the latter. There is, therefore, relatively speaking, vacuum in the flues and pressure at the furnace. Mechanical means taken to "increase" the vacuum in the flues gives us a system of induced draught. Mechanical means taken to increase the pressure at the furnaces gives us a system of forced draught.



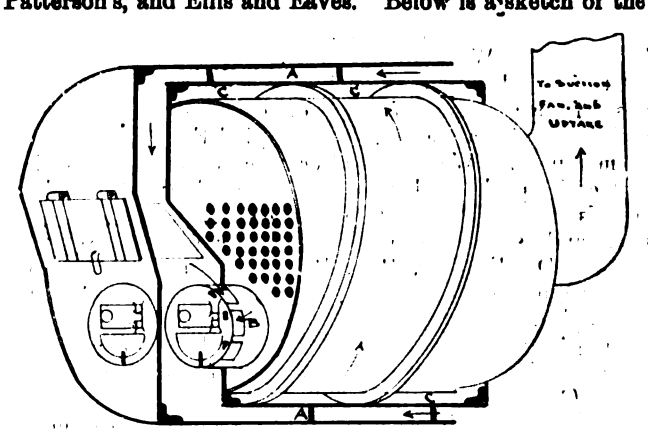
The Ellis and Eaves Induced Draught Apparatus.—A. M. O.

Induced draught, to which we confine our attention at present, is generally produced by a fan fitted in a convenient position in the flues and driven by a steam-engine or electric motor. The writer has selected for description that system known as "Ellis and Eaves," to which attaches special interest, as it provides for the heating of the air supply before it reaches the furnaces. The accompanying sketches, obtained from *Engineering*, 1893, shows the course of the gases and general arrangement very clearly. The cold air enters a series of tubes at the back of the boiler, as shown in the side section. On reaching the front of the boiler, they pass down on either side to the furnaces as shown in the front section, thence through the flues and return tubes. On reissuing, they are led centrally upwards and diverge on either side, passing into an outer casing containing the tubes through which the cold air enters, and onwards to the fan and uptake. The system works well, one of its best features being smokeless combustion. The following are some additional advantages claimed by the makers: small floor space; high evaporative efficiency; great range of steam production; absence of smoke; possibility of burning inferior coal; increased durability of boiler; absence of large chimney.—A. M. O.

Answer to No. 166 (*awarded* 5*s.*).—The principle of induced and suction draught consists in creating a partial vacuum in either the uptake, or subsequently to the gases leaving the furnaces, in contra-distinction to force a draught where there is a pressure either in the ashpit or somewhere previously to the air going through the fires. The oldest and most familiar example of induced draught in practice is the locomotive, where the exhaust steam, after leaving the engines, passes through a blast pipe in the smoke-box, and so causes a vacuum ranging from 8in. to 12in. water gauge in the latter, falling to atmospheric pressure as the fire-box is approached. There are several other systems in vogue, most of them involving the use of fans. The advantages accruing from induced as opposed to forced draught have been the subject of some discussion in the past, but the system is undoubtedly gradually gaining favour owing to its combining higher rates of combustion and increased economy.

With forced draught 30lb. to 40lb. of coal per square foot of grate seems to be the limit beyond which it is not wise to go if the life of the boiler is to be considered, one of the great sources of trouble being the destruction of tube ends (multitubular boilers), whereas in the exhaustive trials carried out by the advocates of suction systems, and also in practice, considerably higher rates than these have been maintained over extended periods with apparently little or no damage to the boilers. The reason why forcing the flame and gases through a boiler should have a more deleterious effect on the tube plates, tubes, firebars, etc, of the latter than drawing them through by creating a vacuum at the uptake is not quite clear, and has never been correctly explained, but nevertheless this is the case in practice.

The principal examples of induced draught are Martin's, Patterson's, and Ellis and Eaves. Below is a sketch of the



helical induced system of the latter as applied to a multitubular marine boiler. The boiler is surrounded by two annular spaces, A and C; cold air for combustion entering the outer one, A, from the back end of the boiler, pursues a spiral course to the air-regulating valves, B, B', in the furnace fronts, and is admitted both above and below the bars at a greatly increased temperature. After combustion the hot gases pass in a similar helical direction round the inner space, C, on their way heating up both the

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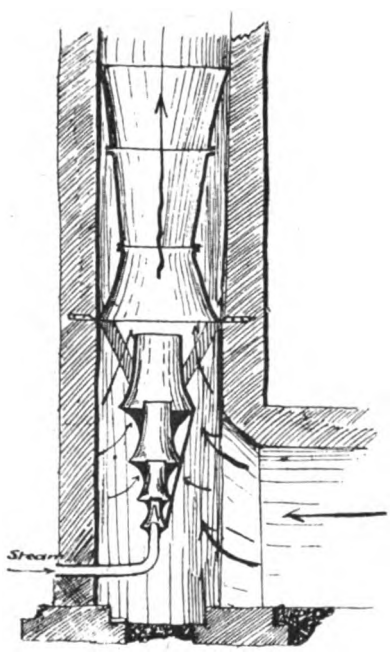
shell of the boiler and the outer space, A, and finally arriving at the suction fan. Soot-doors are placed at intervals in the casing to allow a brush being passed in to sweep away any deposit on the shell. The fan is usually placed at the foot of the uptake, and various methods are adopted for driving it. Very often its spindle is vertical, and is driven by an electromotor, thus economising both space and initial cost. With this arrangement an evaporation of 13lb. of water per pound of coal from and at 212deg. F., with a rate of combustion of 30lb. per square foot of grate, is easily maintained without damage to the boiler, the efficiency reaching as high as 80 per cent.

An ordinary marine boiler of similar dimensions, with good natural draught, would probably evaporate half this amount at a reduced efficiency of about 15 per cent., so that to do the same amount of work two boilers would be required. In comparing this system with forced draught, it ought to be mentioned that a bigger fan and casings are required, owing to the increased temperature of the gases, but the difficulty of keeping the furnace fronts or the stokehold (if the closed stokehold system is adopted) airtight is obviated.—H. F. E. B.

Answer to No. 166 (*awarded* 5*s.*).—Induced draught is so called from the fact that it is obtained by the creation of a vacuum in the boiler flue, and thus differs from forced draught in that the latter system depends upon pressure in the ashpit. Either system can be worked by (1) mechanical means (exhausting or blowing fans), (2) steam jets (exhausting or blowing). The steam-jet apparatus for induced draught has some points of advantage over mechanical methods, as it takes up little space, and, having no moving parts, is not liable to wear and tear. The construction is clearly shown in the sketch. The apparatus consists of a



series of concentric nozzles of increasing area, in which a steam jet is used first, by means of its inductive action, to create a vacuum or difference of pressure between the flue at this point and the ashpit, thus inducing a draught; and secondly, to form the motive power for the flue gases. The use of a number of nozzles in place of one single one enables larger quantities of gases to be pumped with a given weight of steam, although at each nozzle the difference of pressure against which the gases can be forced becomes smaller and smaller. This type of apparatus can easily be fixed, is simple, and its cost price is low. The nozzles can easily be constructed to resist the high temperatures of the waste gases. The special cases necessitating the use of induced draught are: for steam boilers where, owing to bad draught, the evaporating power is insufficient; for burning poor quality fuel; and where an additional boiler is put down, they save the heavy capital outlay required for an extension to the chimney—in fact, they can be used in place of a chimney.—H. H. HARRISON.

ELECTRIC LIGHTING IN THE CITY.

A special meeting of the Court of Common Council was held at the Guildhall on Monday, when the question of electric lighting in the City was again discussed. The Lord Mayor presided.

Several questions were asked with respect to the position occupied by members of that Court who might also be shareholders of the City of London Electric Lighting Company.

The CITY SOLICITOR pointed out that if any such members of the Court happened to be also shareholders of the company mentioned and voted on the matter they would become liable to a severe penalty. It then transpired that so far as the latest return of shareholders showed only three members of that Court held shares. These were Mr. Rowland Perrin (recently deceased), Sir George Faudel-Phillips (who was simply a trustee for others), and Mr. Foster McGeagh.

A report from the Streets Committee was then read. It stated that they had had a conference with Sir David Salomons (the chairman) and the Board of the Electric Lighting Company, and had invited their attention (1) to a reduction of the price of the electric light, (2) to the lighting of the minor streets, (3) as to a basis of future purchase by the Corporation of the company's undertaking. The following reply, dated May 17, had been received by the town clerk from Mr. Bull, the manager and secretary of the company: "Sir,—Referring to the interview which the directors of this company had with the Streets Committee on the 15th inst., the directors have given most careful consideration to the three points on which the Streets Committee desired that a written communication should be forwarded, and with reference thereto I am instructed to say: (1) The directors regret that, in justice to their shareholders, and in view of the obligations imposed upon the company by the Corporation, both by the contracts and by the provisional orders, they are unable at present to reduce the price of electric energy. I am to point out that the company, without waiting for the application of the sliding scale fixed by the Corporation, voluntarily reduced the price of energy, and it is the avowed policy of the Board to make further reductions as and when the financial results of the working of the company show such reductions to be practicable. (2) If it be the wish of the Corporation that this company should surrender its right to light the minor streets, my Board are prepared to do so upon the understanding that if such streets are at any time lighted by electric lamps, the contract therefor shall be offered in the first place to this company. As regards the question of purchase, my directors would be prepared to recommend to their shareholders to sell the company's undertaking to the Corporation on terms that would yield a very handsome profit to the Corporation, calculated upon the basis of the credit of the Corporation being at the rate of 2½ per cent. per annum for borrowing purposes."

Another letter, dated May 24, was read from the same source as follows: "Sir,—Referring to my letter of the 17th inst., my directors have further considered the question of price, and I am instructed to say that if the Corporation will withdraw the request which they have made to the Board of Trade to defer the granting of the formal approval by that department of the company's system of continuous current, and if the Corporation on their part will give all reasonable facilities for the extension of that system, so that the large additional continuous plant now on order may be got to work before next winter, my directors will undertake to reduce the maximum price to 6d. per unit as from Jan. 1 next. Further reductions will, of course, be made as and when the financial conditions of the company permit."

A third letter, also dated May 24, was read from the company as follows: "Sir,—Referring to my letter of the 22nd ult., I beg to inform you that the advertisement has appeared in the papers, and on the dates mentioned in such letter and the month specified in the Board of Trade regulations having now expired, I am directed to apply hereby for the approval of the Corporation to this company fixing the standard pressure of its supply of energy at 200 volts instead of 100 volts. In order that the company may be enabled to arrange to carry out any alterations which may be required to the lamps and fittings of consumers before the winter demand commences, for which there is not much time, I shall be glad to have the approval of the Corporation to the alteration of pressure at the earliest possible date.'

In conclusion, the Streets Committee recommended that the City of London Electric Lighting Company be informed that although the Corporation was advised that the existing contracts were null and void, it did not desire to take advantage of the circumstance, provided the company was prepared to come to satisfactory arrangements in regard to the supply of electricity to private consumers.

The TOWN CLERK next read a letter which had been received from the Board of Trade, Sir Courtenay Boyle intimating that he proposed deferring his report until June 7, the latest date to which he could postpone the matter.

The report of the electrical engineer (Mr. A. A. Voysey),

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who was asked to prepare this in view of the Corporation becoming the electric lighting authority, was read, in which he urged that the Corporation should become such lighting authority as soon as possible.

Mr. ALGAR moved the adoption of the report. He said there were really no difficulties in the way, as a fresh contact could be entered into with the company, which in turn could make it impossible for any member of the Court to be a shareholder in it. He ought to mention that on the receipt of the two letters of May 24 from the City of London Electric Lighting Company he on Thursday called a meeting of the Streets Committee for Friday, in order that a supplementary report based upon those two letters might be drawn up. But the committee were very much divided in opinion, and when the two letters in question had been discussed for two or three hours he was unable to find a quorum. (A VOICE: Whose fault was that?) Of course, he was unable to go on, because of several members leaving the committee. (Cries of "Why?") No doubt those members who left would explain why they did so. The Court ought to have the courage to say whether they looked upon these contracts as being null and void. Once that decision was arrived at, another contract could be entered into in identical terms. The Court had authorised three of the most legal minds of the day to give an opinion as to whether the contracts were good or whether they were void. In the first place, they took the opinion of Mr. Danckwerts, who advised the Court that the contracts were absolutely null and void. The Court no doubt, in their responsibilities as trustees of the ratepayers, thought they ought to have further information, and they gave instructions to lay the whole of the facts before two other counsel, who had also not the slightest doubt that the contracts were null and void. The question was put to one of the counsel as to the position in which the Court was placed, and Mr. Danckwerts pointed out that there was no difficulty in putting everything right, provided the Court was willing to enter into a new contract. The whole of the difficulty connected with his committee had been that some members still persisted that these contracts were valid and consistent contracts. The Corporation had been treated by the Board of Trade with the greatest courtesy throughout. Sir Courtenay Boyle had, at the wish of the Court, withheld his hand, and he had stated in firm but pleasant language that the time had now come when he could hold his hand no longer.

Mr. LEE asked whether the amendment standing in his name last on the agenda could not be taken next?

Mr. C. T. HARRIS objected to this, as his own amendment ought really to have been the report of the committee, at a meeting of which on Friday one gentleman spoke for 40 minutes, and refused to say what his amendment was, and it was not only a gross affront to the committee, but an act of gross obstruction, and prevented the committee from bringing up a report which was practically his amendment.

Mr. BROOKE-HITCHING expressed a hope that the amendments would be proceeded with in the manner in which they came on the agenda.

Mr. B. TURNER then moved the first amendment: "That, having regard to the opinion of counsel, Sir Courtenay Boyle, K.C.B., and the City of London Electric Lighting Company be informed that it is the intention of the Corporation to treat the electric lighting contracts as null and void." He said the opinion given by the three legal gentlemen consulted left the Court perfectly free in their relations with the electric light company. The Corporation had paid for advice and had secured it. There was nothing prevaricating about it, and one of the eminent counsel had described the contracts as being as "dead as mutton." His desire was that the citizens should have a good light at a reasonable price, without caring where this came from or whether a competing company was called into existence. He believed that if the whole question had been referred in the first instance to the Lord Mayor, the Town Clerk, and Mr. Algar it would have been settled in a few minutes as it had taken hours.

Mr. MCCARTHY seconded the amendment, remarking that it was the first duty of the Corporation to tell this company that the contract was null and void. It was one of the most disgraceful contracts ever entered into.

Mr. BURNETT considered there could not be a more unworthy suggestion than that contained in the amendment proposed by Mr. Turner. Although the Court had heard from counsel that the contract was null and void, it was not likely that this company would accept unchallenged such opinion.

Mr. CLOUGH opposed the amendment. It would be unworthy of the Corporation, after having entered into a contract, to take advantage of a technicality and declare such contract null and void. The more respectable thing would be for the Court to place before the company frankly and fully the statement made by counsel. The company could then either take independent opinion or be guided by that which had been furnished to the Corporation and thus meet them in a fair and proper spirit. He could not see how any self-respecting man could remain a member of any responsible body which repudiated a contract.

Mr. MORTON said he had to complain of the unworthy attack which had been made upon him by Mr. Harris. An attempt was made by Mr. Harris and his friends to get the committee to pass a resolution on which they had no evidence, and of which they knew practically nothing about. He (Mr. Morton) made it clear that this giving of a continuous current would mean the opening of the roads again. The members of the committee who broke up the quorum had not the courage to face the amendment he proposed, but sneaked off from their duties. Mr. Morton was proceeding with further observations, when

Mr. CLOUGH rose to a point of order. He submitted that some of the terms the previous speaker had used were utterly unparliamentary, and should be withdrawn. He quoted the words "sneaked away" and "ignoramuses." He submitted that these words were not parliamentary, and that in the interests of the dignity of the Corporation, they should be unconditionally withdrawn.

The LORD MAYOR thought the words should be withdrawn.

Mr. MORTON said he would withdraw anything the Lord Mayor thought proper, but that would not alter the facts.

Mr. CLOUGH, again rising, considered that Mr. Morton, instead of withdrawing his statements, had reaffirmed them. The standard of dignity of debate had been debased and dragged into the mire, and he again appealed to the Lord Mayor for his ruling with regard to the expression that he was willing to withdraw, "but that would not alter the facts."

Mr. MORTON: But it is quite true.

The LORD MAYOR said that anything which was withdrawn should be absolutely and honourably withdrawn.

Mr. MORTON remarked that Mr. Harris had been allowed to make an attack upon him, and all he asked for was fair play. In 1891 Mr. Harris objected to the company having a contract at all, but since then he had changed his mind, and what he (Mr. Morton) contended was that Mr. Harris could not be in the right on both occasions. Either he was in the right then or wrong now, or *vice versâ*. All on the Commission of Sewers knew that that contract was entered into by improper means. The company knew that they (the company) could not go to law. They had come to the Corporation and actually made them an offer of terms, but this was only after the opinion offered that the contract was null and void. They had defied the Corporation up to the last moment. If it was merely a question of pulling up roads, what was the difference between allowing the existing company to do this and a competing company to do so? As to the suggestion that the Corporation should pay the price the company asked for its undertaking—if it did this it would never be in a position to reduce the cost of the electric supply, except at the expense of the ratepayers. He maintained that the price named by the company was prohibitive. The company had practically become obsolete as far as their mains were concerned, and to make the work effective new mains would have to be laid all through the City. ("No.") It was all very well to talk about the honour and credit of the Corporation, but that Court should be swept clear of those who were concerned in the promotion of companies of any sort whatever.

Mr. JUDD said the Corporation must not do that which as individual men of honour they would shrink from. In this instance the innocent were likely to suffer for the guilty.

Mr. MORRISON urged that the public, relying upon the honour of the Corporation, had invested their money in the company, and should not be allowed to suffer. The fact should not be forgotten that the citizens were getting their public lighting as cheaply as any other similar body of people in the country.

Mr. ALGAR was of opinion that the only way in which the matter could be satisfactorily dealt with, was that the contract should be declared null and void. They must have some basis to work upon.

The CITY SOLICITOR pointed out that there were two remedies to apply—one, to enter into a fresh contract; and the second, for the company to apply to Parliament to get the necessary relief. At the same time, it did not follow that the opinion of the Corporation's counsel was binding, or would be followed by the company.

On a show of hands, Mr. Turner's amendment was rejected.

Mr. W. H. THOMAS, in the absence of Mr. Brooke-Hitching, who had left earlier for Marylebone, moved the following amendment, which stood in Mr. Brooke-Hitching's name: "That in view of the fact that the directors of the City of London Electric Lighting Company are prepared to recommend their shareholders to sell their undertaking 'on terms that would yield a very handsome profit to the Corporation,' Sir Courtenay Boyle be informed that the Corporation of London prefers to withhold its consent for the present, pending the conclusion of negotiations with the company, and that the committee be instructed to enter into negotiations to ascertain a basis for a purchase price, employing an expert consulting electrical engineer and a firm of chartered accountants to ascertain the financial effect of purchase, on a basis to be mutually arrived at by the directors of the company and the Corporation, and to report."

Mr. LILE, in seconding the amendment, said it seemed to him that the Streets Committee were so tired of the question,

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while Mr. Morton had tired the members still more by talking against time, that the sooner the work was taken from that committee the better it would be.

Mr. ELLIS supported the amendment, which he considered the most businesslike on the agenda.

Mr. MORTON said he rose to answer Mr. Lile, who made his statement without having been there. That statement was absolutely untruthful, and ought not to have been made without enquiry.

Mr. BROOKE-HITCHING (who had now returned to the Council chamber) expressed a hope that the amendment would, at any rate, receive the attention of the Court. He would like to point out that in the Metropolis there were 13 electric lighting companies working, and, with two exceptions, all paying large dividends. As against this, there were only four local authorities with electric lighting stations in full work at the present time. In the provinces, however, there were only 26 electric lighting companies working, while no less than 56 of the local authorities were supplying electricity, and most of them were earning large dividends. He did not see that the Corporation ought to buy this company's undertaking at a ridiculously high price, unless it could be proved to that Court that they would make "a very handsome profit" by so doing; and it would be well if they, as business men, should be afforded an opportunity of ascertaining whether the statement made by the company could be borne out by fact. It was for that company to prove that they could sell "on terms that would yield a very handsome profit to the Corporation."

On a show of hands the LORD MAYOR declared the amendment carried, and a division was demanded.

Mr. BROOKE-HITCHING said he was content with the expression of the Court, and would withdraw the amendment.

The Court, however, divided, with the result that 24 voted for the amendment and 104 against, giving a majority of 80 against the amendment.

Mr. WOOD, in the absence of Mr. C. T. Harris, moved the following amendment standing in the name of the latter: "That, provided the City of London Electric Lighting Company will undertake to reduce their maximum price to 5d. per unit as from Jan. 1 next, subject to revision at any future time by the Board of Trade, the Corporation will withdraw its request to the Board of Trade to defer the granting of the formal approval of that department of the company's system of continuous current, and express the opinion that the admission of a second company into the City at present would not be to the general advantage of the public and consumers." He did not think the Corporation could expect the company to supply at a lower rate than that mentioned in the amendment, nor did he think that the Corporation could supply at so reasonable a rate themselves.

Mr. PAINTER seconded the amendment, which was supported by Mr. SMALLMAN.

Mr. C. T. HARRIS now said he believed his amendment would pave the way for surmounting a very difficult and dangerous question. At the same time it would satisfy consumers of electricity and prove creditable to the City.

On being put, the amendment was lost by a large majority.

Mr. EDWARD LEE then moved: "That in the event of the City of London Electric Lighting Company not agreeing to reduce the maximum price for electric lighting to 5d. per unit, subject to revision at any future time by the Board of Trade, by Wednesday next, Sir Courtenay Boyle be informed of the failure of the negotiations, and it be suggested to him, under the circumstances, that it would be desirable in the interests of private consumers and the public that competition should be allowed in the City, subject to such terms and conditions as may be approved by the Corporation, such terms and conditions to be set out in the provisional order." The mover said there was not a word in this amendment calculated to injure the report of the Streets Committee, and it might, if adopted, be added to that report.

Mr. CALDWELL MOORE seconded.

Mr. BROOKE-HITCHING said this was a most iniquitous amendment, which said to the company, "Unless you are prepared to reduce the maximum charge to 5d., we recommend the Board of Trade to admit a second company into the City." He asked whether the Court was prepared to take upon its shoulders the odium of acting dishonestly? Having been called to order, Mr. Brooke-Hitching withdrew the latter observation, and asked whether the amendment was not really in favour of a certain company—the Charing Cross? The amendment was moved by Mr. Lee, who presented a petition on behalf of the Charing Cross Company. (A VOICE: And containing 5,000 signatures.) Yes; but a petition presented on behalf of another company had 10,000 signatures. (A VOICE: Not so many.) It was no use anyone saying, if the amendment were passed, that the Corporation would have an opportunity on some future occasion of supplying electricity. That opportunity would be lost for ever. Had the Court made up its mind never to have its own undertaking?

The amendment having been lost by an overwhelming majority, the report of the Streets Committee was adopted.

KINGSTON-UPON-HULL.

From the electric lighting accounts of this city for the year ended March 31, 1899, it appears that the total capital expenditure up to March 31, 1899, amounts to £94,958. 12s. 10d. We give herewith an abstract of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc.:

REVENUE ACCOUNT.

Dr.		£ s. d.
Generation of Electricity.		
Coal, or other fuel, including all expenses of placing the same on the works	£2,034 3 4	
Oil, waste, water, and engine-room stores	298 9 10	
Wages at Dagger-lane station	937 9 9	
Wages at Sculcoates-lane station	448 18 4	
Repairs and maintenance: buildings, £7. 0s. 1d.; engines and boilers, £201. 8s.; dynamos, exciters, transformers, motors, etc., £15. 15s. 2d.; other machinery, instruments, and tools, £315. 9s. 8d.; accumulators and accessories, £398. 1s. 3d.	937 14 2	
		4,656 15 5
Distribution of Electricity.		
Wages and other remuneration to linesmen, fitters, labourers	194 4 0	
Repairs, maintenance, and renewals of mains of all classes, including materials and laying the same	703 13 2	
Repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises, together with cost of materials and lamps sold	46 4 1	
Repairs, maintenance, and renewals of apparatus at distributing stations, £73. 2s. 11d.; less claim under insurance, £73. 2s. 11d.	0 0 0	
		944 1 3
Rents, Rates, and Taxes.		
Rents payable	227 15 9	
Rates and taxes	616 15 6	
		844 11 3
Management Expenses.		
Salaries (engineer's department)	964 15 4	
Printing and stationery	156 18 3	
General establishment charges	307 13 6	
		1,429 7 1
Law and parliamentary charges		6 7 6
Special charges—insurance		123 13 10
		8 004 16 4
Balance carried to net revenue account		8 483 1 10
		£16 487 18 2

Cr.	£ s. d.
Sale of current per meter: 2½d., 3d., 5½d., and 6d. per B.T.U.	15,545 12 4
Rental of meters and other apparatus on consumers' premises	456 0 11
Other items (miscellaneous)	271 5 6
Premiums	60 0 0
Stores on hand, March 31, 1899	154 19 5
	£16,487 18 2

GENERAL BALANCE-SHEET.

Liabilities.	£ s. d.
Capital account—loans raised by stock	53,474 3 6
Treasurer	40,484 9 3
	93 958 12 10
Sundry depositors' deposits on supply of current	41 12 0
Revenue account—balance at credit thereof	8,455 0 11
	£102,455 5 9

Assets.	£ s. d.
Capital account—expended on works	94 748 12 8
Less instalment written off meters	1,000 0 0
	93,748 12 8
Stores on hand	210 0 2
	93,958 12 10
Revenue account — stores on hand March 31, 1899: coal, £57. 0s. 6d.; oil waste, etc., £45. 11s. 11d.; repairs, etc., mains, £52. 7s.	154 19 5
Sundry debtors for current supplied to March 31, 1899	6 244 7 8
Materials and work done	64 15 0
Treasurer	2 032 10 10
	£102,455 5 9

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STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units	968,132
Quantity sold to private consumers by meter	749,690
Quantity used on works	127,495
Total quantity accounted for	877,185
Quantity not accounted for	90,947
Total maximum supply demanded (kilowatts)	1,074·7

COMPANIES' MEETINGS AND REPORTS.

SOUTHPORT TRAMWAY COMPANY.

The adjourned meeting of this Company was held at Donington House, Norfolk-street, Strand, on Wednesday last week.

The Chairman (Mr. Emile Garcke) said the profit and loss account showed a net profit of £905. 11s. 6d., which the directors proposed to apply thus: reserve fund, £300; dividend at the rate of 4 per cent. per annum free of income tax, £390; and £215. 11s. 6d. to be carried forward to the next account. The financial position of the Company had improved. In consequence of an intimation received from the Corporation of Southport inviting the directors to take steps for adopting electric traction on the tramways, a Bill was presented in the present session of Parliament for this purpose, but the Southport Corporation had not seen their way to assent to it as yet. The Corporation did not appear to have any objection to the adoption of electric traction, because they desired the Company to take the requisite steps for that purpose. Moreover, the Corporation had promoted a provisional order of their own, with the view of taking over the tramways and using electricity as a motive power. Yet, when it became necessary to enter into an agreement between the Company and the Corporation, the directors found it exceedingly difficult, if not impossible, to arrange terms. The directors hoped that the Corporation of Southport would yet take a reasonable view of the position, and assist the Company to introduce electric traction. The British Electric Traction Company, who were now large shareholders in this Company, had also made arrangements with the Birkdale and Southport Tramways Company, which, if the local authorities would only assist, would enable them to consolidate the whole of the tramways in Southport and work them by one uniform system. The Southport Company had a lease which had still many years to run, and the lease of the Birkdale line had rights over their lines for at least another four or five years; and neither the Corporation of Southport nor the District Council of Birkdale were in a position independently to deal with the problem.

The report was adopted.

CASTNER-KELLNER ALKALI COMPANY, LIMITED.

The third ordinary general meeting of shareholders of this Company was held on the 30th inst. at the Cannon-street Hotel.

Mr. William Mather, who presided, said that the complete installation which was undertaken at the formation of the Company was now at work, the last portion coming into operation towards the close of March. The profit accruing from the working of their four installations, which involved a large expenditure of capital and did not arrive yet at a maximum output, was, according to the figures submitted in the balance-sheet, very satisfactory. The process was a success not only from the point of view of the patent which they held, but during the last three years they had made several experiments and improvements which were not patentable, but from which they would derive benefit in time. The report referred to the lawsuits they had had with their competitors, the Commercial Development Corporation, for the alleged infringement of one of the Company's patents. The judgment of Mr. Justice Bingham in August last was in favour of their Company, but this was reversed in the Court of Appeal in April, though the Court was divided in opinion, as one Lord Justice delivered judgment in favour of this Company. The directors were now advised to appeal to the House of Lords, and he was assured they had good prospects of winning the case. Notice had been given to pass a resolution increasing the borrowing powers of the Board to £150,000.

Sir Henry Roscoe seconded the resolution.

The adoption of the report, together with the resolution for increasing the capital, was agreed to.

Mr. William Mather and Mr. Frederick Burton, the retiring directors, were re-elected.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.

The forty-fourth ordinary general meeting was held on Tuesday at Winchester House, Mr. William Andrews presiding. The adoption of the report and the payment of the dividends recommended, as noted in our last issue, were agreed to.

RAND CENTRAL ELECTRIC WORKS, LIMITED.

The annual ordinary general meeting was held on the 25th inst. at Winchester House.

Sir C. Rivers Wilson presided, and stated that the accounts showed that at the end of the past year £16,000 was outstanding in respect of money due for electricity supplied, etc., but £14,000 of this had since been remitted to this country. The item of £29,748, payable by Messrs. Siemens and Halske, included £5,742, being the deficiency on the working of the year, the balance representing the 8 per cent. on the capital which, under their guarantee, that firm had to provide. As a company, they were still passing through what he might call an experimental period, but they felt perfectly safe so long as the guarantee of Messrs. Siemens and Halske lasted.

The report was agreed to.

HARROW ELECTRIC LIGHT AND POWER COMPANY, LIMITED.

Directors: Charles Colbeck (chairman); Edmund Robert Bartley Denniss; Robert Cary Gilson; Edward William Flemyng Stiven, M.D., J.P.; Frederick Stuart Winkley. Consulting engineer: W. C. C. Hawtayne. Resident engineer: A. H. Shaw. Secretary and solicitor: R. E. H. Fisher.

Report of the directors presented to the shareholders at the third annual general meeting on May 30, 1899:

The directors are glad to report that the Company's business has continued to increase very satisfactorily, the equivalent of about 2,715 8-c.p. lamps having been connected in 1898, against 1,540 in 1897. At the end of 1897 there were 87 consumers connected, with the equivalent of 5,435 lamps, whilst at the end of 1898 there were 145 consumers with 8,150 lamps. In the first quarter of 1899 the equivalent of about 823 lamps have been connected, so that the increase in business is steadily continuing. The remainder of the buildings of Harrow School were wired during 1898. The output for 1898 was 79,419 Board of Trade units sold, against 50,109 in 1897. The amount received for current supplied, meter and installation rents, etc., was £2,786. 0s. 4d. in 1898, as against £1,730. 3s. 3d. in 1897. To meet the steadily rising demand, the directors have found it prudent to order another boiler. The directors pointed out in their last annual report that they thought the Company would shortly be in a position to reduce the price of current. After careful consideration they determined to make a reduction as from Lady Day, 1899. Notice was accordingly given to consumers and duly advertised of a reduction from 8d. to 7d. per Board of Trade unit, the consumer having the option of adopting the demand indicator system, and being charged at 8d. per unit for the number of units corresponding to a consumption at the rate of his maximum demand for two hours a day during the Christmas and Lady Day quarters, and one hour a day during the Midsummer and Michaelmas quarters, and at 6d. per unit for all units in excess of that number. An explanation of this system was also circulated. The directors have continued their policy of extending the mains where a reasonable percentage on the outlay can be obtained, and new mains were laid in 1898 in South Hill-avenue, Sheepcote-road, Bessborough-road, and Headstone road. It was found necessary, owing to the increase of load, to extend the existing feeders and put in an additional feeder to supply the Greenhill district, in which there had been a great accession of custom. The cost of these extensions amounted to some £2,750. Consumers still avail themselves readily of the system of wiring on rental, and in the year 1898 34 customers had their houses so wired. The directors are also glad to report that the result of the Company's working the station themselves has been satisfactory. In the first half-year of 1898, when the station was worked by Messrs. Cromptons, the cost was £497. 4s. In the second half of the year, which is, of course, the heavier, the cost was, roughly, £520, whereas, had Messrs. Cromptons still had the contract, it would have been over £620. The directors were fortunate in securing as their resident engineer Mr. A. H. Shaw, who had for some time previously been with Mr. Hawtayne. Of the additional £2,500 debentures offered in 1898, £2 300 were taken up within the year, and the remainder have been subscribed in 1899. At the end of 1898 the share capital up to £19,950 was taken up, and the directors offered the last £5,000 for subscription; £1,300 of this amount were taken up in 1899 and there are only £3,750 now available. As the capital expenditure at the end of 1898 was £35,916. 12s. 10d., and as in consequence of the increase of the Company's operations further expenditure will shortly be necessary, it will be seen that more capital is required. An additional boiler is wanted to meet the demand which is coming upon the station in the autumn, and another steam dynamo will be required in 1900. The chief capital outlay is, however, caused by the continually increasing demands for the extension of mains and house installations. The rental system of wiring houses is the principal means of securing the custom of the villas with which parts of the neighbourhood are being so rapidly covered, and the nucleus of a business has been formed in these parts which is already profitable, and which promises in a short time to become extremely so. The need for a much larger capital than was at first contemplated is not one, therefore, which calls for further explanation, and it has to be met. The directors propose to provide for it by increasing the authorised capital by £10,000, and by providing that of the whole capital so authorised an amount not exceeding one-third may, in the discretion of the Board, be constituted preference shares bearing a preferential dividend of 4½ per cent. If the resolutions embodying these proposals are carried, the directors propose to issue £1,400 of such preferential shares at once. With the increase in the Company's business the earnings of the current year ought to be sufficient to provide for the interest on the debentures and preference shares, and to pay a dividend of 4 per cent. on the ordinary shares. The directors hope that the preference shares may be subscribed and held, as the debentures have been, by their friends at Harrow. The £150 voted for directors' fees for 1898 was paid to them, and the shareholders are asked to decide

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upon their remuneration for the year 1899. As the result of the year's working, after paying interest on debentures and mortgages, there is the sum of £716. 7s. 6d. available for dividend. Out of this the directors propose to pay off the balance of the preliminary expenses, £166. 12s. 1d., to write a further £25 off leasehold property. to pay off a further £52. 14s. 8d. legal charges, and £8. 11s. 1d. the balance of the cost of the working contract, and to pay a dividend of 2½ per cent., which will absorb £449. 7s. 9d., leaving a balance of £14. 1s. 11d. to be carried forward. Mr. R. C. Gilson and Dr. Stiven retire from the Board by rotation, and, being eligible, offer themselves for re-election. Messrs. Jackson, Pixley, and Co., the Company's auditors, offer themselves for re-election.

REVENUE ACCOUNT, JAN. 1 TO DEC. 31, 1898.

Dr.	£	s.	d.
Generation of Electricity.			
Inclusive charges of Messrs. Crompton and Co., Limited, for half-year to June 30, 1898, under a working contract dated Oct. 13, 1896—viz.: generation of electricity, £272. 4s.; maintenance of station, £225	497	4	0
Generation of Electricity to Dec. 31, 1898.			
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£169 15 0		
Oil, waste, water, and engine-room stores	14 4 10		
Proportion of salary of engineer	57 0 0		
Wages and gratuities at generating station	148 11 3		
Repairs and maintenance as follows: buildings, £16. 17s. 3d.; engines and boilers, £19. 10s. 6d.; other machinery, instruments, and tools, £10. 18s. 11d.	47 6 8		
	436	17	9
Special items—viz., loss on resale of second-hand steam dynamo, etc.	101	9	4
Distribution of Electricity to Dec. 31, 1898.			
Proportion of salary of engineer	20 16 8		
Wages and gratuities to linesmen, fitters, and labourers	13 3 6		
Repairs, maintenance, and renewals of mains of all classes, including materials, and laying same	12 11 11		
Repairs, maintenance, and renewals of meters, switches, fuses, and other apparatus on consumers' premises	14 1 8		
	60	13	9
Rents, Rates, and Taxes.			
Rents payable, station, and offices, £14; house property, £25	39 0 0		
Rates and taxes: station and offices, £104. 16s. 4d.; house property, £4. 6s. 3d.	109 2 7		
	148	2	7
Management Expenses.			
Director's remuneration	150 0 0		
Salary of secretary	100 0 0		
Salary of collector	25 0 0		
Stationery, printing, and postages	57 6 0		
General establishment charges	27 13 11		
Auditors of Company	10 10 0		
Auditor appointed under the provisions of the order	12 0 0		
	382	9	11
Law and Parliamentary Charges.			
Costs *re* transfer of mortgages on land now written off	50 13 4		
Costs *re* sundry wiring agreements charged to capital now written off	2 1 4		
Costs of working contract (balance written off)	8 11 1		
	61	5	9
Preliminary expenses—balance written off	166	12	1
Depreciation in respect of leasehold property	25	0	0
Special Charges.			
Insurances: station and offices, £37. 15s. 8d.; house property, £2. 2s. 3d.	39 17 11		
Repairs to house property	52 19 7		
Discounts, allowances, etc., to customers	52 4 3		
	145	1	9
Balance carried to net revenue account	986	12	1
	£3,011	9	0

Cr.	£	s.	d.
Sale of current as under:			
At 8d. per B.T.U.	2,596	18	8
,, 7d. ,,	34	8	7
,, 5d. ,, (motors)	13	11	3
	2,644	18	6
Rental of meters, etc., on consumers' premises	73	16	8
Installation rents	67	5	2
Sale and repairs of lamps, arc or incandescent	19	16	7
Rents receivable	132	12	5
Transfer fees	0	12	6
Commission received on sale of lamps and sundries	72	7	2
	£3,011	9	0

Dr. GENERAL BALANCE-SHEET.	£	s.	d.
Capital account—amount received	31,075	0	0
Amount due to bankers	3,664	5	9
Amount due on temporary loans	1,200	0	0
Sundry tradesmen and others, amount due on construction of buildings, plant, and machinery, etc.	958	19	8
Sundry creditors on open accounts	511	11	8
Depreciation fund account	85	0	0
Net revenue account	463	9	8
	£37,958	6	9

Cr.	£	s.	d.
Capital account—amount expended	35,916	12	10
Coal on hand at Dec. 31, 1898	43	0	9
Sundry debtors for current supplied, meter and installation rents	1,535	10	3
Other debtors	463	2	11
	£37,958	6	9

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Madrid.—The Public Works Department invite tenders for electric tramways for Madrid. Tenders by June 14.

Blackpool.—The Corporation invite tenders for the supply of coal, oil, and carbons. Tenders by 10 a.m. on June 20.

Madrid.—The Post and Telegraph Department require 26,000 2in. cylinders for electric batteries. Tenders by June 13.

Lisbon.—The Mozambique Company will receive at their offices in Lisbon tenders for the erection of electricity works by July 10.

Southampton.—The Corporation invite tenders for motorcars and equipment and electrical equipment of lines. Tenders before noon on June 5.

Birkenhead.—The Corporation invite tenders for 100 electricity meters by 26th inst.; also a 225-kw. direct-current high-speed steam dynamo by June 9.

Beira (East Africa).—The Colonial Office at Lisbon invites tenders for construction and working of electric lighting and telephones in Beira by July 8.

Carlisle.—The Town Council invite tenders for rewiring, etc., the public library, art gallery, etc., buildings for the purpose of lighting the same with electricity.

Hackney.—The Electric Lighting Committee of the Vestry invite tenders for trenching, troughing, cables, joint-boxes and jointing, and house services, by June 13.

Alcala la Real (Province of Jaen, Spain).—The Municipality require tenders for an electric lighting installation and the working of the same for three years. Tenders close June 25.

Huddersfield.—The Corporation invite tenders for the supply of copper rail bonds for electric traction. Specifications, etc., may be obtained from the Borough Surveyor, 1, Peel-street, Huddersfield. Tenders by 10 a.m. on June 12.

Knaresborough.—Tenders are invited for supplying an efficient searchlight, electric, acetylene, or other illuminant, for the Knaresborough Water Carnival, Aug. 17. Full particulars on application to Messrs. Wm. Bowler, jun., and Chas. F. Smith, hon. secs.

Belfast.—Tenders are invited by the Public Health Committee for the erection of a destructor of 12 cells, including all the works connected therewith, at Lagan Bank-road. Specifications, etc., may be obtained from the City Surveyor. Tenders by 10 a.m. on June 15.

Russia.—The Secretary of State for Foreign Affairs has received a dispatch from her Majesty's Consul at Taganrog, stating that tenders are invited by the Municipality of Kertch for the supply of materials for the construction of electric lighting plant and tramways in that town.

Teneriffe.—Tenders are invited for the erection and working of an electric tramway between Santa Cruz and San Cristobal. The deposit required is about 776.214 pesetas (about £350). Specifications, etc., are to be obtained from, and tenders addressed to, Public Works Department, Madrid, by 1 p.m. on June 14.

Halifax.—The Guardians invite tenders for the electric lighting of the workhouse and union offices from the Corporation mains. Plans and specifications may be obtained from Messrs. Shepherd and Watney, Greek-street-chambers, Leeds, on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders by noon on June 8.

Patricroft.—The Guardians of Barton-upon-Irwell Union invite tenders for the wiring, with lamps and fittings, of their new infirmary buildings, Green-lane, Patricroft. Specifications, etc., can be obtained from Mr. G. R. Peers, A.I.E.E., 96, Deansgate, Manchester, upon deposit of a cheque for £3. 3s., which will be returned on receipt of a bona fide tender. Tenders by June 6.

Blackpool.—The Blackpool Masonic Hall, Limited, invite separate tenders for the following works in the Masonic Hall, Adelaide-street: electric lighting preparations; electric bells (preparations and fittings); heating apparatus. For particulars apply to Mr. J. A. Nuttall, architect, Birley-street, to whom tenders must be delivered, endorsed according to work tendered for.

Sheffield.—The Health Committee invite tenders for the supply and erection of engines, electric lighting plant, pumps, shafting, pulleys, and other engineering work required at the destructor,

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Lumley-street, Attercliffe, Sheffield. Specifications, etc., may be obtained at the office of Mr. Charles F. Wike, C.E., city surveyor, Town Hall, Sheffield, on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders by June 5.

Dudley.—The Electric Lighting Committee invite tenders for: (Section A) water-tube boilers, economiser, etc.; (B) steam dynamos, balancers, and switchboard; (C) cables and other street work; (D) arc lamps, etc.; (E) travelling cranes. Specifications, etc., can be obtained from Messrs. Wilson and Story, 66, Victoria-street, Westminster, upon payment of £2. 2s. for each section, to be returned on receipt by the Council of a bona fide tender. Tenders by June 17.

Wimbledon.—The Urban District Council will advertise for tenders for sufficient cable to meet the requirements for the next six months, and the following quantities are to be obtained in the first instance: Private lighting (armoured), 1,000 yards estimate, £100; public lighting, 1,000 yards estimate, £85; private lighting (unarmoured), 1,000 yards estimate, £85; high-tension, 100 yards estimate, £50—£320. Also for the supply of Welsh coal to March 31, 1900, the quantity not to be less than 1,000 tons.

York.—The North-Eastern Railway Company invite tenders for the following articles in such quantities as they may require during six months ending Dec. 31, 1899, delivered carriage paid at the company's telegraph stores at York: (1) telegraph apparatus; (2) telegraph wire and line stores. Payment for each month's delivery will be made at the end of three clear months, or in cash less 2½ per cent. discount. Forms of tender may be obtained on application to Mr. Graves, Telegraph Department, York. Tenders by noon on June 5.

Prestwich.—The Committee of Visitors of the Prestwich County Lunatic Asylum invite tenders for steam-pipes, condensers and cooling tower, steam dynamos for 274 kw., mains, switchboards, storage batteries, and wiring for an electric light installation. Firms desiring to tender are directed to send their names, with a statement of the parts of the work they desire to quote for, to Mr. Charles Hopkinson, M.I.C.E., 29, Princess-street, Manchester: or to Messrs. Hopkinsons and Talbot, 26, Victoria-street, London, S.W. They will then be informed when the specifications are ready for issue.

London, S.W.—The Vestry of St. Mary, Battersea, invite tenders for the supply and erection and the carrying out of work in connection with the electric lighting of the parish to specifications as follows: (Specification No. 1) feeders, distributing mains, and arc light leads, including laying and jointing; (2) water-tube boilers; (3) steam dynamos and engines. Specifications, etc., may be obtained from the Vestry Clerk, at the Municipal Buildings, Lavender-hill, S.W., on payment of £3. 3s. for each specification, etc., which sum will be returned after the receipt of the specification, etc., accompanied by a bona fide tender. Specifications and drawings can also be seen at (but not obtained from) the office of Prof. Alex. B. W. Kennedy, 17, Victoria-street, Westminster. Tenders by 12 noon on June 7.

Huddersfield.—The Corporation invite tenders for the electric equipment of their present steam tram service, also for works to be executed, plant and machinery to be supplied, as follows: Contract No. 1—(Section A) engines and appurtenances, overhead travelling crane; (B) direct-current generators, switchboard, station lighting, motors, cables, trolley poles, controllers, etc.; (C) cableways, overhead construction, trucks, and car bodies; Contract No. 2—(D) steam-boilers and accessories; (E) condensers, valves, heaters, pumps, etc.; (F) economiser, elevator, and conveyor. Any contractor may tender for the whole or part of the work included in Contracts Nos. 1 and 2. Specifications, etc., may be obtained from the Borough Engineer, 1, Peel-street, Huddersfield. Tenders by 10 a.m. on June 12.

RESULTS OF TENDERS.

Poplar.—The District Board have received the following tenders for steel roofing to the electricity station: Messrs. Bruce and Steel, £1,883; Messrs. Croes and Cross, £1,846; and Messrs. Smith and Co., £2,702. The tenders have been referred to the Electric Lighting Committee.

Ealing.—The Urban District Council have received the following tenders:

Contract No. 2.—Boilers, superheaters, etc.

Stirling Boiler Company	£2,490	0	0
Stirling Boiler Company (alternative)	2 968	0	0
R. Taylor and Sons (accepted)	2 696	0	0
Yates and Thom†	2,800	0	0
E. Danks, Limited	2,837	0	0

Contract No. 3.—Steam-piping, etc.

J. Spencer, Limited (accepted)	2,427	0	0
G. Wailes and Co.	2,894	13	6
C. S. Mallett and Co.	2,976	6	0

Contract No. 4.—Switchboard and connections.

Cowans, Limited	1,045	0	0
Warburgh, Diamond, and Co.	1,065	0	0
Bertram and Thomas	1,187	0	0
Verity's, Limited	1,278	7	0
Laing, Wharton, and Down	1,286	0	0
Prestwich and Burt	1,334	17	6
Siemens Bros. and Co.	1,340	0	0
Fowler, Lancaster, and Co.	1,350	0	0
Ferranti, Limited (accepted)*	1 810	0	0
Edison-Swan Company	1,934	12	0

* This tender includes connections and switch gear to each of the six existing alternators. † £300 of above amount was approximate.

Hammersmith.—The Vestry have accepted the tender of Messrs. Martin, Wells, and Co., of Vauxhall, at £10,199, for the erection of the second extension of the generating station.

Reigate.—The Town Council have received the following tenders:

Contract No. 1.—Boilers.

R. Hornsby and Sons	£2,476	10	0
Babcock and Wilcox (accepted)	2,118	0	0
Stirling Boiler Company	1 980	0	0
D. Stewart and Co.	1,938	0	0

Contract No. 2.—Steam-pipes, etc.

G. Wailes and Co.	1,760	10	0
J. Spencer, Limited	1.730	0	0
Babcock and Wilcox (accepted)	1 679	0	0

Contract No. 3.—Steam alternators, etc.

S. Z. de Ferranti	5,727	3	0
British Thomson-Houston Company	5 352	0	0
J. Fowler and Co.	5 277	0	0
British Schuckert Company	5,094	0	0
Bertram-Thomas	4,978	0	0
Brush Company	4 820	13	6
Crompton and Co.	4.779	0	0
W. H. Allen and Co.	4 717	0	0
Electric Construction Company (accepted)	4,602	0	0
Rosling and Appleby	4,499	0	0
Johnson and Phillips	4,465	0	0
Mather and Platt	4,451	10	0

Contract No. 4.—Switchboard, etc.

Fowler and Lancaster (approximate tender only)	1,150	0	0
J. Fowler and Co.	926	0	0
North Wilts Company	913	7	0
S. Z. de Ferranti	862	15	0
Bertram-Thomas	732	9	6
Johnson and Phillips	699	0	0
Edison and Swan	689	0	0
General Electric Company	624	10	0
Cowans, Limited (accepted)	616	0	0
Cowans, Limited, extra bar	58	0	0
Crompton and Co.	546	0	0
British Schuckert Company	500	0	0
Verity's, Limited	454	10	6
Dobsons and Curtis Bros.	426	15	2
Dobsons and Curtis Bros.	396	15	2

Contract No. 5.—Mains and lamp-posts.

Bertram-Thomas	10 356	15	2
Henley's, Limited	9.643	11	5
Crompton and Co.	9,577	3	9
W. T. Glover and Co.	9.378	6	0
General Electric Company	9 164	15	6
Johnson and Phillips (one item approximate estimate)	9.062	12	8
Callender's Cable and Construction Company	8.767	13	7
British Insulated Wire Company (accepted)	8,516	4	5

Alternative tenders—Boilers.

Babcock and Wilcox	2,042	0	0
Babcock and Wilcox	1,921	0	0

Steam alternators, etc.

S. Z. de Ferranti*	5 810	10	0
Bertram-Thomas	5 278	0	0
W. H. Allen and Co.	4,881	0	0
W. H. Allen and Co.	4.813	0	0
Electric Construction Company	4 698	0	0
Electric Construction Company	4,903	0	0
Johnson and Phillips	4 747	0	0
Mather and Platt	4,690	10	0
Mather and Platt	4,674	10	0

* A second alternative was sent in incomplete.

BUSINESS NOTES.

Aberdeen.—The proposed additional extensions for the electric supply system are estimated to amount to £15,000.

Parliament.—The Liverpool Overhead Railway Bill was read a second time in the House of Commons on Wednesday.

Hornsey.—The Urban District Council have been petitioned by residents in Highgate who ask to be supplied with electricity.

Telegraph Manufacturing Company, Limited.—The transfer-books of the Company will be closed as regards the ordinary shares to June 12.

Twickenham.—The date of the public enquiry into the Council's application for power to construct an electric tramway has been fixed for June 12.

Bristol.—The reduction in the price of current notwithstanding, there is a profit of £2,000 in the last accounts of the Electric Lighting Committee.

Brussels.—Messrs. Siemens and Halske and Messrs. Felten and Guilleaume have received the contract for the proposed underground telephone lines.

Ilford.—Application is to be made to the Local Government Board for sanction to borrow £4,300 for providing a site for an electric lighting station, etc.

Cheltenham.—The date for the holding of the official enquiry into the Cheltenham tramways or light railway scheme has been postponed until the 23rd inst.

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St. Pancras.—We learn that owing to the Vestry elections the tenders recently sent in for cables will not be considered until the appointment of the new committee.

Leigh.—At last week's meeting of the District Council it was stated that this year £10,000 would have to be borrowed for the Council's electric light undertaking.

Surrey.—The County Council have convened a conference of representatives of local authorities to ascertain how far electric tramways may be adopted throughout the county of Surrey.

Shanghai Tramway Syndicate, Limited.—This Company has been registered with a capital of £5,000 in £1 shares, and the object is to construct and work tramways in China or elsewhere.

Removal.—Messrs. Lehmann Bros. (late T. Lehmann), of 38, Hampshire-street, Torriano-avenue, London N.W., will shortly remove from above address to Hampshire Works, Walthamstow, which they are now building.

Hereford.—A circular has been issued asking the residents in certain streets where the Corporation propose to lay mains to inform them without delay if they desire the service. The charge for the current will not exceed 6d. a unit.

Presentation.—On Wednesday, the 24th ult., Mr. H. St. Hill Mawdsley, the chief electrician to the Newton Electrical Works, Limited, Taunton, was presented with a handsome clock and vases by the employés on the occasion of his marriage.

Stock Exchange Settlement.—Application has been made to the Stock Exchange Committee to appoint a special settling day in the Westminster Electric Supply Corporation's further issue of £50,000 3½ per cent. first mortgage debentures.

Bromsgrove.—A scheme for an overhead electric tramway, of which Messrs. Pritchard and Co., civil engineers, of Birmingham and London, are the engineers, is being prepared. The proposed line will connect the town with the Midland Railway Station.

Tynemouth.—Mr. R. H. Bicknell has held an enquiry into the Corporation's application to borrow £34,850 for an electric supply scheme. Current is to be supplied for lighting, motive power, and for the working of the British Electric Traction Company's tramways.

Stone.—Messrs. Mavor and Coulson have obtained the contract for the electric lighting of the City of London Asylum, at Stone, near Dartford. The work is being carried out to the specification of Mr. A. A. Campbell Swinton, M.I.C.E., the consulting engineer to the Visiting Committee.

Ross.—Mr. Kilgour, electrical engineer, of Cheltenham, who has been engaged to make an inspection of the district which it is proposed to illuminate with the electric light, attended a special meeting of the Urban District Council on Saturday last. No decision has yet been arrived at.

Leeds Electrical Supply Company, Limited.—This Company has been registered with a capital of £2,000 in £1 shares to acquire the business carried on by Clarence M. Stead at Merrion-street, Leeds, as the Electrical Supply Company, and to carry on the business of electrical engineers, etc.

Stock Exchange.—The Stock Exchange Committee have appointed Wednesday, June 14, as a special settling day for the City and South London Railway Company's 37,500 ordinary shares of £10 each, £2 paid, Nos 22,501 to 60,000, and also ordered these securities to be quoted in the official lists.

Elland.—A limited company having approached the District Council with a view to supplying the town with electric lighting and tramways, the Electric Lighting Committee have recommended the application for a provisional order empowering the Council to lay down the necessary plant and supply the town with electric lighting.

Eastbourne.—Mr. W. C. C. Hawtayne has been appointed consulting engineer to the Corporation. His duties will include the preparation of a full report as to the carrying out of electric light works and advising the Corporation for the purpose of making application to the Local Government Board for power to borrow the amount agreed to be paid to the company.

Sunderland.—The annual report of the municipal electric lighting works shows a net profit for the year of over £364. The gross profit was £2,855, or 4¼ per cent. on the capital outlay. The average price obtained for current was 3·78d. per unit. There are about 26 000 lamps connected, and motors totalling 400 h.p. The number of units sold was 472,240, an increase of over 70 per cent.

Portsmouth.—The Corporation's electric lighting balance-sheet shows a net profit on the year's working, after making allowances for the sinking fund, etc., of £2,500. Of this sum it is proposed to hand over £1,000 towards the relief of local rates, treating the balance as a reserve fund. The Corporation are now completing their arrangements to take over the tramways and run them by electric traction.

Appointments Vacant.—A resident engineer is required at the Corporation's electricity works at York.—The Tramways Committee of the Hull Corporation have vacancies for two junior electrical assistants as switchboard attendants at their power station.—The National Electric Supply Company, Limited, Preston, require a junior engineer for their works.—Particulars of these and other appointments appear elsewhere.

Knott End Extension to Lancaster.—Notice of application by the Knott End Railway Company to the Light Railway Commissioners for an order pursuant to the Light Railways Act, 1895, authorising the construction of a light railway between Pilling and Lancaster, has been published. The proposed gauge to be adopted is 4ft. 8½in., and the motive power will be steam, electricity, or other mechanical power.

Llandudno.—The Electric Light Committee have resolved not to entertain any proposal for the supply of current other than at the switchboard, and to offer to supply energy for working the proposed railway at the following rate—viz., 1¾d. per unit for every unit up to 100,000 units, 1¼d. per unit for every unit over 100,000 up to 400.000, 1d. per unit for every unit over 400,000, the minimum supply in any one year not to be less than 350,000 units.

Accrington.—At the meeting of the directors of the Accrington Tramways Company on Thursday, it was decided to call a special meeting in order to arrange for a meeting of the shareholders to consider a proposal for selling their undertaking to the British Electric Traction Company. The purchase price is said to be £56,000. As the tramway company's lease has only about eight years to run, the Accrington Corporation will probably oppose the transfer.

Hull.—At the last meeting of the Electric Lighting Committee of the Corporation the Chairman stated that during last year the consumers increased from 678 to 960, and there was on the year's working a net profit of £3,660. The accounts appear in another column. The Chairman said if they had been a limited company they could have paid a dividend of 9 per cent. A reduction of ½d. per unit on all current sold for lighting purposes only was approved.

Constantinople-Constanze Cable.—A Constantinople telegram to the *Financial News* states that the British Minister at Bucharest presented on May 16 last to the Roumanian Cabinet a note applying for authority to the Eastern Telegraph Company to effect a cable connection with the Constantinople-Constanze line. On May 20 the Roumanian Cabinet replied unfavourably, owing to similar permission having already been given to a German company.

Leamington.—At a meeting of the council of the Town Improvement Association on the 30th ult. the following resolution was passed: "That in the opinion of this council any scheme for the adoption of overhead electric traction for the tramways would be entirely detrimental to the best interests of the town, and should never be permitted, and this council respectfully recommends the Town Council to take all steps to prevent such a disfigurement of the town."

Bidston.—With regard to the coming application of the Birkenhead Town Council to the Board of Trade for a license to supply electricity in Bidston and Noctorum, a clause will be inserted protecting the right of the Cheshire County Council to alter or rebuild any bridge or main road without having to pay compensation and possible damages to the electric cables, and under those circumstances the County Council has withdrawn its objection to the grant of the license.

Hackney.—At the last meeting of the Vestry the Lighting Committee reported on the question of a site for the electric lighting and refuse destructor station, and asked for the authority of the Vestry to negotiate for the purchase of a site. This report had not been reached when the Vestry adjourned, and was therefore not dealt with. At the meeting of the Vestry to-day the report of the Electric Lighting Committee, noted in our last issue, will be submitted.

Barnsley.—At the last meeting of the Guardians the committee appointed to go into the matter of lighting the workhouse, infirmary, and premises by electric light stated that they had consulted a Manchester firm, who estimated the cost of plant at £2,038. 10s. The British Electric Traction Company, Limited, have given notice of intention to apply for a provisional order to establish tramways in Barnsley and to Stairfoot and Worsborough, and the Corporation have decided to oppose.

Lancaster.—At a meeting of the Town Council on Wednesday it was decided to oppose any proposal by public companies to construct a tramway through Lancaster from the Fylde to Morecambe, and a committee was appointed to consider the desirability of the Corporation constructing and working any tramway that may be necessary for the convenience of the inhabitants of the borough. The profits from the electricity department for the year ending March 25 last were reported to be £1,191. 3s. 7d.

Perth (W.A.).—A correspondent of the *Financial Times* wires as follows: The laying of the double track of the Perth electric tramways has been completed from Thomas-street to Milligan-street and from Pier-street to Bay-street. The erection of the cars has also been finished, and the car-house is complete, excepting a portion of the roof. The Babcock and Wilcox boilers have arrived, and are now being placed in position in the power-house, and the artesian well has been sunk to a depth of 470ft.

Nernst Lamp.—A conference was held at Berlin last week, at which the holders of the patents for the whole world attended. The conference lasted for many hours, and the protocol embodying the understanding on all points was signed by those present. There were present Prof. Nernst; Mr. Rathenau, of the Allgemeine Gesellschaft; Mr. George Westinghouse, of Pittsburg; Dr. von Hoor and Czerhaty, of Ganz and Co., Budapest; Mr. James Swinburne and Mr. Bernard Drake, of the Nernst Light, Limited.

Wycombe (Borough) Electric Light and Power Company, Limited.—This Company has been registered with a capital of £30,000, in 600 shares of £5 each; £5,000 have been subscribed for by Messrs. Edmundson's Electricity Corporation, Limited, and £5 000 are now offered for subscription locally. There are also £15,000 in 5 per cent. debentures, the whole of which have been taken up by Messrs. Edmundson's Electricity Corporation, Limited. The subscription list opens to-day, and closes on Saturday, June 10.

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Walton-on-Naze.—The contract for the electrical arrangement for the pier has been taken by Messrs. Lowdon Bros., of Glasgow, Edinburgh, and Dundee, and their representative at Walton is Mr. W. G. Malcolm. Mr. Addenbrooke is the supervising engineer. The station is in near proximity to the Pier Hotel (which it supplies with current), and contains a 60-h.p. boiler and 220-volt dynamo. There are 26 lights of 100 c.p. each on the pier. The electric tramcars are run on the third-rail principle.

Dewsbury.—The Gas, Electricity, and Water Committee of the Dewsbury Corporation recently visited Rugby to see the working of a 110-kw. steam dynamo and Willans engine, which the Corporation propose purchasing. Whilst at Rugby they were shown over the works of Messrs. Willans and Robinson. Engines of this type have been supplied for electric lighting and traction purposes to the Liverpool Corporation, to Buenos Ayres, the Brighton Corporation, the Vestry of St. Pancras, the Bradford Corporation, etc.

Birmingham.—The Finance Committee of the Corporation, in a report to be submitted on the 6th inst., recommend that, subject to the passing of the Birmingham Corporation Bill, now before Parliament, application be made to the Commissioners for the advance of a loan of £500,000 in December next, for the purchase of the undertaking of the Birmingham Electric Supply Company, Limited, and other purposes of the Bill. This loan is to bear interest at the rate of 2¾ per cent. per annum, and to be repayable to the Commissioners in 30 years.

City and Guilds of London Institute.—The courses of instruction at the institute's Central Technical College, Exhibition-road, are for students not under 16 years of age; those at the institute's Technical College, Finsbury, for students not under 14 years of age. The entrance examinations to both colleges are held in September, and the sessions commence in October. Particulars of the entrance examinations, scholarships, fees, and courses of study may be obtained from the respective colleges, or from the head office of the institute Gresham College, Basinghall-street, E.C.

Wakefield.—The salary of Mr. J. K. Brydges, the electrical engineer, has been increased by £25 per annum, rising by yearly increments of £25 to a maximum of £300. The Corporation are desirous of obtaining quotations for the supply of smudge from the various colliery proprietors in the district for the electric lighting department for a period of 12 months. The electrical engineer has been instructed to procure a 3-h.p. motor for the purpose of running the auxiliary plant at the electricity works at the cost of £33, and to extend the low-tension service cable from Westgate along Drury-lane at an estimated cost of £18. 10s.

Ealing.—Mr. Councillor Green has been elected chairman of the Electric Lighting Committee for the ensuing year. The work of extending the mains in the park, and linking the same up with St. Mary's-road mains, is to be proceeded with at an estimated cost of £136. 10s. 4d., as is also the extension of the mains on the Drayton House Estate. This will cost at the commencement the sum of £320. The engineer has been instructed to prepare an estimate for renewing the pilot voltmeter wires. Application is to be made to the Local Government Board for a loan of £18,000 to cover expenditure already incurred and new works proposed.

Clontarf.—The Clontarf and Hill of Howth Tramroad Company is authorised by a special Act of last session to construct and work by electrical power a tramroad from the end of the Clontarf tramway of the Dublin United Tramways Company at Dollymount to the east pier of Howth Harbour, a total length of 5 miles 3 furlongs. An agreement has been made between this company and the Dublin United Tramways Company whereby a supply of electricity for the working of the line will be supplied from the Clontarf power station, at the rate of 2d. per Board of Trade unit, subject to periodical revision on arbitration terms, failing agreement.

Coventry.—The completed part of the new tramways extensions having had a very satisfactory trial, it is expected that the cars will be running in a fortnight. The Electric Light Committee have presented the following comparative quarterly statement: 1898—Electricity supplied, 35,090 units; rentals, £891. 4s. 5d.; number of consumers on March 31, 112; mileage of mains on March 31, high tension, 2 miles 1,592 yards; low tension, 3 miles 791 yards. 1899—Electricity supplied, 37,248 units; rentals, £945. 19s. 5d.; number of consumers on March 31, 135; mileage of mains on March 31, high tension, 2 miles 1,592 yards; low tension, 3 miles 791 yards.

Stoke-on-Trent.—At Wednesday's meeting of the Rural District Council the surveyor (Mr. L. Sugden) reported with regard to the proposal of the Parish Council of Stoke Rural to provide an electric light scheme for the township, worked from the District Council's steam-boilers, etc., that the boilers were quite adequate for the extra service proposed for some years to come, and an electrical station could conveniently be constructed parallel to the boiler-house. The probable requirements would be 730 16-c.p. lamps. Seventy-two street lamps would be required. The cost he estimated at about £2,750. The consideration of the matter was deferred until the next meeting.

London Gazette.—The last day for receiving proofs in the estate of J. S. Blackwell, Leicester (trading as the Central Electrical and Engineering Company), has been fixed for June 9. Receiving orders: No. 307, E. L. Joseph, electrical engineer, Brondesbury; No. 9, H. J. Wimshurst, electrical and motorcar engineer, Coventry. The first meeting in this case will take place to-day, and the public examination is fixed for the 5th inst. The first meeting under the Companies Act, 1862 to 1890, of the Electric Exploration Company, Limited, Walbrook, E.C., will take place at Carey-street, Lincoln's-inn, W.C., on June 6. The last day for proofs in the estate of G. F. Rogers, electrical engineer, Notting Hill, and 5, Great Winchester-street, is the 13th inst.; Mr. E. Barrow Lamb, 85, Gracechurch-street, is the trustee.

Gateshead.—At a special meeting of the Town Council on Thursday week a report from the Parliamentary Committee was adopted upon the refusal of the Board of Trade to include in the Gateshead electric lighting provisional order certain clauses dealing with the charges where prepayment meters were used, and where the consumers installed their own wires and fittings, and providing for the payment to the Corporation of excess of profits, and for regulating free wiring and prepayment meters, etc. The committee referred to the introduction into Parliament by the Board of Trade of a Bill confirming the provisional order, and it recommended that a petition be presented to the House of Commons in opposition to the confirmation of the order, asking that the terms of the arrangement which had been excluded from the order should be inserted therein in committee.

Ernest Scott and Mountain, Limited.—We have received from this firm of electrical and general engineers, of Close Works, Newcastle-on-Tyne, one of their well got-up folding, compact, and exceedingly handy power tables. There is also given a description of the firm's enclosed two-crank side-by-side compound double-acting central-valve engines, for coupling to dynamos, fans, and to other machinery. These engines combine simplicity in construction with economy in working; and complete plants, including engines attached to the dynamos of the firm's make, or to machines of other manufacturers, are supplied. The power table referred to will be of value to engineers specifying engines of this class, as it furnishes the effective horse-power and electrical output to be obtained at different steam pressures and speeds. There is also given a power table of three-crank compound tandem engines with forced lubrication, these engines being suitable for higher powers than the compound side-by-side engines.

Amalgamation of German Electrical Interests.—The Bank fuer electrische Industrie and the Electricitaets-Gesellschaft Felix Singer und Co., Actien-Gesellschaft, both of Berlin, and the Helios Electricitaets Actien-Gesellschaft, of Cologne, with its financial company, the Gesellschaft fuer Electricitaets-Anlagen, are to be amalgamated. The Helios Company will raise its capital from £500,000 to £800 000, making it equal to the share capital of the Gesellschaft fuer Electricitaets-Anlagen, while the Bank fuer electrische Industrie and the Singer Company will go into liquidation. As a result of this combination of interests, the Helios Company, which has hitherto been mainly occupied with the manufacture of electric lighting plant, will embark upon the construction and installation of material for electric traction. It is understood that Mr. Felix Singer, the founder and general manager of the Bank fuer electrische Industrie and of the company which bears his name, will not join the Helios Company.

Personal.—Mr. Percy B. Wilson has severed his connection as secretary with the National Electric Free Wiring Company, and joined the British Electric Works Company, of Stellite Works, Birmingham, in a similar position.—We learn that Mr. Douglas C. Bate, managing director of the Stewart Electrical Syndicate, of 5, New Compton-street, W.C., is proceeding to America next week in search of novelties for his company.—We are informed that Mr. V. A. Fynn has joined the staff of Messrs. Roeling and Appleby, and will take charge of their dynamo-designing department. In fact, the whole of the designing, drawing office, and testing staff will be placed under his control. The firm have secured rights to manufacture both direct and alternating current generators and motors under Mr. Fynn's well-known patents. It will be remembered that he was for years on the staff of Messrs. Brown, Boveri, and Co., Baden, and that on returning to England he became the electrical designer for Messrs. Easton, Anderson, and Goolden, Limited. We wish Mr. Fynn every success in his new work.

Copper.—The copper boom has brought forth a crop of new companies, and amongst the latest we notice the following: The Lloyd Copper Company, Limited, with a capital of £250,000, formed for the purpose of acquiring Lloyd's Burraga Copper Mine, together with all plant at the mine and at the refining works at Lithgow. The Panuco Copper Company, with a capital of £500,000, has been established to acquire, work, and further extend the Panuco Copper Mine situate in the Candela mining jurisdiction, Northern Mexico. The Copper Company of British Columbia, Limited, with a capital of £100,000, has been formed to acquire the copper mines known as the Lancaster, Simcoe, and Toronto Traction, British Columbia. The Elmore Copper Companies have been amalgamated under the title the English Electric Metallurgical Company, with a capital of £700,000, divided into £300,000 6 per cent. cumulative preference and £400,000 ordinary shares. Within the course of the next few weeks the Swedish Copper Mines will be brought on the market, with a capital of £200,000 in ordinary shares of £1 each (170,000 at present being issued). The company is to acquire freehold properties on the Areskutan Mountains, in the county of Jemptland, Sweden, covering an area of about 12,600 English acres.

The Schattner Standard Meter.—We have received from Messrs. Schattner and Co., electrical engineers, Timberhill, Norwich, their list of standard meters for measuring electrical energy supplied to consumers from central stations. The meter in question is designed on the same principle as the Long-Schattner prepayment meter, which we described last autumn. In fact, the meter is simply a deposition meter, with an accurate balance combined, so that the meter readings can be taken without removing the plate, as had to be done with the Edison deposition meter. It consists

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of a lever pivoted at one end, near to which the plate is suspended in a bath of copper sulphate. The long arm of the lever is used like the arm of a steelyard, and is also provided with a sliding weight and also with hooks upon which standard weights can be attached. The voltameter circuit is shunted with a resistance, so that only a small part passes through the solution. The action of the meter is such that the plate decreases in weight, and copper is deposited on the copper containing vessel. On going to the meter to read it, it is then only necessary to adjust the slider of the long arm until an accurate balance is obtained, after which the actual units consumed can be read off at a glance. The makers claim that the meter is exceedingly correct, and that they have proved its commercial practicability by careful trial. They recommend that a thin layer of oil should be poured over the top of the copper solution to prevent evaporation. As regards the accuracy of the meter, outside tests have been made on the 10-ampere size, which prove the scale to be accurate within 2 per cent. at all loads, from one ampere to ten. At 0·15 ampere the reading was correct to within 4 per cent.

Penzance.—Mr. Frank Latham, C.E., surveyor for the borough of Penzance, has prepared an exhaustive scheme for the supply of electricity to the district of Penzance and the construction of a refuse destructor in the borough. He advises the Corporation to obtain an order which will enable them to supply electricity to, firstly, the Esplanade, Morrab-road, Alexandra-road, Chapel-street, Market Jew street, and Alverton-road; and, secondly, the whole borough. The low-tension continuous-current three-wire system, with accumulators, is recommended. He estimates the cost at £21,365, and the annual expenditure for working and maintenance at £3,468, making the cost per light 18s. 7d. per annum. This will work out at less than 2d. per Board of Trade unit, but renewals of incandescent lamps will bring the cost to 3d. The surveyor judges that probably the equivalent of 2,000 16-c.p. lamps would be connected within a reasonable time. The public lighting required for the proposed streets would consume an amount equal to 600 16-c.p. lamps, so that he allows for 1,400 being taken up by private consumers. Current will be supplied by meter, and will be charged for at the rate of 10s. for any amount up to 20 units, and 6d. for each unit over 20 units per quarter. Dealing with the question of a refuse destructor, Mr. Latham points out that the deficiency per annum on the present system of disposing of refuse is about £128. The probable cost of a suitable destructor would be £5 900 and the annual expenditure (including repayment of principal and interest on loan for 20 years) £742. He estimates that £249 would be realised by sale of mortar, etc., and supplying steam to electricity works, leaving a yearly deficiency of £493, or £365 over and above the present system.

Islington.—At the last meeting of the Vestry, the Electric Lighting Committee brought up a report stating that it had considered the proposed extension of the electric lighting mains to the Hornsey Rise and Newington Green districts with a view to the giving of both a public and private supply therein, and in connection therewith the engineer's estimate of the cost, if undertaken, would take a period of over two years to accomplish, and as the extensions would undoubtedly prove advantageous to the public and to the electric lighting undertaking by reason of the demand which exists for the supply of electricity throughout the parish, it is of opinion that these extensions are desirable; that it is also of opinion that the lighting of the thoroughfares in the Highbury New Park district by means of arc lamps, a scheme for which has been held in abeyance pending the carrying out of certain experiments by the electrical engineer, should also be proceeded with in accordance with the engineer's estimate. The committee recommended that upon receipt of the sanction to the borrowing of the necessary funds, the several works referred to in the engineer's estimates should be executed and paid for out of a loan to be raised for that purpose. Mr. Albert Gay, the electrical engineer, reported that he had gone carefully into the probable cost of extending the electric lighting mains to the two districts of Hornsey and Newington Green. Two complete circuits were effected, the first being Hornsey-road, Hornsey-rise, Crouch-hill, Stroud Green-road, Blackstock-road, Gillespie-road, and Drayton-park. That equalled a total length of 7,575 yards. The second scheme included St. Paul's-road, Newington Green-road, Mildmay-road, Mildmay-park, and Balls Pond-road, being a total length of 3,635 yards. In the Hornsey district 105 street arc lamps, he considered, would be sufficient. In the Newington Green scheme 56 lamps will be required. His estimate for the Hornsey scheme was as follows: for all the necessary conduit pipes, cables, roadwork, including labour and relay, with 105 street lamps, provision for low-tension mains, and six transformers for both public and private supply, £34 000. Newington Green scheme: for all the necessary conduits, pipes, cables, labour, etc., including 56 street lamps and providing for low-tension mains and four transformers for both public and private supply, £26,000. His estimate was £7,150 for the erection of 72 arc lamps in the following roads: Highbury-place, Highbury-terrace, Highbury-crescent, Highbury-park, Highbury-quadrant (North and South), Highbury New-park, Highbury-grove, and part of St. Paul's-road, with all the necessary cable, lamp columns, lamps, switches, converters, connections, labour, etc., and conduits in Highbury-crescent, Highbury-terrace, Highbury-quadrant North, and part of Highbury-grove, where they have not yet been laid (the total length of street to be lighted being 6,200 yards). The recommendation of the committee was agreed to. At the meeting to-day the Electric Lighting Committee will submit a report, stating "that the engineer has advised the committee that considerable economy would result if condensing plant was utilised at the electric lighting station, and has estimated that the cost of the necessary appliances complete, including surface condensers capable of condensing 20,000lb. of steam per hour, including air and circulating pumps, accessories and erection, cooling tower, with all accessories complete, steam and exhaust pipes, valves, fittings, connections, hot-well, etc., as well as the alteration to the existing pipes with contingencies, would be £4,000; that the engineer has also estimated that the saving which would be effected would not be less than £800 per annum, or 20 per cent. clear upon the capital expended; that in view of the high price which is being paid for water to supply the boilers, it has also had under consideration the advisability of sinking tubular wells at the station, and is of opinion that such a course is highly desirable, and that a considerable saving would be effected if this was adopted; that the engineer has reported in connection with this suggested scheme as follows: 'It goes without saying that the boring of a well is a somewhat speculative matter, but I think it is worth risking the preliminary £700 for one borehole, in view of the success attendant upon a similar operation at Hornsey-road baths. I therefore recommend that the work be carried out at the following estimated cost: two tubular wells sunk to a depth of 500ft. each, two pumps for same with engine, fixing foundations, steam and other pipes and contingencies—total, £2,750'; and recommending that both schemes be adopted; that the necessary funds be raised by loan, and that the work be commenced as soon as the sanction to the borrowing has been received." Through the powers of compulsory purchase possessed by the Great Northern Railway Company, the committee have completed the purchase of the land and cottage known as 44, Burnard place for the sum of £735. 17s. 9d., including the costs incidental to the acquisition of the property.

PROVISIONAL PATENTS, 1899.

MAY 23.

10699. Improvements in and connected with street lamp-posts, electric light standards, and the like. William Jones, 75, Chancery-lane, London.

10726. Improvements in electrical switches. Bertram Thomas, Cornbrook Telegraph Works, Manchester.

10744. Storage batteries. Edwin Lyman Lobdell, 154, St. Vincent-street, Glasgow. (Complete specification.)

10768. Improvements in electric arc lamps. The British Thomson-Houston Company, Limited, 83 Cannon street, London. (Richard Fleming, United States.) (Complete specification.)

10769. Improvements in means for electrically igniting gas. Frederick William Golby, 36, Chancery-lane, London. (La Société Anonyme "Lux Nova," Belgium.) (Complete specification.)

10791. Improvements in electric lighting apparatus. Andrew Plecher, 53, Chancery lane, London. (Complete specification.)

10815. Improvements in incandescent electric lamps. Charles Ludwig Rudolf Ernest Menges, 45, Southampton-buildings, Chancery lane, London (Date applied for under Patents, etc., Act, 1883, Sec. 103, Oct. 27, 1898, being date of application in France.) (Complete specification.)

10817. Improvements in terminals and binding screws for electric batteries and connections. William Rowland Edwards, 65, Chancery-lane, London.

MAY 24.

10839. Improvements in automatic electric cut-out devices for electric cooking apparatus. Friedrich Wilhelm Schindler, 15, Took's-court, Cursitor-street, London.

10843. Improvements in concentric electrical fittings. Samuel Thomas Robinson, Sloan's Hotel, Fade-street, Dublin.

10860. Improvements in or relating to shunting devices applicable for use on electric cars and the like. Ernst Andreas, 111, Hatton-garden, London.

10861. Improvements in or relating to cooling devices for motors. Angelin Joseph Marius Julien, 111, Hatton-garden, London.

10863. Improvements in electric switches. Bertram Hopkinson, 26, Victoria-street, London.

10867. Improvements in magnetic apparatus for exhibiting and changing letters, signs, advertisements, and the like. Arthur Douglas Douglass, 12, Aseys-row, Essex-road, Islington, London.

10877. An improved method of and arrangement for protecting the anticathode in Rontgen tubes. Carl Heinrich Florenz Müller, 45, Southampton-buildings, Chancery-lane, London.

10892. Improvements in electrical warp stop-motions for looms. William Henry Baker and Frederic Ellsworth Kip, 6, Lord-street, Liverpool. (Complete specification.)

10903. Improvements in telegraphic transmitters and receivers. William Lloyd Wise, 46, Lincoln's-inn-field, London. (Albert Cushing Crehore and George Owen Squier, United States.)

10911. Improvements in primary batteries. Albert Pfannenberg, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

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MAY 25.

10922. An improved relay for magneto bells. James Gregory Whittle, 61, Walton-road, Kirkdale, Liverpool.

10978. Improved telephone switch. Arthur Edwin Lamkin and John George Lemon, 53, Chancery-lane, London.

MAY 26.

11010. A waterproof lampholder for Swan incandescent electric lamps. Hugh Donald Fitzpatrick, 100, Wellington-street, Glasgow. (G. Brandt, Germany.) (Complete specification.)

11012. Improvements in the construction of electrometers. William Peck, Calton Hill Observatory, Edinburgh.

11024. An improved electrical switch and fuse. Henry Charles Gover and Charles Walter Cox, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

11052. Improvements in electrical resistance switches and automatic cut-outs for starting, regulating, and protecting electric motors. Verity's, Limited, and Louis John Steele, 11, Burlington-chambers, New-street, Birmingham.

MAY 27.

11097. Improvements in sockets or holders for incandescent electric lamps. Albert Vandam and Thomas Herbert Marsh, 322, High Holborn, London. (Complete specification.)

11101. Improved methods of utilising high-potential electrical spark-gaps. Benjamin Howarth Thwaite, 29, Great George-street, Westminster, London.

11105. Relay apparatus for closing a subsidiary circuit of an electrical installation when a current in the main circuit has a certain strength or voltage. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske, Aktien Gesellschaft, Germany.) (Complete specification.)

11106. Improvements in synchronised electric clocks. Siemens Bros. and Co., Limited, and Edward Friedrich Hermann Heinrich Lauckert, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

11110. Improvements in electric switches. Alexander Melville Clark, 53, Chancery-lane, London. (The General Incandescent Arc Light Company, United States.) (Complete specification.)

11117. Improvements in quadruplex and multiplex telegraphy and to apparatus for use in connection therewith. Sidney George Brown, 22, Holland-road, Kensington, London.

SPECIFICATIONS PUBLISHED.

1898.

10177. Lamp irons applicable to the suspension of electric fittings. Meiklejohn.

11627. Electric cables. Smith.

12731. Electric telegraphs. Muirhead.

14058. Means for operating electric railways by a combination of alternating and continuous currents. Pollak.

14513. Method of and apparatus for producing electrical spectacular effects. Cox.

14810. Electric couplings. Davy.

14983. Means of making connection with electric cables. Hatton and W. T. Henley's Telegraph Works Company, Limited.

16999. Electric accumulators. Andreas.

19785. Incandescent bodies for incandescent electric lamps and process of manufacturing same. Kellner.

20850. Trolley head of electric tramcars. Towle.

22190. Joint-boxes and switches therefor in connection with concentric systems of electrical conductors. Wilkinson.

1899.

387. Manufacture of iron wall carriers for electric insulators and other objects. Unterberg.

427. Electric igniters for gas-engines. Cotton.

1835. Switches for starting and controlling electric motors. Hirst and Mead.

2780. Cut outs applicable both in the case of fuses and of switches. Manley.

4442. Manufacture of accumulator plates. Majert and Berg.

5551. Devices for starting alternating electric current motors. British Thomson-Houston Company, Limited. (Steinmetz and Berg.)

6061. Process of and apparatus for electrically heating compact or pulverised substances difficult to fuse or infusible. Borchers.

6157. Electric arc lamps. Johnson and Wunderlich.

6478. Electric arc lamps. Hall.

6684. Carbons for electric arc lamps. Bacon.

7277. Apparatus for measuring and recording electric currents. Aron and Aron Electricity Meter, Limited.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1899.	Corresponding week 1898.	Increase or decrease.	Total receipts for half-year. 1899.	1898.
		£	£	£	£	£
Birmingham Tramway Co.	May 27	4 509	4,150	+ 359	82,264	75,406
Blackpool and Fleetwood Tramroad	,, 27	1,435	—	—	6,483	—
Bradford City Trams	Feb. 5	145	—	—	6,733‡	—
Bristol Tramways and Carriage Co.	May 26	3,816	2,653	+1,163	—	—
City and South London Railway	,, 28	912	1,012	- 102	23 270	22 678
Dover Tramways	,, 27	214	147	+ 67	3,260	2,492
Dublin U.T., elec. cars	,, 26	1,357	947†	+ 410	20,173	16,130†
Dublin S.D. Electric Tramways	,, 26	1,056	574	+ 481	14,693	9,443
Halifax Corporation Tramways	Mar. 29	312	—	—	10,712*	—
Liverpool Overhead Railway	May 28	1,825	1,412	+ 413	30,139	30,712
South Staffordshire Tramways	,, 26	948	601	+ 347	13,264	12,445

* Since June 30, 1898. † Including horse cars. ‡ Since July, 1898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	23-24
Bournemouth and Poole Electric Supply, Limited, Ord.	10	13½-13⅝
—— 4½ per cent. Cum. Pref.	10	10½-11½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	18½-19½
—— 6 per cent. Cm. Pf., 30,001-40,000 (all paid)	10	13½-14½
—— 6 per cent. Cm. Pf., 40,001-60,000	10	13½-14
—— 5 per cent. Perpetual Debenture Stock	100	127-130
Brush Electrical Engineering Limited, Ordinary	2	1⅞-2⅛
—— Non. Cum., 6 per cent. Pref.	1	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	103-106
Callender's Cable Company, Debentures	100	114-117
—— Ordinary	5	13-14
Central London Railway, Ordinary	10	10⅞-11⅛
——	8	8⅞-9⅛
—— Pref. Half-Shares	3	3⅛-3⅜
—— ,, ,,	5	5⅛-5⅜
Charing Cross and Strand	5	11-12
—— 4½ per cent. Cum. Pref.	5	5⅞-6⅛
Chelsea Electricity Company	5	8-9
—— 4½ per cent. Debentures	100	114-116
City of London, Ordinary	10	16½-17½
—— 6 per cent. Cumulative Pref.	10	15-16
—— 5 per cent. Debenture Stock	100	125-130
City and South London Railway, Consolidated Ordinary	100	68-70
—— Ordinary	3	4⅛-5⅛
—— 4 per cent. Debenture Stock	100	132 134
—— 5 per cent. Pref. Shares	10	14½-15½
—— ,, ,, ,, '96	10	14-15
County of London and Brush Prov. Elec. Light Co., Ord.	10	11-12
—— 6 per cent. Cum. Pref.	10	14-15
—— 4½ per cent. Prov. Certs.	—	54-56
Crompton and Co.	3	3½-4½
—— 5 per cent. Debentures	—	98-101
Crystal Palace District, Ordinary 5 per cent. Stock	100	132 137
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2-2⅛
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	96-98
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5⅛-5⅜
Electric Construction, Limited	2	2⅛-2⅜
—— 7 per cent. Cumulative Pref.	2	3-3⅛
—— 4 per cent. Perp. 1st Mort. Deb.	100	103-106
W. T. Henley's Telegraph Works, Ordinary	10	25-26
—— 7 per cent. Preference	10	18-20
—— 4½ per cent. Debentures	100	112-115
House-to-House Company, Ordinary	5	8-9
—— 7 per cent. Preference	5	9-10
Imperial Tramways, Limited	6	24½-25½
India Rubber, Gutta Percha, and Telegraph Works	10	21-22
—— 4 per cent. Debentures	100	101-105
Kensington and Knightsbridge Ordinary	5	12-13
London Electric Supply, Ordinary	3	3⅞-4⅛
—— 6 per cent. Pref.	5	6⅛-7
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	106-108
Metropolitan Electric Supply, Limited, Ord., No. 1-62,500	10	16½-17½
—— ,, ,, No. 62,501-85,000	10	15½-16½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-122
National Telephone, Ordinary	5	4½-5
—— 6 per cent. Cum. First Pref.	10	11-12
—— 6 per cent. Cum. Second Pref.	10	11-12
—— 5 per cent. Non. Cum. Third Pref.	5	4⅞-5⅛
—— 5½ per cent. Deb. Stock, Red.	100	99-102
Notting Hill Electric Lighting Company, Limited	10	16-17
Oriental, Limited, 1879	1	1½-1⅝ xd
—— £5 Shares	5	7⅛-8 xd
—— £4½ Shares, New	4½	6½-7 xd
Oriental Telephone and Electric Company	1	¾-1
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6¾-7½
Royal Electrical Company of Montreal	1⅛	165-185
—— 4½ per cent. First Shares Mortgage Debentures	100	105-107
South London Electric Supply, Ordinary	3	4⅛-4⅜
St. James's and Pall Mall, Limited, Ordinary	5	17-18
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	13	37-41
—— 5 per cent. Bonds	100	105-108
Waterloo and City Railway, Ordinary	100	105-108
Westminster Electric Supply, Ordinary	5	14½-15½

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NOTES.

Calcutta.—We are informed that Messrs. F. and C. Osler, of Calcutta, have recently been appointed electricians to his Excellency the Viceroy of India.

Conversazione.—We would remind our readers of the conversazione of the Institution of Electrical Engineers, which is to be held on Thursday next at the Natural History Museum, South Kensington.

Cable Extension.—The Eastern Extension, Australasia, and China Telegraph Company notify that their Manila-Iloilo cable has been extended to the town of Cebu, thus establishing direct cable communication between Manila, Iloilo, and Cebu.

Faraday House.—Mr. James Swinburne, vice-president of the Institution of Electrical Engineers, is now giving a course of lectures on "Dynamo and Transformer Construction" to the students of the Electrical Standardising, Testing, and Training Institution at Faraday House.

Physical Society.—The next meeting of this society will be held to-day (Friday), at 5 p.m., at the rooms of the Chemical Society, Burlington House, when two papers will be read. The first is "On the Distribution of Magnetic Induction in a Long Iron Bar," by Mr. C. G. Lamb; and the second "On the Absolute Value of the Freezing Point," by Mr. J. Rose-Innes.

At Last.—A manufacturing profit is at last to be distributed to the shareholders of the General Electric Company of America. It seems that at a meeting of the directors held on May 22 a dividend of 1½ per cent. was declared upon the reorganised common stock. The directors expect to declare quarterly dividends at this rate hereafter. The shareholders will, we expect, quite fall in with this latter proposal, and will also hope for larger distribution.

Marseilles Electric Tramways.—Our French contemporary *L'Etincelle Electrique* states that the public who have awaited with legitimate impatience the inauguration for general service of the electric tramways of Saint-Marcel and Mazargues will very soon have their wishes gratified. Some preliminary trials are about to be made, and our contemporary says that all must hope that nothing will retard the tramways being brought into general utility.

Motor Vehicle Trials.—The Liverpool Self-Propelled Traffic Association has sent letters to each of the London local authorities relative to the trials of motor vehicles to be held in Liverpool from July 31 to Aug. 2, enclosing particulars of competition and asking to be informed whether any of the committees of the authority wish to take advantage of the opportunity of observing the different types of vehicles and the uses to which they can be put.

Electric Traction at Dieppe.—We gather from *L'Etincelle Electrique* that the Municipal Council of Dieppe has unanimously voted in favour of the project undertaken by M. Chalafour for the construction of tramways on which electric traction is to be used, and for the laying-out of an electric lighting system. The cars to be employed on the tramway will be of the same kind as those used at Rouen and at Havre, and the employés are to be chosen by preference from Dieppe or from the arrondissement.

Birthday Honours.—Amongst the names appearing in the Queen's birthday honours list that of Mr. W. H. Preece amongst the K.C.B.'s will be welcomed by all electrical engineers. The honour is well deserved, and comes as a grateful recognition after Mr. Preece's retirement from the arduous post of electrician and engineer-in-chief to the Post Office. Mr. G. H. Murray, the secretary of the Post Office, has also been raised to K.C.B., and Prof. Michael Foster, this year's president of the British Association, shares the promotion as well.

Tidal Power.—It is stated that a London capitalist has offered to construct at Southend a huge sea-wall at a cost of £600,000. In return he asks permission to use the tidal force for working a generating plant with the idea of supplying London with electricity. He guarantees there shall never be less than 3ft. 6in. of water on the beach; in fact, it will be a huge marine lake. We find no figures as to the power to be obtained, or of the type of water-engine to be used to generate this power with variable head.

Old Students' Dinner.—The second annual dinner of the Association of Old Students of the Central Technical College will be held on Thursday, July 6, at Frascati's Restaurant, Oxford-street. Any old students wishing to be present can obtain full particulars by applying to Mr. F. S. Miller, at the College, South Kensington. The dinners afford a good opportunity for the maintenance of corporate feeling between old students of the Central Technical College, and we trust that a large number will take part in the dinner this year.

Death from Lightning.—In the current number of the *Lancet* we notice an interesting contribution by Mr. Harold Whichello, L.R.C.P., respecting a fatal accident in which two brothers were killed by lightning. The gentlemen in question were in a dog-cart, and were killed instantaneously without any appreciable damage being done to the cart itself. In the case of the younger, there were a number of external signs of injury on the body, but the elder brother presented no such appearance. The curious fact is that there was no indication of how the charge proceeded to the ground, and also that the horse was quite unhurt.

The Electrophone.—The Electrophone Company, Limited, has made proposals for our Sunday recreation which we regret to say will be disappointed. It seems that the company are connecting the principal London hospitals with certain churches on Hospital Sunday, June 11. As members of the Press are not likely to be detained in all the hospitals that day, a special *salon* at Gerrard-street, Shaftesbury-avenue, will be placed at their disposal. In this representatives of the Press will be able to hear sermons to their hearts' content, both at 11 a.m. and 6.30 p.m. We trust that the *salon* in question is of ample dimensions.

Light Railways.—Applications for orders to authorise the construction of light railways under this Act are made half-yearly to the Light Railway Commissioners in the months of November and May. We are informed by the Board of Trade that in May of this year 40 applications for orders were made and in the preceding November 54, a total of 94 for the year. In the previous years the numbers were 65 and 56 respectively. For each successive year since the Act came into effect the estimated cost of constructing the lines applied for, exclusive of the capital expenditure upon equipment, promotion, etc., has amounted to the sums of £2,903,072, £4,652,904, and £6,722,963 respectively.

Volta Centenary.—The International Congress of Telegraphists at Cannes has commenced its meetings, and seems to be well attended. Most European nations are represented, France and Germany having sent fully 40 delegates each. Great Britain is only represented by five, the Superintendent of Telegraphs at Cardiff being one, and the Superintendent of the Foreign Gallery, London, another, while the central telegraph offices of London, Edinburgh, and Glasgow have each sent one. The chief function which has so far taken place has been the unveiling of the

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monumental crown at the statue of Volta, a ceremony which was performed by M. Baudot, the inventor of the type-printing telegraph of that name, which is now being largely adopted on the Continent, and which is gradually finding its way into England. The International Congress of Telegraphists was inaugurated by a paper on the utility of a knowledge of foreign languages to telegraphists.

Amiens Tramway.—The electric tramways in Amiens have recently been used for traffic. We gather from our contemporary *L'Electricien* that the work in connection with them has been executed by the French Thomson-Houston Company. From the illustrations given a good idea of the arrangements of the plant in the engine-room, and also of the overhead construction, may be obtained. The central-pole type of suspension is used for the trolley wires in all the principal streets where sufficient width is secured. The whole length of the line now equipped is about 12 miles. Underground feeders are used to connect the power station with the line. We are rather surprised to see that in this installation the dynamos are belt-driven from two slow-speed Corliss engines run at 72 revolutions per minute. The two dynamos are of the six-pole Thomson-Houston type, each capable of giving 150 kw. at 540 volts. The service seems to be highly appreciated by the inhabitants.

Electric Horse Libel Case.—The outcome of the case, Inger *v.* the *Star* Newspaper Company, was a verdict for the plaintiff with two farthings as damages. As regards costs Justice Bruce reviewed the decision of the jury, in which they gave the plaintiff, on two issues for libel, damages to the amount of one farthing on each issue. He thought that the finding of the jury was to the effect that the cause of action was not made out. The jury had, in effect, found that the plaintiff had an evil reputation, and that he was mixed up with so many transactions that no good cause existed for bringing the action. In these circumstances, seeing that the jury had found only a farthing damages, he thought he was right in exercising his discretion by depriving the plaintiff of his costs. The same principle applied to the second issue, in which the plaintiff complained of an inadequate report, and on both issues he therefore deprived the plaintiff of costs. From this it will be seen that Mr. Inger has found his libel suit quite as profitable as the electric horses.

Greater Britain Exhibition.—An instructive object lesson demonstrating one great advantage of electricity *v.* gas, can be obtained by watching the lighting-up of the beautifully arranged illuminations at Earl's Court. When the appointed time comes, the electric lights flash out in a second in answer to one touch at the switchboard. But there are endless rows of gas lamps around the Imperial Court, for instance. It is half an hour's painful work for several men to start these. One can see them trudge about from lamp to lamp long after the electric light has been in full swing. The exhibition this year contains Colonial exhibits both dead and alive, the latter assisting in grand warlike spectacle in the Empress Theatre. Electricity contributes its quota to the entertainment in the shape of funny and fantastical pictures produced by the biograph. The electrophone seems still to hold its own, as the establishment has this year been improved and enlarged. The ubiquitous boxes of the phonograph and the kinetoscope also continue to collect coppers from the crowds attracted by the present fine weather.

From Steam to Electricity.—The conversion of the steam railroad track of the Buffalo and Lockport branch of the Erie Railroad, which runs from Tonavanda to Lockport, New York, presents some interesting features. The new equipment, which was put into operation comparatively recently, consists of two 36-ton electric locomotives for freight service and 10 electric motorcars for passenger service. These cars are run at intervals of half an hour, instead of at such long intervals as was usual with the employment of steam, so that five cars at this rate are required to operate the 25 miles of railway between Buffalo and Lockport. In the first trip the electric cars attained a speed of 50 miles an hour, including stops. It is thought that if in its operation it successfully attains the results anticipated, it will conclusively prove that electricity can be economically applied to the operation of branches and feeders of steam trunk-line systems. It is also considered, however, that it would be too much to expect an immediate conversion of these latter main lines from steam operation to operation by electricity. But it is thought that with electric locomotives and motorcars profitably carrying on both freight and passenger traffic on their feeders, the entering wedge will be driven still further, and the ultimate result will be so much nearer being accomplished.

Automobile Club Show.—This show will be held from June 17 to 24, and will be preceded by trials of vehicles. The judges and general public are requested to assemble at the times and places as below on the dates of the trials. Friday, June 9, meet at the Star and Garter Hotel, Richmond, at 11 a.m. for the hill-climbing trials; Saturday, June 10, meet in London and South-Western Railway Company's goods yard, adjoining Richmond Station, at 11 a.m., for the long-distance electric trials; Monday, June 12, meet at the Red Lion Hotel, Southall, about five minutes' walk from the Great Western Railway Station, at 10 a.m. for the long-distance petrol trials; Tuesday, June 13, meet at the Chequers Hotel, High-street, Uxbridge, about 10 minutes' walk from the Great Western Railway Station, at 11 a.m. for long-distance heavy trials; Thursday, June 15, speed trial at 2 p.m. The place for this will be fixed later. The following have been selected as judges: Mr. W. Worby Beaumont, M.I.C.E., M.I.M.E., Prof. C. Vernon Boys, F.R.S., Mr. Dugald Clerk, A.M.I.C.E., Mr. Bryan Donkin, M.I.C.E., M.I.M.E., Prof. Hele-Shaw, F.R.S., LL.D., M.I.C.E., M.I.M.E., Major Holden, R.A., F.R.S., Sir W. H. Preece, K.C.B., F.R.S., Pres.I.C.E., Mr. Beverton Redwood, F.R.S.E., A.M.I.C.E., Sir David Salomons, Bart., J.P., A.M.I.C.E., and Mr. James Swinburne, M.I.C.E., M.I.M.E.

Induction Motor Slip.—Dr. Heof in a recent paper in the *Zeitschrift für Elektrotechnik* shows that the usual methods of determining the slip in induction motors are crude, unreliable, and inaccurate. He describes what he considers to be a very much better one which will give accurate results and requires only very simple apparatus. It consists in a determination of the number of current impulses per minute in the inducing circuit, this number of impulses being equal to the difference of the primary and the secondary pole changes. It may even be used for determining the slip when the motor is short-circuited. He measures the current pulsations by means of a sort of transformer made of a small coil which is surrounded by one turn of the mains, a telephone being in circuit with the secondary coil. Experience has shown that the method is a very simple and effective one. The coil which he uses has an outside diameter of 6cm. to 7cm., and contains between 300 and 400 turns of 0·2mm. copper wire. The telephone shows the maxima and minima of the current quite plainly, and with the ear it is easy to calculate 250 to 300 and even up to 500 pulsations per minute. With 5,000 pole-changes he can determine a slippage of 10 per cent quite accurately. Instead of the telephone, any other sensitive current-measuring instrument may be used. Even

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the smallest slip occurring in practice can be determined accurately. We are indebted to Mr. Carl Hering's digest for the above abstract.

Instruction by Correspondence.—The work done within a single year by the Electrical Engineer Institute of Correspondence Instruction, under the management of its president, Mr. Joseph Wetzler, has, says the *Electrical World*, been phenomenally successful. During the year Mr. Wetzler has rallied to his service some of the foremost electrical engineers in the States as authors of the institute instruction papers, and the endorsement of the institute and its methods has been universal throughout the profession. At the electrical exhibition this year the booth of the institute has been made of special interest, as usual, by a live exhibit, the chief feature of which is a liquid forge in full operation. Once the spectator's attention is engaged by this, he finds himself unconsciously taking in a popular lecture on electricity, and before he knows "where he is at" he has become a student in embryo ready for his first instruction paper. If there were more stalls like this in the exhibition, it would be hard to overestimate the educational value of the show as a whole. Besides distributing its regular literature freely, the institute gives away a neat little *brochure* of electrical information, so meaty and useful, it might well be called an electrical pocket-book in miniature. The public is evidently keen after data on electrical matters. It yearns after the ability to size up volts and amperes, and desires to substitute sound knowledge for the irresponsible yawpings of the sensational Press. In other words, it craves to be taught.

Magnetic Decoherence.—Prof. R. Tommasina, of the physical laboratory of the Geneva University, contributes a note in the *Moniteur Industriel* on experiments made by him recently on the breaking up of the adhesion in a coherer by means of a magnet. He observed that the conductivity disappeared immediately a magnetic pole was brought under a coherer, the whole or part of the filings of which were forming a compact mass at the time. The conductive adherence was only reproduced after the magnet had been withdrawn, and after a new electric wave had begun to operate. Naturally he endeavoured to utilise this observation in order to restore the sensibility of the coherer automatically without the help of the agitator. He obtained this result by fixing one pole of an electromagnet a few millimetres below the filings, the coherer being placed in a horizontal position between the two electrodes. The circuit was formed by an accumulator with a resistance and the relay, which served to open and close the circuit of the electromagnets. There was also used two accumulators and a telephonic receiver, conveniently shunted. After being once regulated, he says, the transmission of the signals was perfect; steel, iron, cobalt, and nickel filings were tried for the granulated matter in the coherer. The movement of the filings could be followed with the naked eye, and the action was of remarkable regularity, resembling that of a pulse. Prof. Tommasina adds that shaking of the floor, or even of the coherer itself, did not in the least affect the working of the apparatus.

Osmotic Theory of the Galvanic Cell.—The following is an abstract from the *Journal* of the Chemical Society of a paper by Messrs. Walther Nernst and Emil Bose which appeared in the *Zeitschrift fur Elektrochemie*. According to the osmotic theory of the galvanic cell, the potential difference between a metal and a solution is $E = R\,T/n \log C/c$. The electrolytic solution tension of the metal, C, and the number of electric charges with which it passes into the ionic state, n, depend on the nature of the metal alone. By changing the concentration, c, of the metallic ions in the solution in any way, the potential difference, E, must also be changed. To test this, a mercury electrode covered with mercurous sulphate and a slowly-dropping mercury electrode, are placed in glass tubes containing normal sulphuric acid, and connected by a long, narrow, horizontal tube. The tube containing the dropping electrode contains, in addition, two platinum electrodes, by means of which any traces of metal may be removed from the solution in contact with the dropping mercury by electrolysis. The potential difference between the two mercury electrodes must be measured by an electrometer, the dropping electrode being polarised excessively readily. The highest potential difference observed was 0·443 volt. With silver electrodes in 0·01 normal hydrochloric acid, the acid surrounding one of them being saturated with silver chloride, a maximum potential difference of 0·423 volt was obtained. The results are thus in agreement with the theory.

A Large Gas-Engine.—The Westinghouse Machine Company, of Pittsburgh, Pa., have lately devoted much attention to the production of large gas-engines. The largest engine constructed by them is of 650 b.h.p., and is direct connected to an electric generator. It has been in operation in the works of the Westinghouse Electric and Manufacturing Company, at East Pittsburgh, for over a year. This engine has a speed of 150 revolutions per minute, and is of the vertical three-cylinder type, with two overhanging flywheels. It is direct connected to an eight-pole, 400-kw., 550-volt generator, capable of carrying 30 per cent. continuous overload. In general outline and design this engine embodies the main mechanical features of the Westinghouse steam-engine. The upright self-contained construction and the self-lubricating features have both been followed. The cylinders are so arranged that with each revolution of the engine shaft an explosion of gas occurs; an electric sparking device, or igniter, causes the ignition of the gas. The working stroke of the piston alternates, so that an impulse is received with each revolution, permitting a very close regulation of speed. A sensitive governor regulates the amount of the explosive mixture admitted with each stroke, and thus closely controls the force of the explosion. The fluctuations from overload to no load are not accompanied by the reduction in the number of impulses, but by the admission to the cylinder of a smaller charge of the explosive mixture. The firm has now secured several orders for these large engines for direct coupling to dynamos.

Block Signalling.—In the last issue of the *Wisconsin Journal* there is a very readable article by Mr. J. P. Coleman on block signalling. The author treats the matter from a rather historical point, and gives a number of illustrations of early methods of block signalling, several of which depended on their action on the length of time which the advancing train had been past a certain point. Mr. Coleman, after describing such antiquated systems, goes on to explain the block systems at present used on one of the best American railways. In conclusion, he points out, much on the same lines as we did in our leading article some months ago, that the present method of block signalling is wholly dependent for its efficacy on the observation of the engine driver. The author describes one or two methods which have been tried for stopping the engine in the event of its running beyond an adverse signal, such, for instance, as the opening of the air-brake vacuum, or even the shutting off of the steam. Other systems and modifications have been tried to close the engine throttle, or to pull the whistle cord,

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but the author considers that all such attempts to perform the engineer's duty are not popular, even if possible. He predicts that the present generation of engine drivers will never tolerate these seeming reflections on their ability to handle their engines. Mr. Coleman does not, however, consider the great advantage which electricity gives to the signalman on the block system. With an electric locomotive the whole section of a block can be rendered dead from a signal-box, so that even if the driver does proceed on to a dangerous section, he is warned by the fact that the current is cut off.

Cardiff Contracts.—The persistent interference by the so-called labour party with the freedom of municipalities as to whom tenders should be given when a question involving a trade union rate of wages is concerned, was again exemplified last week—this time at Cardiff. It is not very long since that at Islington the Vestry inserted clauses with respect to the trade union rate of wages and penalties for default, both of which had to be rescinded before contractors would consent to send in tenders at all. It now appears that at a meeting of the Cardiff Electrical Committee held last week, a letter was received from the Cardiff branch of the Ironfounders' Society asking the committee to give them the name of the firm who received the last order for iron posts. From a report in one of the local papers, it seems that Councillor Fox took exception to the *ex parte* statements of firms that they were paying the union rate of wages being accepted without enquiry, and he quoted a case where a firm received contracts on their asserting that they paid a fair trade wage and were eventually found to be paying a sweating rate. He moved that the tender of the firm he mentioned should not be accepted until they had before them a list of their rate of wages. In reply to Councillor Lewis Morgan, Councillor Fox maintained that the onus of proof rested upon the tendering firm. In further explanation, Councillor Fox said the rate of wages was that accepted by the trades unionists in the particular district, and not a rate in operation in any other district. Councillor Fox agreed to move in Council that in future the rate of wages paid by the firm be stated in the contract. The contract has not been accepted by the Council, and Councillor Fox will move that it be referred back until the information is forthcoming.

Telephone Call Recorder.—In the light of the proposal that subscribers to the Government system of telephones will pay a small annual fee, and then a fixed charge per message, it is interesting to learn that 70 per cent. of the subscribers to the telephone in New York pay on a similar basis. In the *Electrical Review* of New York there appears a description of an apparatus designed by Mr. H. T. Richards, of New York, for recording the number of complete messages which any subscriber sends. In certain parts of the day the switch-room operators are too busy to keep records of messages, and the need for a simple recorder is therefore apparent. Mr. Richards provides two instruments for each line, one being placed at the subscriber's end and one at the exchange. When a subscriber is desirous of making a call, he calls up central in the usual way. If the number required is not busy, the central operator, before making the connection (automatically by her plug or by a push button), projects a current, grounded at the central office, through the calling subscriber's register, at central, electrically moving the register one number ahead, and thence through one of the wires composing the pair of the subscriber's circuit out to the subscriber's telephone. In the subscriber's telephone is a circuit breaker, which is normally open, but which is closed when the receiver is removed from the hook for purposes of conversation. While the receiver is off its support, the change of the position of this support puts into operative condition the grounded circuit from central and locks the registering mechanism to the receiver hook or support, so that when the subscriber, on finishing his conversation, returns his receiver to its hook, the downward movement of the receiver hook serves to operate the subscriber's register. The registering circuit referred to, after locking the subscriber's mechanism, is grounded at the subscriber's station, thereby completing the circuit.

The Electric Furnace.—At a meeting of the Vesey Club of Birmingham recently, Sir William C. Roberts-Austen, K.C.B., D.C.L., F.R.S., etc., assayer to her Majesty's Mint, delivered his presidential address, and chose as his subject the uses of the electric furnace. The meeting was held in the metallurgical theatre of the Municipal Technical School. The president briefly sketched the progress that has been made from the time of Faraday in utilising the intense heat of the electric arc, and described the furnace designed by the French scientist Moissan. Sir William having explained the commercial use of the electric furnace at the Niagara Falls Works for the electrolytic reduction of alumina in order to show that the furnace is not merely a scientific toy, but a means of utilising the illimitable forces of nature, the demonstration was commenced. In a corner of the gallery had been installed an electric furnace, supplied by arrangements specially designed for the occasion. Manipulated by Dr. Stansfield, the furnace was made to fuse and volatilise in succession copper, silver, chromium, and cast iron. As the carbon poles were drawn apart, and metals began to fuse and then to volatilise, the screen displayed colours with which the most gorgeous sunset could not vie, from the deepest violet and the most intense metallic blue to the most vivid orange and crimson, with almost every imaginable combination. On coming to the experiment with cast iron, Sir William explained that this was the first stage in the artificial production of genuine diamonds. Metals in the electric furnace became associated with a certain amount of carbon from the carbon poles, and consequently are reduced in the form of carbides. Cast iron so treated, if suddenly chilled by being dropped into melted lead, receives an enormous compression from the contraction of the external coat, and the carbon is released in the form of very minute diamonds. These diamonds, Sir William said, had no commercial value, but they were of immense geological interest.

National Electric Light Association. — The twenty-second convention of the above American association was held in New York at the end of May. The president this year is Mr. A. M. Young, and in his address he referred to the electric industries of that city in the following words: "In opening the twenty-second annual convention of your association, I take great pleasure in welcoming you to the city of New York. I shall not attempt to enlarge on the beauties, advantages, and wonders of this great city, because you all know it stands first among the cities of America, and in many ways is the first city of the world. In electrical progress it has no equal. Within its limits are located 35 electric light stations, which furnish more than 1,000,000 incandescent lights and more than 30,000 arc lights, and at least 30,000 h.p. in electric motors. The capital invested for carrying on this great business is nearly £40,000,000. It may interest you to know that in 1897, in the city of Brooklyn alone, there were 10 street railway companies, having 678 miles of track and a capitalisation of £11,000,000. In that year these railway companies carried 223,180,504 people." As an example of the rapid growth of the electric lighting business, Mr. Young stated that at the semi-annual convention of the association, held in New

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York in August, 1895, the question of large and small engines and dynamos was discussed, and the late R. T. McDonald, of Fort Wayne, stated his experience at Peru, Ind. They were operating a large plant—something like 165 arc lights—with two large engines and two large boilers. After running them a short time, it was found no money could be made operating in this way. Small engines were substituted, after which the company earned good dividends. In some of the large cities at the present time are being erected 6,000-h.p. units of engines and dynamos, and in most of the electric stations throughout the country large engines and direct-connected dynamos are the order of the day, and only by their use can the best economies be obtained.

The Telephone Question.—On Friday last a deputation from the National Chamber of Trade, representing a number of associations throughout the country, who desired to support the Government in their efforts to encourage municipal corporations to compete with the National Telephone Company, waited on Mr. Hanbury at the Treasury. Sir J. T. Woodhouse, in introducing the deputation, said the deputation would not have asked for an interview had it not been for the deputation from Liverpool which recently waited upon Mr. Hanbury. Those gentlemen represented the richer portions of the community, whereas the deputation from the National Chamber of Trade represented the retail trade. Mr. Hanbury said he was glad to have received so important a deputation, which represented more than any body which had yet waited upon him the desire to popularise the telephone system. Everyone admitted that the present state of things could not be permitted to exist. He had vainly endeavoured to get from those who cried aloud for nationalisation any advantages that would accrue from the exchanges being nationalised. They had not shown that there were any such advantages, but, on the other hand, their action would delay the passing of the Bill. The Government wanted to throw the service open, and so strongly did he feel on the subject, that when the Bill was read a second time they would be prepared to carry its proposals very much beyond the county boroughs, and practically to extend them to all urban sanitary districts. Under the present system, the telephone service was limited entirely to the richer classes. The deputation, as representing the taxpayers of the country, put the whole story into a nutshell. They wanted the popularisation of the telephone as against the monopoly of the telephone. He was very much obliged to the deputation for the assistance they had given him with regard to the Bill, and they might depend upon him to do his very best to push this Bill forward, and so render what he thought would be a service to the great bulk of the tradesmen of the country.

A Multiple Energiser Momentum Engine.—The technical (?) editor of the *New York Herald* has discovered something at last. Philadelphia is the home of the multiple energiser momentum engine, which, to quote our contemporary, "has for its purpose the economising of fuel by the ingenious utilisation of Nature's own power—the power which she has used for ages in the spinning of the globe upon its axis. This wondrous engine has been building, piece by piece, for a year, from plans that cost 10 years of incessant toil, privation, and patience, to say nothing of an expenditure of £18,000. The machine in question has for its dominant purpose the saving and utilisation of momentum as power, the successful development of this heretofore lost force being brought into play by four driving wheels, which revolve independently on a shaft, just as a wagon wheel turns on its axle. Behind each wheel is a small steam engine, and when one wheel attains a given speed of 190 revolutions a minute the engine back of it ceases to use steam, and the wheel is ingeniously caught by a powerful clutch and made to whirl the shaft and its load. The 'working wheel' drops its burden at the end of half a second, and the little 5-h.p. engine in its rear has a second and a half in which to impart to the wheel, which is running unrestrainedly on the shaft, sufficient momentum to enable it to take up its work again, after each one of the other wheels has gone through the same process. It will be seen by this that all the diminutive steam-engine is called upon to do is to whirl the flywheel it faces to a speed of 190 revolutions, rest half a second while the wheel takes hold to allow the momentum in the rim of the wheel to keep the machinery flying, and then get down to work again the instant the automatic clutch releases the flywheel." The beauty of the apparatus is only dispelled by the fact that the editor has not explained how the power is derived from the spinning of the earth. We would suggest that the remuneration paid by the proprietors of the *New York Herald* for the article in question should be used by the technical editor for a course of lectures in elementary mechanics.

Electrical Radiations.—We notice in the April number of the *Journal* of the Western Society of Engineers, which is published at Chicago, a most interesting paper on electrical radiations by Mr. Arthur V. Abbott, C.E. Although the author does not advance any striking new theories or facts, his historical description of the work of various scientists on electrical radiations is clearly put, and will be of great service in young engineers. Thus, speaking of Hertzian waves, he discusses the relation between the dimensions of the condensers used in producing the discharges from which these waves are set up, and explains that, in order to bring the wave-length down to that of light, it would be necessary to have spheres the size of the ultimate atom to charge and discharge. In his table of wave-lengths the order is arranged with the longest length of wave at the top, and we should have liked to see in the article some explanation as to how the author arrived at the upper figures. For instance, he gives the wave-length of the magnetic waves from the sun at $1\frac{1}{4}$ million miles; in other words, a complete vibration extends over $6\frac{1}{2}$ seconds. Again, he estimates the wave-length of a flash of lightning at 11,000 miles, which gives 17 vibrations per second. These figures we do not remember having before seen, and we do not see how they have been determined. Continuing down the list, the author gives the wave-length produced by the discharge of a pint Leyden jar as 54ft., while a large oscillator produces a wave 1ft. long. The shortest electrical wave that has been given up to the present is said by the author to be one of $2\frac{1}{2}$in. As the wave-length of red light is roughly $\frac{3}{100000}$in., there is a great gap between these two. Towards the end of his paper, Mr. Abbott considers the efficiency of wireless telegraphy by comparing the energy required to produce the electrical radiations at the sending station with the amount of energy received at the receiving station. The figure works out at an efficiency of $\frac{1}{100000000}$, or 1 per cent. The author points out that while this low efficiency is abhorrent to the commercial instinct of the engineer, one cannot but be amazed at the delicacy of the apparatus which is able to detect such minute quantities of energy as are received. On the question of the scope of wireless telegraphy, he considers that unless vast improvements are made in the efficiency of the oscillator, and some way found of concentrating the energy along a predetermined path, wireless telegraphy will only be of value in cases where a connecting wire is impracticable.

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INSTITUTION OF CIVIL ENGINEERS.

SECOND CONFERENCE.

The second conference of the Institution of Civil Engineers was commenced on Wednesday, resumed on Thursday, and is to be concluded to-day (Friday). The proceedings began with an address by the president, Sir William Henry Preece, K.C.B., F.R.S., in the theatre of the institution, and other accommodation for the various sectional meetings was provided at the Institution of Mechanical Engineers, the Surveyors' Institution, and at the Guildhall, Westminster.

CONGRATULATING THE PRESIDENT.

Sir DOUGLAS FOX said that before they had the pleasure of listening to the remarks of the president he felt sure all of them would realise that it would be very proper and very pleasant for them to convey to him their hearty appreciation of the honour which her Majesty had thought right to confer upon him. They realised most fully that the high honour had been earned by him by a lifelong service in connection with the Government. They all appreciated what he had done in connection with the Post Office and other Government departments, but at the same time they could not but appropriate to themselves some of the pleasure that the honour had been conferred at a time when he represented them as their president. Under these circumstances he would ask them by acclamation, and even without the formality of a seconder, to convey to their president, Sir William Henry Preece, K.C.B., their hearty appreciation of the honour which the Queen had thought right to bestow upon him.

The suggestion having been cordially responded to,

The PRESIDENT, in acknowledging the compliment, remarked that that unexpected interruption to the punctuality of their proceedings had taken him a little by surprise. As they said in the railway world, everyone was proud of having a head-light and a tail-lamp. Their Queen had been kind enough to bestow these two accessories upon him. His impression was that it was likely to be a very serious taxation. The first effect had certainly been a duplication of the number of applications to support hospitals, charities, and churches. He would regret that if it were not accompanied by something else. They all knew that it was the hope of reward that sweetened labour, and in the service in which he had spent by far the greater portion of his active life a reward of this kind was the only one that an industrious worker could get. He found that Republicans were just as bad in this respect as elsewhere. If they went to France, every man who had made his mark was emblazoned with a ribbon, and if they went on the other side of the Atlantic he was not quite sure that they did not find a small kind of love of titles and conceit in the possession of them. However, whether Republican or Monarchical, it was something that one might feel some pride in having one's work sanctioned with the seal of the approval of one's sovereign. However gratifying that might be, it was not to be compared with the pleasure—the absolute and unqualified pleasure—which one felt when a mark of this kind was endorsed by the approbation of colleagues and friends.

Opening Address of the President, Sir W. H. Preece, K.C.B., F.R.S.

We have gathered together from all parts of the kingdom to hold our second metropolitan engineering conference, and we welcome here many who temporarily at home pursue their ordinary work in distant parts of the Empire or in foreign countries. We represent every department of engineering practice, and we are here assembled to discuss questions of great pith and moment affecting the applications of the fundamental principle of energy to further the interests, and promote the comfort, health, and happiness of mankind. Engineering does not run in one groove, nor are its votaries Chauvinistic. We endeavour to benefit every race, and we welcome in our midst every nationality. We embrace in our sphere of operations the whole world. We desire to make our home in Great George-street the Mecca of engineering, and in furtherance of this idea I am bold enough to suggest that at the next conference the council should take measures to secure the presence of some of our members, delegated specially to represent engineering in our Empire beyond the seas.

This conference is not international, in the sense of that held at Chicago in 1894, or of that which may be held next year in Paris; but it may well be imperial. In whatever quarter of the globe we find ourselves, membership of this institution has become a password; and the invariable support accorded to the institution by its members in India and the Colonies, suggests the desirability of uniting them in a definite and formal manner with our proceedings on such occasions as this.

Conferences facilitate intercommunication among our members, and, by bringing us more into personal and social relations with one another, promote harmony, allay jealousy, and secure progress. Our weekly ordinary meetings are especially convenient for those who live in London; and the audiences are generally restricted to those occupied in the special branch of engineering under discussion at the moment; but these conferences, in association with our annual conversazione and by combination with well-arranged excursions and visits to works, tempt many to come to Westminster who are rarely seen there, and facilitate the interchange of ideas between all the departments of our many-sided profession.

They disseminate knowledge by exciting discussion and extracting opinions from those who have acquired them, from the only true master—experience—in every quarter of the world. Our weekly meetings receive and discuss papers selected from those submitted for approval, often of the character of probational essays. They open to the young and rising engineer a means of securing the attention and the support of the *patres conscripti* of his profession; but the discussions set in operation in these conferences are based on short papers prepared for the purpose by those who have been selected as masters of their particular subjects, and invited by the council to lay the foundation of our talks.

After very mature consideration the council came to the conclusion that the objects of our gathering would be best secured by meeting biennially. The reasons that led to this conclusion are financial and administrative. If ever we secure another building—an event by no means improbable and not perhaps very distant, for the whole of this side of Great George-street has been absorbed by the new design for Government offices—I venture to hope that we shall realise the dream of Sir John Wolfe Barry, and have a hall large enough to hold our annual dinner and to receive the whole of our members and their friends in one evening at our conversazione—a hall that will vie in splendour with those of the ancient guilds of the City of London. No guild and no merchant venturers' society ever compared in numbers and universality of operations with this institution of ours—the home of an association that embraces every clime and knits together by physical agencies the whole world into one connected whole. Each morning's *Times* is the daily journal of the world; we learn by our work what took place yesterday everywhere.

Now we have to give up our own building to the conversaziones and to throw ourselves upon the courtesy of our friends and neighbours for accommodation for the meetings of our various sections. The Mechanical Engineers have spontaneously offered us their new home, and there the sections dealing with machinery and electricity will meet. The Surveyors' Institution—before even their own formal occupation of the building—have given us the use of their meeting and council rooms, where the sections dealing with railways, harbours, mines, and metallurgy will assemble. The Middlesex County Council have allotted to us their Council-chamber and committee-room, where those interested in docks, canals, waterworks, sewerage, gasworks, and shipbuilding will foregather and discuss. The programme shows a plethora of important subjects for discussion. The visits to works will, we hope, provide objects of interest and instruction to every visitor. Their popularity is shown by the applications which have been received from over 1,000 members to take part in them. We are deeply indebted to those liberal and hospitable persons who have so

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kindly undertaken to meet our wishes in this essential feature of the conference.

We found it inconvenient and unpractical to print and circulate the proceedings of our first conference. We already receive four bulky volumes every year, and old members like myself find it necessary periodically to increase the dimensions of our libraries, and would rather experience a diminution than an increase in the number of our publications. The proceedings of the conference are equivalent to one and a half times the bulk of our annual ordinary meetings, and comprise three times the number of subjects ordinarily discussed in an institution session. The proceedings are thrown open to the Press, and we hope that the enterprise of those admirable technical papers that form such a credit to our industries and such a benefit to our profession will, by the completeness of their reports and the rapidity of their issue, render full publication on our part unnecessary.

The growth of engineering is illustrated not alone by the increasing number of affiliated institutions, societies, and members, but by the new fields of application which the advancement of knowledge and the progress of civilsation are opening up. At the present moment, in 10 distinct associations more or less intimately associated with our parent institution, there are some 22,700 paying members. *Science*, a much abused term, is the systematised collection of the facts and laws of nature, and *engineering* is their practical application to the use and convenience of man. There is a great tendency to put the cart before the horse. Science has followed, it has not led engineering. It is their intimate association which is the foundation of all industrial progress. The war of the microbes, the latest development of biology, is a consequence of sanitary requirements. Our knowledge of the diffusion of molecules and the solution of solids have sprung from the investigation into the mechanical properties and constitution of iron and its alloys, and the disturbances of the æther are becoming familiar through the practice of the so-called wireless telegraphy. Facts are derived from accident, observation, or practice; laws are the result of research. Engineers have always appreciated science up to the hilt, but they wish that its special votaries were less dogmatic and more modest.

The fathers of our profession, whose names you see emblazoned on our walls—Smeaton, Cort, Watt, Telford, Stephenson—acquired their science by their own researches when professors were largely teaching nonsense and text-books were full of errors. We, however, acknowledge our indebtedness to pure science by giving the place of honour over this chair to Newton, and by adding the name of the most accomplished experimenter of the age, and the most modest but clearest expounder of his own great discoveries—Faraday. Of the three men who have been raised by our Sovereign to the peerage for their scientific attainments, we claim two—Kelvin and Armstrong—on our roll, while Lister, who belongs to the nation, is also an honorary member of our institution.

The practice of the engineer as the great civiliser has been well eulogised by our distinguished honorary member, Lord Salisbury. The engineer not only immediately follows the military conqueror, but he sometimes even precedes the civil pioneer. Mr. Cecil Rhodes is opening up Africa by the "wonder-working wire." In a few months there will be an unbroken line of telegraph from Cape Town to Lake Tanganyika. Peace and goodwill are messages thus distributed without fire, blood, or famine.

Before dismissing you to your different sections to discuss the various questions allotted to you, I venture to allude to some questions that cannot well be discussed in public, but which may form the subject of conversation among us. The Lord Chief Justice's Bill for the suppression of illicit commissions is one welcomed by every member of this institution, and it is most gratifying to find that no suspicion of improper practice has been adduced against our profession. We do, however, hear at times of a dangerous border-ground between consultation work and contracting, which is a pitfall to be avoided and to be surrounded by danger signals. Again, occasionally, and, fortunately, rarely, we find the diploma of the institution converted into an advertisement. This the council strenuously protests against in the best interests of the entire body. The examination system introduced just at the epoch of our first conference has proved a most unqualified success, and it has been welcomed by none more than by those who are subjected to its troubles. During the last session 107 candidates passed the associate-membership examination, in addition to 31 who qualified by passing exempting examinations elsewhere, and 65 who satisfied the condition of election by theses. Further 53 passed the institution examination for studentship, whilst 167 qualified in that respect by passing various recognised examinations. The council feel that the system of examination has enhanced the intrinsic value of the diploma of the institution, and that it has added materially to the dignity and responsibility of the profession. The diploma of this institution has become so valuable and so necessary to the practising engineer that occasionally would-be practitioners improperly assume the title of member or associate. Fortunately criticism is too wide-awake, and the public interest too well served by all who are jealous for the prestige of their profession, to permit deceptions of this kind to escape speedy detection.

The position of engineering has rendered it necessary for all new universities—and especially for the Imperial University of London—to form a faculty of engineering, but the council of this institution has deprecated the idea of conferring degrees in engineering. Every engineer must acquire a knowledge of the scientific principles and mental tools that form the bases and aid the operations of his profession, but he can be an engineer only by becoming an expert in its practice. Examination can test the former qualification alone, and this is what we have introduced. Practical training is not a matter amenable to examination. Hence we consider that degrees in science are quite sufficient to signify the successful completion of a university career, which should be strictly scientific; and that the diploma of the institution should be the criterion of that professional qualification which is the result of practice.

And here may I mention that there is a tendency observable to avoid the condition that those admitted into our junior ranks shall be persons who are or have been *bonâ fide* pupils of corporate members of the institution. Further, no one can be said to be regularly educated as a civil engineer unless he has passed through the ordeal of the training to be acquired in the workshop and the drawing office. It would be well, for the comfort of the council, if those who rather lightly, and sometimes thoughtlessly, sign forms for election, would first enquire if the conditions printed on the back of every form were properly complied with. Let us sincerely hope that this conference of 1899 will be as successful, as pleasant, and as fruitful as that which took place in May, 1897.

The President was cordially greeted on resuming his seat.

Sir JOHN WOLFE BARRY, in moving a vote of thanks to Sir William Preece, said he was sure they all appreciated the many valuable hints he had given them as to the objects of their profession and the course they should pursue in furthering these.

Sir EDWARD H. CARBUTT seconded, and the motion was carried with acclamation.

The PRESIDENT briefly acknowledged the compliment.

Methods of Electrical Transformation.

BY JAMES SWINBURNE.

The only transformer to be considered a few years ago was the ordinary stationary alternating transformer; but with modern developments of extra urban supply stations, and with general supply systems, the most important transformer may soon be one of the numerous forms of dynamotor. A system of transformation in the sense of the title means a system for transforming energy at the power-house to energy delivered to the consumer, and is therefore a large subject.

The general tendency, or fashion perhaps, for there are fashions even among engineers, is to generate triple currents, and to transform them into direct currents locally. There are other possible systems, however—such as generating high-pressure direct currents, generating

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single or double currents, with transformation into any sort desired at the supply end.

As regards the generators, the direct current has the objection of high-pressure commutator, and perhaps somewhat extra cost. The direct current was, however, originally put out of the running, because it demanded a dynamotor instead of a stationary transformer; but now that the rival systems demand the same when direct-current supply is contemplated, direct-current generation requires reconsideration, at least for moderately high pressures. It has never had fair play. The extra cost of the dynamo is a small matter, and their efficiency and the efficiency of the whole system may be higher.

The most important question is, in long-distance work, the leads, consisting of copper and insulation. All sorts of precise statements as to the copper needed by each system are made, but such statements are meaningless unless the assumptions on which they are based are stated.

Take first the question of copper only. The first consideration in a comparison is, What pressure is to be used? The next, Is it the maximum, the effective, or the mean? The third, Is it as compared with the earth or with other parts of the circuit? It will be assumed that in all alternating currents the maximum pressure has to be taken as being the critical pressure as regards insulation rupture, and especially as regards life. For comparison a set of definite cases may be taken, say 10,000 volts and 2 square centimetres of copper at a density of 200 amperes per square centimetre.

Case 1.—The system earthed at a middle point, no wire to be more than 10,000 volts from earth. The direct current is then 20,000 volts and 200 amperes. The single alternating has 7,100 each side, the double alternating the same, but has its thick wire grounded, and has smaller currents. The triple current has a middle point earthed, and though its wires never go over 10,000 volts above earth, they go more from each other.

Case 2.—One conductor to be earthed. This is a condition that may be compulsorily enforced, and practically means concentric mains with little insulation on outside conductor. In this case the direct current has 10,000 volts and 200 amperes, the single alternating 7,100 and 200, the double alternating is as before, but the triple current comes down considerably.

Case 3 is where the difference between no two conductors exceeds 10,000 volts. In each case the leads have a total area of two square centimetres and a density of 200 amperes per square centimetre.

These results may be tabulated thus:

Case.	System.	Output in kw.	Case.	System.	Output in kw.
1	Direct	4,000	2	Double alternating..	1,650
1	Single alternating ...	2,824	2	Triple	2,824
1	Double ,, ...	1,650	3	Direct	2,000
1	Triple	5,000	3	Single alternating...	1,412
2	Direct	2,000	3	Double ,, ...	1,170
2	Single alternating ...	1,412	3	Triple	2,824

In all these cases the triple current is best and the direct second.

The next question is insulation, to which little attention is generally given. Questions of insulation resistance must be discarded as a criterion, and it must be remembered that the disruptive stress is not uniform throughout the insulation. The thickness of insulation has been calculated out on the assumption that at no part of the dielectric must there be a stress exceeding 20,000 volts per centimetre. It is unnecessary to give the calculations. The formula comes out

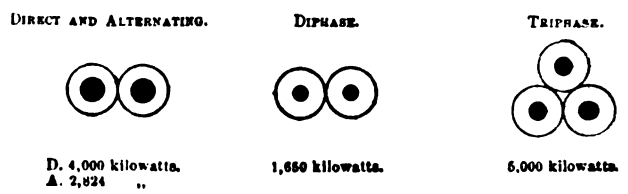
$$\log R = \frac{E}{S\,r} + \log r,$$

where R is radius of insulation, E is the pressure, S the maximum stress, and r the radius of the wire. It must be insisted on that this is only an assumption. In practice cable-makers do not follow such a rule as this. It is only true for homogeneous dielectrics. Cable-makers vary their homogeneity by the unwilling introduction of spangles and other foreign bodies. It is difficult to find out what principles cable-makers work on. They indulge very largely in secret processes, which is always a suspicious proceeding, and it may be hinted by other people that cable-makers work in a haphazard rule-of-thumb way, without any principles whatever. Some of the cables shown are caricatures. A small solid conductor causes such a sudden fall of potential at its surface that a larger tube takes a covering of smaller diameter.

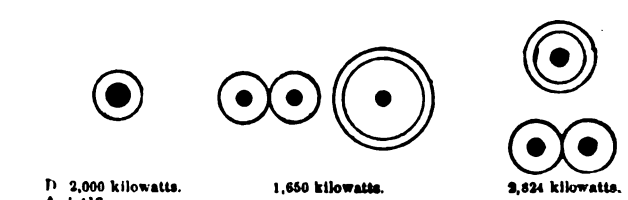
These figures go to show broadly that the direct and single alternating are preferable, as far as cost and convenience of insulation go, on the assumptions made. Distances are getting longer and pressures higher, and the cost of the cables is a more and more important matter. The cost of cables demands the most careful consideration, and it is to promote discussion in that direction that these diagrams have been made.

The whole question of loss by dielectric hysteresis is left out of this consideration. My own experience in this direction is with condensers rather than cables; but if there had been time it would have been considered too. It is important, and this way of losing power is peculiar to alternating and multiple currents.

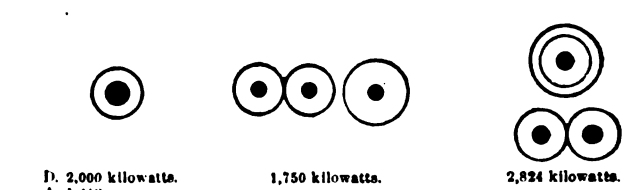
As to cost of transformers, if direct current is needed for distribution there is not much to choose; if alternating is to be delivered the single alternating system has a clear lead right through.



Case 1.—10,000 volts from Earthed Point.



Case 2.—10,000 volts from Earthed Conductor.



Case 3.—10,000 volts between Conductors.

As to convenience in measurement and handling, the direct current is far ahead, closely followed by the alternating, and the double and the triple come in a long way behind, if at all. Capacity effects and all sorts of inductive effects are drawbacks peculiar to alternating and multiphase work. They are more troublesome in multiphase work. Bare copper conductors ought to be considered with reference to incipient discharge at the surface, and waste of power in the air. A tubular conductor is thus preferable and sometimes necessary, instead of a solid rod of the same cross-sectional area.

Major Cardew, in opening the discussion, said regarding the use of the different systems, it seemed to him that nearly all had their proper field.

Dr. Edward Hopkinson having criticised the author's diagrams, said he very much wished that he could explain Mr. Swinburne's figures.

Dr. A. C. Crehore was very much indebted for the invitation to contribute to the discussion, but hardly felt prepared to do that, as he had not seen the paper until he came into the room that morning.

Mr. Robert Hammond also regretted Mr. Swinburne's absence, as it made it difficult to discuss the paper while certain questions were unanswered. From 15 years' experience in single-phase alternate-current working he concluded that that system had failed to comply with the requirements of power distribution. On the other hand, the troubles feared in the early days from the use of high voltages had

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been successfully overcome. It was only with respect to the motor load that the system was defective. With regard to the general question of power distribution by multiphase currents, he had had to consider the practicability of such schemes in connection with a proposal before Parliament. In the case in question, the promoters laid stress on the cheap coal they would obtain in a central generating station. He had calculated that, in order to show 10 per cent. on the necessary mains and feeders, £12,000 worth of coal would have to be saved annually before any gain would be derived on the distribution. Regarding the two-phase system, he thought common return should be used, as otherwise there was no saving of copper over the single-phase system.

Mr. R. E. CROMPTON said that on further perusal of the paper he considered that Case 3 was the most interesting to engineers. He found, however, that Mr. Swinburne's treatment was very incomplete, as he had not taken the power factor into account, hence his results were only true for non-inductive circuits such as were not found in practice. For instance, a power factor of ·7 would render the three-phase system equal to the direct-current in Case 3. He had recently had a conversation with Mr. C. E. L. Brown on the subject, and his opinion was perhaps the most valuable that could be obtained. Mr. Brown had told him that German and Swiss experience proved that, as far as copper was concerned, the three-phase system and the direct-current system were equal. As far as the conductors were concerned, bare copper gave no trouble except when exceedingly high pressures, such as 40,000 volts, were used. Up to, say, 20,000 volts, he thought no waste of power from static discharges would be found.

Sir HENRY MANCE considered that Mr. Swinburne's condemnation of cable-makers was quite unjustified. They did not select their materials at haphazard. With 1,000 volts direct current at Oxford, seven years' working had shown no deterioration of the insulation. The only two faults which had occurred were due to mechanical defects in jointing. It was predicted that they might have electrolytic trouble, but that had not occurred. In fact, continuous currents at 1,000 volts had proved quite satisfactory. The whole system had an efficiency of 75 per cent.—*i.e.*, 75 per cent. of the current generated was paid for.

Sir W. H. PREECE took serious exception to Mr. Swinburne's remarks about cable manufacturers. He had had to order and to maintain a very large amount of cable, and had always found manufacturers most careful and capable. He suggested that Mr. Swinburne's experience was rather the fault of the parties specifying the cable and testing it. He would again emphasise the importance of such work being placed in experienced hands. With respect to the question of the shortening of the life of cables raised by Mr. Cardew, he had not found any such depreciation for any voltage below 1,000. As regarded the choice of system, it was impossible to lay down a general conclusion. Each case must be considered on its own merits.

Prof. BOTTOMLEY said he had always found makers of cables most careful in their work and anxious to maintain its good character. Regarding the life of insulating material, Lord Kelvin had recently inspected in Rome one of the oldest power distribution systems existing. The cables in it were all giving way owing to disintegration of the insulation. [Prof. AYRTON said that the cable was covered with some special composition, not rubber.] He thought that the ageing of the insulation was an outcome of the mechanical stresses set up by the alternating currents.

Mr. E. K. SCOTT remarked that the direct-current high-tension system was greatly retarded by the cost of transformers, which was so much greater than that of the transformers for alternating currents. He suggested greatly increased speed as one solution of the difficulty.

Mr. J. C. VAUDREY considered that the cable question was sometimes neglected while all attention was given to the generating machinery. That was so in spite of the fact that to change the cables was much more expensive than to change machinery. It was regrettable that a number of cables drawn into cast-iron pipes 10 years ago had had to be completely renewed. He gave instances of defects arising in concentric cables which were lead covered owing to the action of the soil on the lead. Subsoils containing slag or salt always attacked the lead in a comparatively short time, and the iron and steel tapes put on to protect the lead had in many places a very short life. For low-tension work in certain localities he thought that bare copper in culverts was difficult to beat. He did not think that finality had yet been reached in cable laying.

Mr. C. E. P. D. SPAGNOLETTI said he was glad to see that continuous-current systems were being favourably considered by Mr. Swinburne. The commutator trouble was the chief one in this respect. The speaker went on to refer to his paper on an equilibrium system of distribution read at the conference two years ago.

Prof. KENNEDY proposed a vote of thanks to Mr. Swinburne, and then called on Prof. Ayrton for his paper.

Some Non-Integrating Electric Meters.

BY PROF. WILLIAM EDWARD AYRTON, F.R.S., A.M.I.C.E.

Materials.—The five most important metals employed in the construction of electric meters are copper, iron, steel, phosphor-bronze, and some alloy of high resistivity. A few years ago copper of 98 per cent. conductivity (Matthiessen's standard) was considered good, now it is stated that copper of 105 per cent. conductivity can be obtained commercially from Mouchel, of France. The great increase in the electric conductivity has been attributed to greater density of the material, but there seems to be considerable doubt about this, and it is desirable to try whether a still further electric improvement, possibly even a relatively large one, might not be produced by using much greater care in removing the last traces of impurities. It is also important to find out exactly how the variation of resistance with temperature increases with increase in the electrical purity. Soft iron for needles of electrical instruments should have small remanent magnetism and small coercive force, while both these qualities should be large in steel for permanent magnets. A large magnetic improvement has been effected in commercial soft iron during the last few years, and even steel can now be purchased in ingots having a far smaller coercive force than the so-called "soft" iron practically employed for electric apparatus six or seven years ago; and, by constructing the meter so that the magnetic induction is kept low, soft-iron instruments may be used for measuring alternating currents and pressures with fair accuracy. It should be remembered, however, that although the number of turns and the maximum scale reading may correspond with a number of ampere-turns which produce only a small induction with a sine or a flat wave, such instruments may read wrongly if the wave be peaked. A satisfactory compensation for variation in the frequency is effected by shunting the instrument with a self-induction, and experiments should be made to devise some such device to compensate for the wave having a peak. The manufacture of steel magnets has much improved during the past few years, as indicated by the following results obtained from tests on steel magnetised with a force exceeding 200:

—	Residual magnetism.	Coercive force.
1885. Oil-hardened steel tested by Dr. J. Hopkinson	11,300	12
1893. Glass-hard pianoforte wire tested by Prof. Ewing	9,500	45
1898. Molybdenum steel tested by Madame Curie	—	85

This marked increase in the coercive force, which is of great importance in preserving the constancy of permanent magnet types of measuring instruments, has been brought about partly by improvement in the composition of the material, and partly by greater experience having been gained regarding the proper way of hardening magnets. Still greater improvement may certainly be anticipated. In instruments employing a spring control, and in which, for magnetic reasons, steel cannot be used, phosphor-bronze is the best elastic metal, but it is far excelled by quartz as regards the absence of sub-permanent set. A really satisfactory method of coating quartz with even a metallic layer of sufficient conductance to serve as the flexible electrode

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for an electrostatic voltmeter using a spring control is very desirable, but, better still, some metallic alloy possessing the mechanical properties of quartz is well worth seeking. Alloys possessing higher and higher resistivities and smaller and smaller temperature coefficients are being constantly brought to notice, but no one seems to be seeking for a substance with a small temperature coefficient and a small resistivity, although that is the kind of substance that is needed for many purposes, as, for example, to wind voltmeter coils with and the bobbins of moving-coil instruments used with a shunt for the measurement of large currents.

Galvanometers.—The moving-coil type of instrument has effected a revolution in galvanometry, and where low resistance and short period are desired it greatly surpasses the moving-needle type. No moving-coil galvanometer, however, has yet been constructed that will even indicate the existence of the small currents which certain moving-needle galvanometers will measure accurately. Development of the moving-coil type of instrument is at present limited by the comparative smallness of the field produced by a permanent magnet, the limiting thinness that can be given to the strip of metal used for the suspension, and the slight trace of magnetism that remains in the so-called non-magnetic materials, used in constructing the coil, even after the application of the best method for freeing them from magnetism. In view, however, of the great improvements that have been introduced into moving-coil types of galvanometers during the past few years, and of the fact that a given volume of wire possesses such an enormously greater value in the moving-coil than in the ordinary moving-needle type of instrument, it may not be too sanguine to look forward to moving-coil galvanometers rivalling moving-needle galvanometers for all purposes.

Ammeters and Voltmeters.—Instruments depending on the action of one coil on another without iron generally use a working field of about 50. Therefore, since the field on a central-station switchboard often exceeds 20, the disturbance may be very great. Indeed, the error arising from the current in the leads alone of such an instrument may be serious. The importance of using copper of much higher conductivity than at present obtainable, so as to employ many more convolutions of wire without increasing either the volume or the resistance of a coil, is here manifest. Some soft-iron needle instruments have also fields not exceeding about 70, and are therefore quite useless for central-station work, unless protected in special ways with soft-iron magnetic shields. The field in which the coil of some moving-coil instruments turn is as high as 1,200, and it might be expected that small stray fields would produce no error. But, as a matter of fact, the iron pole-pieces, and especially the iron core, concentrate the stray field on the coil; so that a stray field of only 0·5 when parallel to the field of the instrument may produce an error of 0·4 per cent., or nearly 10 times as great as the ratio of the fields alone would lead one to expect. The employment, however, of an astatic pair of narrow coils without an iron core greatly reduces this error. For measuring large alternating currents it is desirable to employ a small transformer giving a maximum secondary current of some 10 amperes, which can be easily led to an ammeter at a safe distance from the main cable, and by keeping the resistance of the secondary circuit low, the transformation ratio will not be affected by changes of frequency. The best way at present of measuring small alternating currents is by means of an electrostatic voltmeter shunting a non-inductive resistance. Electrostatic voltmeters have practically no errors due to stray magnetic fields, unless they are rapidly alternating. In that case, unless the needle and inductors be properly subdivided, eddy currents may be induced and a disturbing force introduced. The error due to impedance is practically zero, as the capacity of a dead-beat electrostatic voltmeter with a 12in. pointer need not exceed about thirty-millionths of a microfarad. Pivot friction and brush discharge between the needle and inductors introduce the greatest troubles, and it is difficult to obtain as much damping as is desirable. Coating the inductors with mica, enamel, etc., greatly reduces sparking between them and the needle, but not the brush discharge with an alternating potential difference, and is therefore of little practical use. A better method of stopping the brush discharge than by immersing the whole instrument in oil is much needed.

Megohm-meters.—Direct-reading ohm-meters, measuring up to 50 megohms, are now obtainable, but apparatus is also needed to enable the insulation of an electric light cable to be tested where laid. At present cable is often supplied which, although possessing only a fraction of the specified insulation, is passed because suitable testing apparatus can be used only in a laboratory.

My cordial thanks are due to Mr. A. Campbell for assistance rendered in the preparation of this note.

Mr. SYDNEY EVERSHED expressed his concurrence with many points raised in the paper. Since 1886 he had experimented largely in an endeavour to find iron with little coercive force. He understood that Prof. Ferraris had discovered some crystals of magnetite which had no coercive force, but on obtaining some of these he (the speaker) had found they were about equal to ferrotype plate in that respect. Iron dissolved in mercury he found to be equivalent to cast iron, while iron obtained electrolytically was worse. Transformer iron he found to be best, and a coercive force of 1·5 seemed about the limit. He understood, however, that Messrs. Sankey and Co., the iron merchants, sometimes found small batches of iron plate greatly superior in that respect to others, and this might lead to the discovery of a better material. Prof. Ayrton's table was misleading, as Ewing's sample of pianoforte wire was not chosen on account of maximum cohesion. The permanent magnets he used had a cohesion of 60. Again, the sample spoken of as having a cohesion of 75 had, he believed, less permeability. He agreed with the author as to the valuable advances which had been made in alloys with no temperature error. The objection to the moving-coil type of instrument was the weight thrown on the jewelled pivot. Mr. Evershed pointed out that it was exceedingly difficult to polish the centre of the cup in the jewel, and that 8 to 10 grains were enough to cause abrasion with time. He did not agree with the author's proposal to measure large alternating currents by means of a transformer. The temperature error due to the heating of the secondary circuit would cause an error in the result. The speaker did not think that electrostatic instruments would find favour in measuring voltages of 100 to 200, owing to the small forces obtainable with comparatively heavy moving parts. The only practical method seemed to be to transform up to a higher pressure. With a high-pressure electrostatic voltmeter care should be taken that they would not be damaged by disruptive discharges at anything like normal pressures.

Mr. R. E. CROMPTON thought that the author should amend his statement by saying that for all practical purposes suspended coil instruments have superseded those with moving needles. He had had no difficulty in obtaining magnets with a coercive force of 60. Regarding the disintegration of the cables, he thought that that was sometimes explained by the demand for very high insulation resistance. A cable which gave the best results in this respect when new often broke down first. He would advocate the selection of cables by their durability, and not specify such high insulation resistances.

Major P. CARDEW, R.E., remarked on the difficulty in ascertaining if a permanent magnet was really going to be permanent. Such a test was most important when trying electricity meters which employed permanent magnets and a copper disc as a brake. With respect to the moving-coil type of instrument used as an ammeter, great pains should be taken to eliminate thermo-electric currents which would be set up by difference of temperature at the ends of the potential leads. When using electrostatic voltmeters, great care should be taken to ensure good contact at the terminals. If one connection was slightly loose, it acted as a second condenser in series with the voltmeter. He had often found a 3 per cent. error from this cause. Respecting the fatigue of suspending wires, he had carried out lengthy experiments with iridio-platinum which was used for suspending the Board of Trade 100-volt standard. They found that there was no ultimate limit in this fatigue, and had to work to a corrected zero for every observation.

Mr. ROBERT HAMMOND commented on the part of the

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paper dealing with iron and steel, and asked if the chemical analysis was not a guide in selecting the iron for instrument work.

Prof. A. B. W. KENNEDY did not think they should blame cablemakers for what had happened with respect to cables in the past. He believed that the trouble was largely due to the introduction of mineral water into the rubber for mechanical reasons. Unfortunately, this mineral material had had destructive effects on the rubber, which were only made apparent after a very considerable time.

Prof. W. E. AYRTON, in reply, said he had not been speaking on the standard of insulation resistance which should be demanded, but had shown by tests that the figures guaranteed by the makers were very often not obtained. He believed that phosphor bronze was the best material for galvanometer or instrument suspensions, as it showed less fatigue than any other substance.

The Relative Advantages of Different Kinds of Power for Tramways, Light Railways, and Motorcar Traffic, both Heavy and Light.

BY THOMAS PARKER, M.I.C.E.

This effort to deal with the subject indicated by the title of this paper is intended to induce discussion; to obtain data of the various methods and points of interest and place them on record.

Horse Traction is the oldest method by which tramways have been operated, and there is ample data available. Its slowness, the occupation of a great length of the road, and the bad sanitary conditions caused by the refuse from the animals, the element of risk in the temper of the animals, variable cost of food, the great destruction of the horses by the very heavy work—these facts and conditions by long usage have become unnoticeable and do not appear to come within the scope of public vision, when judging of the efforts made by engineers to replace the horse by mechanical means. But the always present cash quantity has condemned horse traction on tramways. For cost of tramways operated by horses taken under average conditions see Table A.

TABLE A.—Operative Costs of Running One Car Mile by the Different Systems enumerated.

—	Horse traction.	Steam traction.	Cable.	Electric overhead.	Liverpool Overhead Railway.
	d.	d.	d.	d.	d.
Drivers' and conductors' wages ...	2·5	3·5	2·67	2 49	
Generating station, including coal, oil, wages, waste, etc.	—	—	—*	0·46	
Repairs, locomotive engines	—	1·75	—	—	
Motors	—	—	—	—	
Machinery	—	—	0·84	—	
Cars	—	0·50	0·42	0 037	3 9
Harness, etc.	0·92	—	—	—	
Fuel	—	1·65	0 25	—	
Lighting	0·02	0·33	0·04	0 02	
Horses, including forage, shoeing, attendance, renewals, etc.	3·61	—	—	—	
Management: general expenses	0·73	1·26	0·18	0·15	0·416
Total	7·78	8·99	4·40	3·157	4·316
Carrying capacity..	26	54	54	3)	140
Weight empty.....	2·75 tons	12 tons	4·7 tons	4 3 tons	31 tons

* Could not obtain reliable figures for generating costs.

Steam is quicker than horses, less costly for results, but has greater disadvantages—viz, much greater weight, and occupying greater length of road, the emission of carbonic acid, carbonic oxide, sulphurous acid, steam and smoke practically into the dwellings along the route, and among the people, the unsightliness and noise, make its use in public streets a painful burden to the community, and, as experience shows, not to be borne when better means can be found. The objections leave little hope for the future of direct steam-driven tramways. The appended costs are taken carefully from practical workings (see Table A).

Compressed Air is a more congenial agent, and has better prospects of success than steam, if the two had to settle their differences alone. It is free from many objections compared with steam. There is little interference with the atmosphere. The small amount of direct firing makes it possible to use only one carriage for motor and passenger; water need not be carried. The total dead load to passenger is in its favour. It needs frequent stations for supplies, as the distance it is possible to run with one store of pressure is limited. Its friends are very active at present, and it is hoped we may hear their case and obtain some practical account of its working. It appears to have higher economy than can be obtained by steam direct. The author has no working data he can give.

Cable.—Endless cable, as a method for driving tramways, has high merits in many respects. It occupies a minimum length of road. Its speed is fair. It is free from nuisances of steam or horses, and it is handy. Its drawbacks are: heavy initial outlay; its occupation of the street; the slot difficulty, of carrying sewer and other requirements in or across the street in which it is laid; the continued noise of the running rope under the streets, causing, in some instances, considerable depreciation in value of property; the stoppage of the whole system upon the breaking of the cable; and the heavy costs attendant upon the system. Taking the statistics of installation, there are very few cable roads being put down now, and we may accept the verdict of the public that the cable has ceased to compete successfully with other methods. There are some tramways being driven by gas engines working on the car, but no reliable practical data is available. The verdict of passengers is that they are required to inhale considerable admixture of coal-gas with the atmosphere in the neighbourhood of the cars.

Electricity.—At the present time electricity is, by general accord, selected as the best method for driving tramways. In electricity we have a very flexible system which admits of great variation of power being used at varying points on the same system. There is no nuisance as with steam or horses. The minimum length of road occupied; speed can be low for inter-town work and high for suburban traffic; cars are easily handled; energy is used efficiently; maintenance is not excessive; streets are not more occupied than simply by the pair of rails, so that taking up streets for laying sewers and pipes, or other needs, is not complicated. The disadvantage is the conductors being carried overhead. Conductors have been used in other forms, but it appears fairly settled that the overhead wires, by their small first cost, the simplicity and security of insulation, and the readiness with which repairs can be carried out, is accepted, at least for the present. Accumulators have been introduced on to cars to carry them through the crowded streets, being charged whilst in the suburbs, running from the line and discharged by inter-town running. Accumulators have been installed on their Bournbrook section by the Birmingham Central Tramways Company, but although still running have not met expectations. The loss of capacity of the cell under the conditions of use was a great difficulty. The energy required to drive the accumulator cars was approximately 4·6 horse-power hours per car mile, whilst the quantity of energy necessary to drive a car of equal capacity with overhead conductors 2·15 electrical horse-power hour per car mile, the speed being much faster and the gradients heavier.

Railways, Light and Heavy.—Electricity as a means of driving light or heavy railways is under best conditions if employed for long runs, and under its most inefficient conditions when called upon to make frequent startings. There is by the steam locomotive practically the same energy economy with one journey per day as 50 journeys per day. For electricity it is necessary first to put down the motive plant, dynamos, and conductors throughout the system, and to provide the motors for hauling the trains. For lines where few trains are required, electricity does not compare with steam, as the capital outlay for running a few trains is the same as for running a number. If we take a case, say, of two towns 50 miles apart—such as London and Brighton—which would support a continuous connec-

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tion, and by the length of run put electricity under good conditions, electricity could give 15 minutes' interval trains, and run at 75 miles an hour, doing the distance in 40 minutes by trains of 100 tons, at 2½d. per train mile, covering costs of power. Such a case shows how completely electricity takes the field under fair conditions, and the advantages are not only in point of power, cost, and speed, but the track need not be so costly, as the weight can be evenly distributed throughout the train, the weight of the train being brought in for adhesion and traction. A 100-ton train would be equal capacity for passengers to a steam train of 140 tons. The cost of maintenance of permanent way and risks would be much reduced. If we turn to a case where electricity is under its worst conditions in comparison with steam, we are able to refer to well-matured data. The Liverpool Overhead Railway is such a case. It has been running for nearly seven years, and is in direct comparison with a number of similar lines worked by steam.

A most important difference between electric motors and the steam-cylinder when starting into motion is, that in the electric motor no effort is obtained unless current is passing through the motor, and the torque is proportional to the quantity, while steam gives its efforts and is liberated to exhaust only in proportion to motion.

Motorcars.—Steam was early in the field, but the requirements needed to make moderate success possible are only of modern achievement. The conditions of the vehicle and road make still further variation of the boiler, engine, and condenser necessary before the steam motorcar can be a standardised article of manufacture. With regard to gear, steering, brakes, and wheels, there are openings for improvements and new applications. There are some good approximations to success of the steam type.

Oil-Cars.—Much has been done to render tolerable the close association of passengers with mechanical movements and rapid explosions forming the combination we call an oil-car. Still much is needed with regard to safety from explosion and fire, reduction of vibration, and efficient transmission. The prospect is that it may be practical, with reasonable first outlay, depreciation, and cost of fuel, to run an oil-car successfully for a much less cost than horses. The movement has brought about great improvements in the oil-engine, but only light oils have been successfully used. Electricity is chiefly used as a means of igniting. Speeds of 1,000 revolutions are obtained, or 500 explosions per minute.

Electricity.—In applying electricity to motorcars, we first met the question of weight of accumulators. This has, by improved motors, gear, and accumulators, within very recent date been reduced to one horse-power hour delivered on to the car at about 56lb. inclusive, so that 5cwt. of cells is sufficient to operate a car, as against 16cwt. two years ago. Motors, gearing, and methods of steering have been much improved. The following data is one of the best examples I have had the opportunity of testing:

Weight of car, complete, without batteries.....	9cwt.
,, batteries	5 ,,
Total	14 ,,
Total weight, with four passengers	20 ,,
Discharge, on level, 12 amperes at 80 volts.....	9 miles per hour.
Approximate horse-power.....	1½
Safe distance	40 miles.
One motor, double-reduction gear	1,200 revolutions.

Mr. THORNEYCROFT, in opening the discussion, remarked that the subject which had been brought before them was one of very great interest, because he felt convinced that steam was going to play an important part on the common road. Mr. Parker had referred to the use of steam on the roads as emitting gases into the air. He thought that that was true in regard to tunnels, but on a road the inconvenience of using fire was perhaps not so much as that which arose from horses. Electricity, no doubt, had very great advantages where they could connect the car by means of wire with an engine which rested on the ground, but when they had to leave the track and go on the common road he thought the figures Mr. Parker had given them did not allow sufficiently perhaps for the difficulties which might arise.

Other speakers took part in the discussion, and were replied to briefly by the author.

Cranes, and the Power to be used with them.

BY WALTER PITT, M I.C.E.

For the purposes of this short note, cranes may be considered as roughly divided into two classes — first, self-contained cranes carrying their own motive power, and, secondly, cranes which are actuated by power conveyed to them from a separate generator. The first class practically consists of hand and steam cranes, and the second includes all the various forms of power-transmission cranes—such as shaft-driven, electric, and hydraulic. Of hand-cranes, it is only necessary to remark here that, wide as is the field of usefulness for moderate sizes, the practical limit is soon reached. It may be assumed that eight men is about the maximum number that can be put to the handles of a single crane; this corresponds to a total effective work at the hook of about 15 foot-tons per minute; or, put another way, it takes 15 minutes to lift 15 tons 15ft. high. Speaking generally, for loads over 10 to 12 tons, a hand-crane is out of place, unless the circumstances are very exceptional.

The steam-crane is undoubtedly the best type to use where only a single crane is required, or where several portable cranes have to be dealt with whose relative positions may be altered within wide limits, or which may at some future date be transferred to another site, in all these cases the steam-crane has advantages not possessed by any other type. It is simple to work, as economical as most of its rivals, ready at short notice, and requires little permanent work for its installation except in the larger sizes of fixed cranes. When, however, it is a case of an overhead traveller, or several fixed cranes, or a number of portable cranes with a limited range of travel, then the consideration of other motive power than steam at once begins. An overhead traveller is in many cases placed under cover, where a steam-boiler placed close under a roof possesses obvious disadvantages, and in very many cases an available supply of power already exists. The overhead traveller has therefore always been well adapted for driving by transmitter power, and the evolution of the power traveller has been roughly as follows: (1) shaft-driven traveller; (2) rope-driven traveller; (3) electro-driven traveller. Shaft-driven travellers work very well where the motive power is not too far away, but they have disadvantages. The loss in friction is probably the greatest of all systems; the speed at which the transmitting organ (the shaft) can be driven is necessarily very limited, and the tumbler bearings are always inclined to be troublesome.

For conveying power by direct mechanical means, it may be considered an axiom that a quick light drive is always to be preferred to a slow heavy one; and therefore it was a decided step in advance when the quick-running rope-crane came in, and by a process of the survival of the fittest settled down into the well-known type in which the driver sits in a cage below the girders and actuates the machine by shifting open and crossed belts, the speed reduction being made at the crab by worm and wheel. The introduction of the electric transmission of power marked a noteworthy departure in crane design, and solved in a very satisfactory manner all the difficulties previously experienced in taking the power from the motor to the crane. Electric leads are easy to erect, noiseless, motionless, cheap, and by their means power can be conveyed along routes that would be quite impracticable by any other means, and with very considerable economy. The author puts the latter point last, because although users much appreciate economy, they appreciate convenience a great deal more. Speed and convenience of working take precedence even of coal consumption. The first electric cranes and travellers were worked by a single motor often kept running continuously, and the various motions were obtained by shifting belts or other forms of friction clutches. Latterly the practice has been to use a separate motor for each motion. Having got so far, a lesson was taken from tramway practice, and series-wound motors were used instead

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of the self-governing shunt-wound motor previously necessary. The series-wound motor, with its big starting torque and its capability of responding to the driver's views as to speed, has much analogy to the engines of a steam-crane regulated by the driver's hand on the starting valve, and the writer thinks that it is precisely this possibility of using series-wound motors that is the great advantage of the single-motor machines. Jib cranes are usually now constructed as two-motor machines, one for lifting and one for slewing. The subsidiary motions of jib derricking and travelling are less often used, and can be well worked from the slewing motor by a change of gear.

The reduction of speed from motor to first motion shaft has been effected in every possible manner. Practically two methods survive, worms and cut-gear. The much-despised worm is noiseless, and very convenient to apply in many cases, and, if properly designed, even a worm will turn, and that with a very respectable efficiency. The author would remark in this connection that the ordinary formulæ for worms will, if used with proper coefficients of friction, give results well borne out by practice. The next important organ in an electric crane is the controlling gear. Here the tendency has been lately to adopt liquid resistances, and still more recently to use controllers which are practically tramcar controllers. It is a striking feature of electric crane design that whereas at first the old power traveller was the model, the tendency is now to go to tramway practice, and there are, in fact, many points of analogy between crane and tramway work, especially in all that concerns the starting and accelerating conditions. In Germany considerable attention has been paid to the problem of recovering the energy lost in lowering the load by generating current in the motor. Many of these arrangements are very interesting, but the writer doubts whether here again efficiency of doing the work required does not take precedence of current consumption, and for quick lowering nothing beats a free barrel controlled by a foot-brake.

The hydraulic crane is too well known to require long notice here; it will probably be always with us, but the electric crane will be a very serious rival. The electric crane itself is more expensive, but the generating and transmitting plant are less costly. Electric cranes are not affected by frost, and they also have the good point that the maintenance repairs are generally within the competency of the man who looks after the crane. Of various intermediate types of crane, the writer would mention a series of overhead shaft-driven travellers driven by hydraulic engines from a pressure main, and the result has been sufficiently satisfactory to warrant a repetition of the design.

Another example of a different type of motive power is furnished by a crane designed by the writer, where a good natural supply of water under moderate pressure being available, a Pelton wheel was keyed directly on to the pinion shaft of the lifting gear, and a cheap and efficient hydraulic crane constructed. The author also remembers having seen at Bilbao a blockyard Goliath, where an electric transmission actuated a direct-acting hydraulic lifting cylinder, and there are other variations and combinations of motive power that may sometimes be authorised by the local condition. Speaking broadly, the author would emphasise the following points: (1) for single cranes, or cranes with a great range of portability, use steam; (2) in all cases where the circumstances warrant a central power station, or where power has to be conveyed any distance, use electricity; (3) for overhead travellers use electricity.

THURSDAY'S PROCEEDINGS.

Mechanical Traction by Electricity.

BY GRANVILLE C. CUNINGHAM, M.I.C.E.

In the installation of mechanical traction by electricity on tramway systems, the point to be considered is how this form of traction compares in cost of construction and working with that it displaces, and what are the conditions that make for a high or a low cost of working. It will doubtless be admitted that unless such form of traction were financially superior to other forms it would not be adopted, but it will be useful to enquire wherein this particular superiority lies, as this indicates the direction in which the skill and resource of the engineer should chiefly be turned. The cost of constructing and equipping an electric tramway system is very much greater than the cost of a horse system. The receipts per car mile may not be much greater, and with the largely-increased mileage run may possibly be even less; therefore, unless the expenses per car mile of the electric system are very much less than the expenses of the horse system, whence can be obtained the large additional net revenue required to pay interest and sinking fund on the greatly increased capital invested? It is accordingly to this lowering of the cost of electrical working that the attention of the engineer should be chiefly directed, and the best results in this respect can be obtained only by care in construction.

In the first place, on what item in working cost may a saving be looked for? In the matter of wages of men on the car, no saving can be effected; two men would be needed on the electric as on the horse car, and the electric employés may even be expected to require higher wages. The maintenance of car-body—painting, repairs, and so forth—would be practically the same in either case; the maintenance of the electric equipment of the car is an addition to any expense of the horse system; so also is the overhead wire and feeder system; the maintenance of the track would be greater for the electric system, including therein the bonding. In all these items the cost in the total would be greater for the electric than for the horse system. There would be some advantage to the electric system in being able to run at a higher speed, thus distributing the wages of motormen and conductors over a larger mileage in a day, and reducing the amount of that item per car mile. But this is not a large amount and would not compensate for the increase in the other items mentioned.

The only item remaining to be considered is the power used in the service, and it is in this item alone that the saving can be effected. For this reason the power-house on an electric system is the point to which the intelligence and skill of the engineer should be mainly devoted. It is upon this that the financial success of the undertaking depends. If it is carelessly constructed with engines, boilers, and appliances that do not ensure a low cost of working, then it is certain that but a small profit—and perhaps no profit at all—will be realised. It is certain that no great financial success will be secured. Everything that will reduce the cost of producing the electric current should be sought out and applied in the construction of the power-house.

The cost of horse traction—and by this is meant the cost of horse keep, wages of grooms, shoeing, veterinary expenses, but exclusive of drivers' wages—may be taken as varying from 3½d. per car mile in an easily-worked town, such as Glasgow, to 5d. per car mile in a hilly and more difficult town, such as Liverpool. This is the cost of horse traction arrived at from the working of fairly large systems showing 7,000,000 car miles annually in Glasgow and over 4,000,000 in Liverpool. The cost of electric power for traction on the overhead trolley-wire system should, with economical engines, boilers, and heat-saving appliances, be under ½d. per car mile for an easily-worked level town, and for a more hilly town with steep gradients but slightly over ½d. per car mile The cost here meant is the cost of all wages, fuel, water, oil, etc., in the power-house, together with the cost of maintenance, repairs, and up-keep of the plant. The cars driven by this power are those weighing about 6½ tons when empty, and capable of seating 26 passengers inside. But in order to ensure this low cost of working, every care must be taken in the power-house. In choosing its site, it should be placed close to a plentiful supply of water, where all that is requisite for condensing purposes may be had at a nominal charge, or merely for the cost of pumping. A river, canal, pond, or the sea would afford what is needed. It should be conveniently situated for the supply of coal from railway line, canal, or wharf so as to save the charges of handling fuel. One shilling per ton saved in cartage would amount to a very considerable sum in a year in a large traction station. But, needless to say,

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the most important matter is the type of engines, boilers, and heat-savers to be used. The writer favours low-speed (70 revolutions) compound condensing engines, such as are built by numerous English firms, boilers of the Lancashire or Galloway type, with Green's economisers. A plant of this character was constructed and worked under the writer's charge on the Montreal Electric Street Railway, with the result that the cost of producing current was a little under ¼d. per kilowatt-hour, and the cost per car mile less than ½d. in the open months of the year, when coal could be obtained for 9s. per ton. The consumption of coal was 3·48lb. per kilowatt-hour, or 2·60lb. per electrical horse-power hour, and this was maintained during months of working. The average for a whole year was only 2·75lb. per electrical horse-power hour. It is not pretended that this is a phenomenally low rate of consumption. On board many of the large ocean-going steamers as low as 1·50lb. of coal per horse-power hour has been reached with triple-expansion engines; but the writer believes that few electrical power-houses have been able to show better results than those mentioned. Nor is the result to be attributed to a very large output; precisely similar results can be obtained by using similar appliances on a smaller scale. In the Montreal house there were six 800-h.p. engines, and the daily output of current averaged 43,000 units. But the author has recently obtained similar results with a small cable plant on the Birmingham cable system. In 1897 this plant consisted of a pair of single-cylinder engines running at 53 revolutions of 287 maximum horse-power, with Galloway boilers, and no special heat-saving appliances. It was necessary to increase the engine power to meet increased traffic. The author put in a pair of superposed compound condensing engines of 400 h.p., running at the same speed as before, and obtained condensing water from a well in conjunction with a tank and cooling tower. The result was that the consumption of fuel was reduced from about 325 tons per month, or 8·9lb. per car mile, to 6·5lb. per car mile; and the introduction of Green's economisers has further reduced the consumption to 4·7lb. per car mile, or to about 3lb. per horse-power hour. On the Birmingham small cable system, the saving does not amount in money to a large sum, but on a great electric system running, say, 7,000,000 car miles in the year, 4lb. of coal saved per car mile, at 9s. per ton, amounts to £5,625 per annum; and it is this consideration that gives emphasis to the plea for an economical power-house plant.

To return to the previous line of argument. Note what a large saving is effected when a cost of ½d. per car mile for power is substituted for 5d.; on a car mileage of 7,000,000 it means no less a sum than £131,250 per annum! and indicates the source whence the increase of net earnings may be obtained to pay for the heavy cost of electrical installation. The whole cost of working a large electric system, including working charges of all kinds, should be under 5d. per car mile; but this can only be obtained with a carefully constructed power-house, where the works cost of the current is cut down to a minimum.

The limits to which this note had to be confined prevent the introduction of any more elaborate figures or statistics than those given; but enough has been said to indicate that, in the writer's judgment, it is to the power-house that the chief attention should be directed in order to ensure the financial success of an electric system. Other parts of the system claim attention, but it is on this that success or failure mainly turns. More money can be lost on the one item of power than would pay all the other working charges, and whether the high-potential system with transformers or the multiple-unit system be adopted, the successful working ultimately depends upon having engines and boilers that will do their work with a low consumption of fuel.

Mr. CLIREHUGH opened the discussion. He said there was one thing which had struck him in the reading of the paper, and that was the author's pronounced recommendation of low-speed compound condensing engines running at 70 revolutions. He thought they would all be very glad if Mr. Cuningham would give them one or two reasons why he did that. In England we had spent so much for electric lighting purposes with high-speed engines, and these were practically condemned from the other side of the Atlantic for electric traction by all who had had experience in the matter. He would therefore like the author to give them some reasons why the engines we had used for electric lighting purposes should not be employed for electric traction.

Mr. H. A. MAVOR said it seemed unfortunate that with such a very large installation of electric lighting as there was at Glasgow, there should be alongside this what was likely to become a very large power installation. It appeared unfortunate that the two systems should be so isolated for several reasons, including, among others, economy, supervision, and the whole question of design.

Mr. R. HAMMOND said the paper was of great interest to him, and particularly that part in which the cost of electric traction per car mile was concerned. Speaking of the Leeds tramways, he said that the introduction of electric traction had shown great economy. At present there were three systems at work in the town, and the cost per car mile worked out as follows: horse tramways, 10·17d.; steam tramways, 10·33d.; electric tramways, 4·83d. The 4·83d. contained many items which were not included in the author's figures. At Leeds the actual cost of generation worked out at ·6d. per unit, which was high when compared with the author's figures of ·25d. He thought this figure was abnormally low, and would be glad if the author would sub-divide the cost into the usual divisions which were required by the Board of Trade in their electric lighting accounts. He would like to know how much of the total was due to the cost of coal, and how much went in stores, repairs, and wages. At Leeds the cost per unit of ·6d. compared favourably with that obtained at the electric lighting works, where the cost worked out at ·78d. The output from the two works was practically the same. He (Mr. Hammond) was rather inclined to think that slow-speed engines did give greater economy in working than those of high speed. He compared Leeds and Bradford with each other, and pointed out that both obtained their coal supply from the same coalfield. At Leeds the cost of coal per unit worked out at about half that at Bradford, where high-speed engines were used.

Mr. R. E. CROMPTON complimented the author on his paper, which was a model of what a communication to a conference like that should be. He had every reason to believe the Montreal figures, and Mr. Cuningham told him that of the cost per unit ·17 was for coal, and that all the other charges were included in the low figure of ·08 per unit. That worked out at a very low sum per day for the wages and repairs bill of such a large station. With regard to the question of high *versus* low speed engines, he had experimented for a long time at Chelmsford, and had found that, although the low-speed engine was rather more economical in coal, the extra cost of the oil required wiped out the saving. On the other hand, a much more skilled attendant was required for the low-speed engine. It was not fair to compare Mr. Cuningham's figures with electric light results, and even when compared with electric stations laid down for electro-chemical work he did not know of a lower figure than ·27 per unit. In this case the cost of coal was lower than at Montreal, working out at ·14 per unit, while oil, waste, stores, repairs, and wages cost together ·13d. per unit. In this case the plant was running continuously for 24 hours.

Dr. EDWARD HOPKINSON said that although the cost per unit at Montreal was ·25d., the cost per car mile was over ·5d., which showed that the cars took rather more than two units per car mile. He asked if accumulators were used in the generating station, as he had found that these greatly facilitated the economical working of the plant. Accumulators were able to take the small peaks and to even out the load. Mr. Cuningham explained that the cars took two units per car mile, owing to the heavy grades, which often amounted to 1 in 10, and to the high speed of over eight to twelve miles per hour on schedule which was allowed. He also thought that a considerable amount of energy was lost in the distribution system, which was not so good as usually required by the Board of Trade on this side.

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Major CARDEW said it did not follow that the increase of speed would mean increase of energy per car mile. For a given track there was one speed at which the least power was required to drive the car. He quite agreed with the conclusions of the author as regarded boilers, but he thought that 70 revolutions was a little too slow for the engine. He did not think that the units per car mile would be increased much owing to a more uniform distribution of pressure on the return circuit.

Mr. E. W. MONKHOUSE thought the figures for cost of power had been reduced to their lowest limit. It seemed to him that the cost of repairs to the electrical equipment of the cars was rather more neglected both in America and on the Continent. He gathered from a visit to America that the high cost of up-keep was due to keeping down the size of the motor and increasing the size of the car, and also to infrequent inspection. As regarded the leakage question, he had seen two systems with a return conductor. One of these was a line 21 miles long, in which the third rail was carried on paraffin blocks of wood. The leakage on this line was only 14 amperes in dry weather, and was not much increased by rain. In the conduits he had seen, in which both conductors were insulated, the leakage was found to be about half an ampere for half a mile of double track.

Mr. E. C. GRIMSHAW questioned the author's figures as regarded the saving effected by the use of economisers; 27 per cent. was a very large amount saved, and he would like to know what the feed-water temperature was at the boiler.

Mr. W. H. PATCHELL referred to the author's larger communication to the Institution of Civil Engineers in 1896. He was particularly struck in that with the low temperature of the gases leaving the boilers. It seemed to him if the figure given was correct, that the boilers were very lightly loaded.

Prof. A. B. W. KENNEDY remarked that he could support the author's figures by others equally as good. From a recent tour in America he adduced the following average results of the cost of working a tramway line: the drivers', conductors', and inspectors' wages came out at 42 per cent. of the total cost; the generating expenses at 18 per cent.; the maintenance of the cars at 12 per cent.; the maintenance of the line and equipment at 12 per cent.; and the general expenses at 16 per cent. With skill these average figures could be varied, and he had instances in which the cost of power was only 10 per cent. of the total. He agreed with Mr. Monkhouse that it was in the reduction in the cost of upkeep that savings could be looked for. As regards high and low speed engines, he did not think there was the least difficulty in the coal consumption, either on trial runs or in regular working. He proposed a hearty vote of thanks to the author for his excellent paper.

Mr. CUNINGHAM, in reply, said he had personally found in America that slow-speed engines were more economical than high-speed ones. It was in 1892 that some engines running at 250 revolutions were laid down at Toronto, and these were put to one side after 1½ years owing to the coal consumption. He thought that when condensing the condensers acted more efficiently with the low-speed types of engines. Leakage was most certainly reduced by the use of two insulated conductors in a conduit. As regarded the consumption of kilowatt-hours per car mile the following figures applied: at Montreal, 2 units; Toronto, 1½ units; Brooklyn, ·8 unit; and at Dublin, ·9 unit. He thought the consumption of coal at Leeds was high. Taking the coal at an average price of 7s. per ton, he calculated that 8lb. was used per kilowatt-hour. That figure was double what it should be. In conclusion, he pointed out that the Montreal cost of generation of ·25d. per unit was obtained from the figures from extended working, and was not the result of trial trips.

Economical Transmission and Distribution of Electricity from a Distance.

BY HORACE FIELD PARSHALL, M.I.C.E.

In introducing for discussion so broad a subject as the economical distribution and transmission of electricity from a distance, only a very general statement is possible, since local conditions cause widely different conclusions to be arrived at in different cases. The subject may be subdivided into: (1) economical generation; (2) economical transmission; and (3) economical distribution.

1. *Economical Generation.*—There is not much to be said on the subject of economical generation, if the electrical conditions alone are considered, since the difference in efficiency, cost, and maintenance between types of generators, whether continuous-current, alternating-current, or multiphase, is but small. In dealing with multiphase transmission, there may arise conditions where the use of step-up transformers will be found more satisfactory, commercially, than the use of generators working at very high pressure.

2. *Economical Transmission.*—In the transmission lines, so far as the cost of conductors is concerned, and the efficiency in transmission up to the commercial limit of cost of generating or transforming apparatus, there is a direct gain in increasing the voltage where overhead lines are permissible. Where underground cables have to be considered, with the present knowledge of cable-making, it may be said that 20,000 volts is the safe limit.

3. *Economical Distribution.*—This has to be determined with reference to the conditions to be maintained in the consumer's circuit. These conditions are as to whether continuous or alternating currents are most adaptable for a particular set of local conditions, or whether the combination of both could be made to meet the widest range, and finally what conditions as to voltage drop have to be maintained. Either for lighting, or in earth returns for electric traction, a very small voltage drop only is permissible.

A number of small electric sub-stations will, from a commercial point of view, be found more economical than would be the case if each were to be a complete generating station. Sub-station plant can be built free from objectionable vibration or noise. It also occupies exceedingly little space. For these reasons, it can be located in situations which would be impossible if complete generating stations had to be laid down. Numerous sub-stations involve lower efficiency in transformation, higher first cost of plant, and heavier attendance charges. On the other hand, a saving is effected both in feeders and distributors, and the efficiency of transmission is increased, due to smaller feeder losses. Any general rule as to the most economical number of sub-stations to employ is impossible. For a particular case of fairly uniform distribution over a large area at a rate of 1,000 kw. or more per square mile, a radius of distribution of half a mile would be warranted from economical considerations. Smaller supply densities, and in general ununiform distribution, will increase the economical radius of supply and diminish the best number of sub-stations. With short feeders the further advantage is obtained that the feeder drops are smaller, and the consequent variation of voltage at different parts of the system through different feeders loading up irregularly is largely eliminated, with consequent simplification in switchboards, better service, and more economical running of the plant. The arrangement of sub-stations has also to be considered in respect to the nature of the load, so that in the case of the average load the losses due to friction and hysteresis will be balanced against the $C^2 R$ losses.

In general, it may be said that single-phase transmission has had its day. In any scheme, even though designed primarily with a view to lighting distribution, it becomes necessary to take into account probable demands for power. So far, the single-phase motor has not been a success, and in districts where single-phase plant has been laid down special arrangements are being generally made for the supply of continuous current for power purposes. The gradual perfection of the generating apparatus, so that current can be obtained reliably at very high voltage, the high efficiency of the transmitting mains, together with the step-down transformers and rotary converter, and the great flexibility of such system, has led many engineers to believe that multiphase transmission with rotary converters and continuous-current distribution will be the ultimate system in dealing with large powers over any extended area.

(Continued on page 731.)

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THE AUTOMOBILE CLUB AND ELECTRIC TRACTION.

The closure of the Automobile Club at the Place de la Concorde in Paris is no doubt an unfortunate result of the recent ebullition of political rancour in the Ville Lumière. To the untravelled Englishman having little acquaintance with the ways and manners of the Latin races, it must seem strange that this result has been brought about through a publicly-expressed solicitude for the welfare of the French army on the part of a vice-president of the club, who is also one of its founders. But the cry of "Vive l'Armée," at the present juncture, may be translated as "Down with the Republic, down with Loubet, down with Dreyfus and all his friends!" It has in any case been sufficient to occasion the arrest and incarceration of the very popular and generally esteemed Comte de Dion, a gentleman who occupies the above-mentioned position, and who has done much to encourage invention in the direction of automotric traction, and to render this a fashionable pursuit and hobby. Considering that the Count was the only member of the club arrested, and that there is no club in Paris where politics are less frequently discussed, the other members naturally think it very hard that M. Cochefert should have affixed the seals of the police on the doors of their meeting-place. But the reactionaries are making political capital out of the event by insisting that the Government have made an irreparable blunder, and have seriously damaged in France an important and rapidly-growing industry, which needs every encouragement rather than the check upon it occasioned by shutting up its headquarters. We sincerely hope and believe, however, that this untoward event, even if M. de Dion should not think fit to resign his official position in the club, will prove to be only a temporary inconvenience to its members; and we certainly cannot think that it will be of detriment to the growing industries connected with the various kinds of autocar. Indeed, if it were not for the international competitive trials of accumulators for road traction which have been organised by the club, we should not be inclined to attach much importance to the patronage and requirements of a fashionable and aristocratic coterie in their relations to a great manufacturing industry. The patronage to which this may look forward is that of the commercial world, if not that of the million; the requirements it has to meet are not those of sensational performance or vehicular luxury, but those of economy and general utility. The true commercial bearings of automotric traction have, we think, been more carefully considered in America than in this country or in France. A Chicago manufacturer of electric motor vehicles has pointed out that his work, and that of other constructors in America, is now directed toward the development and perfecting of vehicles for general and commercial use, instead of to one or two specific forms of so-called "machines" for amateurs. "The prospective purchaser," he says, "will buy his carriage, not because it goes without a horse, not because he

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wants to be a conspicuous figure in the street, but because, on the whole, it is the most economical, suitable, cleanly, and rapid means of conveyance for himself and his family, and for use in his business." In country districts, there is no doubt a sphere of utility for automotric vehicles worked by steam or petroleum. But the facts that in towns these are altogether objectionable, and that, on the other hand, the advantages of electrical power are incomparably greater, provided a suitable accumulator be forthcoming, should have been recognised in practice at least two years ago. Many of the steam and oil motors used by amateurs are but beautifully-made toys; they may produce sensational results, but have no commercial future to look forward to. Electric motor-cabs, under certain auspices, may have failed in London; but, to say nothing of America, they have in Paris completely beaten out of the field the hackney carriages propelled by petroleum motors which used to be seen in the streets of that city two years ago. Several companies have constructed and are constructing electrical vehicles for public use; and some months ago the Société des Petites Voitures announced its intention of ultimately replacing all its horse-drawn cabs by electric motor carriages. For fire-engines at least, the less cleanly and convenient motors might have been considered well adapted; but the Paris Fire Brigade, after due trial, prefer electric motor traction, and intend to adopt it exclusively. The improvements which have been made, and are being made, in accumulators for traction purposes would suffice to convert automotric conveyance by means of electricity from a probability into a certainty. And this progress is certainly due in great measure to the Automobile Club of France. They showed that, in every respect excepting that of long duration, the Fulmen accumulator surpassed in its performance anything that could have been anticipated five years ago; and, following its lead, we have now several other batteries from which as much, or more, may be inspected. As we go to press we hear that the Comte de Dion has written to the Prefect of Police to say that he is willing to resign the vice-chairmanship of the Automobile Club if by so doing he can pave the way for it to obtain leave to reopen its doors.

THE CENTENARY OF THE ROYAL INSTITUTION.

The centenary banquet of this institution was held on Monday last in Merchant Taylors' Hall, the chair being taken by the president (the Duke of Northumberland). The Prince of Wales, the Duke of Cambridge, Lord Lister, Lord Kelvin, Lord Rayleigh, and other notable men were present.

In answer to the loyal toasts, proposed by the CHAIRMAN,

The PRINCE OF WALES said he considered it a great honour to take part in the celebration of the hundredth anniversary of the institution. Although it was nearly half a century ago that he and the Duke of Coburg attended the lectures given by Michael Faraday, he had not forgotten the clear way in which that professor explained difficult scientific problems and experiments. It was now 100 years since Count Rumford founded the institution in the same building in which lectures were given and work still carried on, in Albemarle-street. Amongst the most remarkable of the discoveries with which the institution was associated was that of Davy, which had saved thousands of lives, and it was needless to speak of the researches of Faraday and of the later achievements of Lord Rayleigh, whose lecture on the morrow they were looking forward to.

The DUKE OF CAMBRIDGE, in proposing "The Royal Institution of Great Britain," said it was worthy of remembrance that the institution of which they were celebrating the centenary was founded by an American gentleman. It came into existence in 1799, but the idea which underlay it was first put forward in 1753. The object declared was the diffusion of knowledge and the introduction of useful mechanical inventions, and the means were to be courses of lectures and experiments illustrating the applications of science to daily life. During those 100 years the march of intellect had been rapid, and in the domain of science the Royal Institution had made contributions to which they were all deeply indebted. As they knew, he was himself a soldier, and soldiers owed much to science and to that institution for the inventions which had made war, not impossible, indeed, but far less likely of occurrence than in former days. They were glad to see the Duke of Northumberland in the chair, and desired to express to his Grace their heartiest good wishes for the prosperity and extended usefulness of the great body over which he presided.

The CHAIRMAN, in reply, said they did not limit their interest to pure science alone, but literature and history had also been the subjects of admirable discourses by acknowledged masters.

The LORD CHANCELLOR proposed the toast of "The Guests," which was responded to by Mr. S. P. LANGLEY.

On Tuesday the Prince of Wales attended at the institution for the purpose of hearing the commemoration lecture by Lord Rayleigh. The lecturer began by taking the discoveries made and developments introduced by Thomas Young in the early part of the century, and presented a brief retrospect of his researches. Having thus cleared the ground, he exhibited some of the most striking of those experiments by which Young had demonstrated the results of his historic investigations. Foremost of these was the wave theory of light. As Newton had adopted the corpuscular or emission theory, Dr. Young's doctrine encountered strenuous opposition, especially from Lord Brougham. It was only after its independent discovery and enunciation by Fresnel that the soundness of Young's undulatory principle was admitted, as it now is universally. He was one of the first to state in accurate language the true conception of energy as measured by the power of matter in motion to do work. The composition of colours, the tides, sound, and heat were also among the subjects of his investigation. In order, however, to remove from the minds of his hearers the impression that Young knew everything, the lecturer recalled, amid laughter, the brilliant *savant's* surprising declaration upon one occasion, that "there is no reason to imagine any immediate connection between electricity and magnetism." The lecture concluded with some interesting examples of instantaneous photography.

The Prince of Wales then proceeded to deliver the diplomas to the distinguished representatives of science introduced to him for that purpose. The names of these gentlemen appeared in a recent issue.

The distribution at an end, the DUKE OF NORTHUMBERLAND, in appropriate terms, proposed a vote of thanks to the Prince of Wales for his presence in the chair and the warm interest he had manifested in the centenary of the institution. The vote was seconded by the DUKE OF DEVONSHIRE.

His ROYAL HIGHNESS, in reply, said he was deeply sensible of the kind words that had fallen from the lips of the Duke of Northumberland and the Duke of Devonshire. He need hardly assure them that he should always look back with the deepest pleasure to the circumstances under which he had taken part in the centenary of the Royal Institution. Having enjoyed the advantage of listening to many great scientific men, who had given lectures in that room, he was glad to have had the opportunity of being present and hearing the interesting lecture Lord Rayleigh

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had so kindly given them and witnessing his excellent experiments. As the Duke of Devonshire had said, theirs was a national institution. It was self-supporting, and during the past 100 years there was no doubt that the scientific knowledge which had been acquired through it had not only been appreciated by this country, but in every part of the world. As vice-patron of the institution, he begged to express their thanks to those distinguished gentlemen who had come across the water to join them in their centenary festival.

The second lecture in connection with the celebration of the centenary was given on Wednesday night by Prof. Dewar, and it was the first occasion at which liquid hydrogen has been seen outside the laboratory.

Prof. DEWAR said his object was to introduce his audience to a new instrument of research—viz., liquid hydrogen. This he exhibited boiling in a vacuum tube immersed in liquid air. They would notice it was a transparent liquid, in which there appeared a whitish deposit. This consisted of solid air, and it was impossible to avoid its presence. A sponge of porous material, soaked in liquid hydrogen and brought into a magnetic field, behaved as if it were magnetic. That, however, was due to the condensation of the oxygen of the air, which, of course, was magnetic, and though an observer might in this way be easily deceived into thinking hydrogen magnetic, Prof. Dewar said he was satisfied that it was nearly neutral or diamagnetic. The real temperature of this liquid, he said, was 21deg. on the absolute scale. It had taken him nearly a year to come to a definite conclusion on that point because he could not get any two thermometers to agree. Extraordinarily low vacua might be obtained by the use of liquid hydrogen, so low, in fact, as to prevent the passage of an electric current.

Lord KELVIN then moved a vote of thanks, which was seconded by Sir G. STOKES.

Prof. DEWAR, in reply, referred in appreciative terms to the part taken in the liquefaction of hydrogen by his assistant, Mr. Lennox. For himself, his chief function had been to get the wherewithal to carry on the experiments, and without the assistance he had received from numerous friends they would have been absolutely impossible.

THE PRACTICAL TESTING OF ELECTRICITY METERS FOR CENTRAL STATIONS.

BY C. A. L. PRUSMANN, A.M.I.E.E., ASSISTANT ELECTRICAL ENGINEER, BRADFORD.

(Continued from page 591.)

Instruments.—It was stated earlier in this series of articles that two sets of tests are carried out on meters: the "short time" test, the object of which is to arrive at the actual accuracy of the meter, and the "front dial" test, the object of which is to ascertain that the train of wheels is properly in gear with the meter spindle, or what corresponds to it, and that the ratio of the gear wheels is correct, etc.

Dealing with the short time test first, what instruments do we require? Turning to Fig. 13, it will be seen there is an ammeter inserted in circuit between the fuse and the connecting bar, and in Fig. 14 a second ammeter connected between a second fuse and the horizontal bar of the plug board. The object of the two ammeters is as follows: The first one is of a different range to the second. Suppose small capacity meters are being tested, say up to 10 amperes, the two ammeters are left in series, the low-reading one being the one used. If, however, meters from 25 to 100 amperes capacity are being tested, the ammeter shown in Fig. 13 is cut out by means of disconnecting links, not shown in the figure, leaving the high-reading instrument only in circuit. It is not our intention to advocate any particular make of ammeter as being the best, as any of the good makers turn out an instrument suited for this particular purpose. The essential characteristics are a clear, well-marked, open scale, a sensitive pointer, and an instrument not likely to alter its calibration. The Thomson ampere-gauge has been largely used for the purpose by the author, with highly satisfactory results.

Ammeters should be provided on all meter-testing circuits. The "short time" test circuits are connected to the plug-board, to which are connected the standard instruments. Thomson balances are undoubtedly the best for this purpose. These instruments are so very well known, and their high degree of accuracy throughout a large range so well established, that they need no description. A set of three of these instruments, as follows, will be found most useful:

One deci-ampere balance, ·1 to 10 amperes.
One deka-ampere balance, 1 to 100 amperes.
One hekto-ampere balance, 6 to 600 amperes.

These balances should be fixed *permanently* on the testing table, and not used as portable instruments. It seems unreasonable to expect instruments of this nature to stand carrying about as portable instruments. We know, however, one engineer who employed Thomson balances for measuring the current taken by the lamps fixed at a consumer's installations, the balance being carried from one place to another. There are one or two points relating to the use of these balances which are not generally known, and which may with advantage be stated. The maximum current for use with the balance must never be left on *continuously*, for if this is done, the instrument will heat up to such an extent that the paraffin wax used on the coils will melt and run out. We have had occasion to inspect a balance where this had happened, and the instrument was certainly somewhat seriously damaged in consequence. Nothing over 75 per cent. of the rated maximum current should be left on the balance continuously. A further very common mistake is that of lifting the movable beam off the suspending ligaments when the balance is not actually in use. This should only be done if there is occasion to move the balance from one place to another, but otherwise the beam should be always left suspended from the ligaments. There are certain other points in the using and handling of these instruments which require careful attention. These are clearly set forth in the pamphlet brought out by James White, Glasgow, relating to Lord Kelvin's instruments, and which well repays perusal.

Another instrument which may be used as an auxiliary standard is the well-known Siemens dynamometer. These instruments are very handy and useful, and if a proper system of checking them periodically is carried out, give entirely satisfactory results. It is therefore necessary to compare them from time to time with some more permanent standard instrument, such as a Thomson balance, or some form of potentiometer, and it may also be found necessary to obtain a new constant for the dynamometer if the torsion spring has altered in any way. These instruments are liable to be affected if exposed to currents of air, and are also affected by magnetic disturbances. The leads going to and returning from the instrument should be run together, straight into the terminals. Having now obtained our ammeters and standard instruments, which are we to actually use in the carrying out of a test? Provided the ammeters are frequently standardised, there is no real reason why they should not be employed for testing, but there must be no doubt as to their accuracy if they are to be used for this purpose. Personally we prefer to carry out a test actually on the standard instruments if convenient, the ammeter simply being used when obtaining the approximate right value of current, before commencing the test. It is not advisable under any circumstances, however, to have only a standard instrument in circuit, as it is then possible to let the current value reach an amount far in excess of the required amount, due, for instance, to placing wrong weights on the balance beam, or other causes of a like nature. A *direct*-reading ammeter should always be left in circuit, so that a glance will show at once what the current is, and, if too large, steps can be taken to remedy, and prevent accidents. A wise precaution is to connect the ammeter only in circuit when obtaining the necessary current for a test, by making use of the "through connecting bar," shown in Fig. 14. When this is obtained

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the plugs must be inserted at different points in the plug-board so as to connect the required standard instrument in circuit. It will then be found that the current in the circuit will have decreased in value, particularly if the smaller balance is in use on top load. The current, however, can easily be brought up to the required amount by adjustment on the resistances. Again, first obtaining the current should be carried out with the meters to be tested not in circuit, particularly with some classes of meters which are affected if overloaded. The same result will of course follow here: a diminution of the current when the meters are connected in circuit, owing to the drop in volts over the meters. Finally, then, the point to be obtained is to always start with the current below the maximum carrying capacity of certain meters and standard instruments, and to gradually increase it in value as may be necessary. The test can then be commenced without fear of accident. We may relate an incident showing how important this is: A large number of meters of a certain make were to be tested on full load. The current was switched on to such an amount as ought to have been safe according to the test-room electrician in charge of the test. But, unfortunately, through an oversight it was very considerably over the supposed value, the consequence being that the calibration of the whole batch of meters, almost without exception, was seriously altered.

Turning our attention to the instruments required for the pressure circuits, all that is required is a really reliable voltmeter or two, having a good open scale at and about the declared pressure of supply. Two makes of instruments are in use at Bradford for this purpose—viz., the Kelvin electrostatic voltmeters and the Weston circular pattern voltmeters. Other instruments which will be found necessary are as follows: A low-reading voltmeter for obtaining the drop in volts across meters of varying sizes and under different loads. The Siemens torsion voltmeter is useful for this purpose, and when provided with extra external resistance is capable of giving a very wide range with great accuracy.

Like the Siemens dynamometer, however, it requires to be checked systematically against some standard, owing to its liability to alter, due to changes in the torsion spring and the permanent magnet. Low-reading portable Weston voltmeters adapt themselves very well to purposes of this kind, reading to two or three volts.

For taking insulation and resistances a Silvertown testing set answers admirably, and the author certainly prefers to use it rather than an ohmmeter and generator. The Kelvin testing set for use either with a battery or the town pressure, is a capital instrument for many purposes of insulation resistance testing. The great advantage, however, of the Silvertown set lies in the fact that a Wheatstone bridge is combined with the insulation resistance testing portion, and the instrument, which is very compact, is therefore capable of serving a dual purpose. A certain number of portable ammeters, of different ranges, and a voltmeter will be necessary where it is required to test meters on consumers' premises. The Weston portable instruments are particularly suitable for this purpose. They possess an excellent degree of accuracy, they are compact, and of such a type as to enable them to be laid flat. Instruments requiring to be screwed against a vertical support are not so convenient for meter testing on consumers' premises, as it is generally easier to arrange the instruments where they can be laid on to a table or box.

This practically completes the list of instruments which ought to be found in any well-equipped meter department, with one important exception. What absolute standard instrument is to be provided for periodically checking all the above-mentioned instruments? Undoubtedly some form of potentiometer. The Crompton potentiometer is the one in use at Bradford, and has proved of the very utmost value in enabling very accurate and reliable results to be obtained. An instrument of this kind with the necessary accessories is a somewhat costly affair, but as its range and uses are almost unlimited, it is an instrument which very soon justifies the outlay. To carry out any electrical tests with instruments as to the accuracy of which one cannot feel quite certain is a most unsatisfactory state of affairs. A test, to be of any value, should give a result with which the person in charge of the test is absolutely confident as to it being accurate and reliable in every respect. To ensure this, very close attention is required to be given to detail, particularly as regards accuracy of instruments in use, setting of zero, reading of dials, and such like points. There is, in fact, no branch of electrical work where attention to detail is of such vital importance as in electrical testing and measurements. A potentiometer, therefore, should certainly be found in every central station, not as being a luxury, but an absolute necessity. It is not within the scope of this present series of articles to go into the uses, the method of fixing up, and practical manipulation of the potentiometer. For full information on this subject the author would advise a careful study of "The Potentiometer and its Adjuncts," by Clark Fisher.

This, then, completes the section relating to instruments. A few remarks respecting the meter department staff may be of interest, after which we may pass on to consider the practical testing, and to enquire into the good and bad points of different makes of meters.

(To be continued.)

INSTITUTION OF CIVIL ENGINEERS.

(Continued from page 727.)

The popular formula amongst the more progressive engineers is to use multiphase transmission at a periodicity of 25 to 50, at from 5,000 to 40,000 volts, according to the distance and conditions of transmission.

There is comparatively little choice between two-phase or three-phase currents. The conditions favouring three-phase transmission are in respect to the small amount of copper required and greater flexibility in the use of transformers. Thus, without increase in complication, the three-phase system requires but three-quarters of the weight of copper necessary for two-phase currents, and the transformers may be connected for six-phase transformation instead of three-phase in dealing with rotary converters—a condition very favourable to practical working.

The theory of the action of the rotary converter has been definitely laid down, and there is at the present day plenty of experience as to its working in practice. The early difficulties experienced have been largely overcome by more careful design both in the prime mover and in the rotary converter itself. It has been found necessary to give attention to the production of constant angular velocity in the prime mover.

In England, on account of the stringent regulations in connection with the working of tramways, multiphase currents become economical at less distance than in most other countries, since the losses due to transformation are compensated for by the advantages gained by centralisation The only two notable multiphase installations in the United Kingdom working are those of Dublin and Middlesbrough. There are, however, the greater installations of the Central London Railway, the London United Tramways, and the Glasgow and Metropolitan. When these are completed, it can be fairly said that these installations demonstrate the general feeling amongst engineers that the multiphase system of generation is the one most likely to give economical results even over comparatively limited areas.

Mr. T. PARKER considered that the paper was wanting in definite information and figures, and he regretted the absence of the author. He (Mr. Parker) had had much experience with high-tension continuous-current machines, and had many working successfully up to 2,500 volts. He had no doubt but that they could be us d commercially up to 5,000 volt pressures. The question of synchronising was one which had caused great trouble with alternate-current plants, and when considering the type of plant to be used by the Midland Company he had fears on this point if two-phase working were adopted. In fact, for all districts which could be run by 5,000 volts he much preferred the continuous-current system.

Major P. CARDEW agreed with the author's conclusions as far as they went. As regarded the difficulties of synchronising, one solution might be to generate continuous

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current and then transform to three-phase for transmission. That would entail one rotary converter at each end of the line, but it would render each such pair independent of the speed of the others. In reply to Mr. Hammond's query raised on Mr. Swinburne's paper of two *v.* three phase currents, the two-phase system should be worked with four wires, so that two concentric mains with outers earthed could be used. If three wires were employed, the three-phase system might just as well be used. When supplying lamps from a three-phase system, one must not split the phases up and try to use one pair of wires only for lighting.

Mr. R. E. CROMPTON commented on the fact that for electric traction and transmission of power greater distances had to be dealt with than with electric lighting. Hence the commercial limits of continuous currents appeared to be exceeded. He had had great facilities for studying the advances in pressure in multiphase work, as their late manager, Mr. Howard, had obtained important appointments in the States and was actually engaged on such work. Mr. Howard looked upon the voltage of 40,000 used at the Telluride Works as something of an experiment, but voltages of 25,000 were quite commercial, and used in everyday work in many places. The practice regarding the winding of generators and motors for high voltages was about as follows: machines of 500 kw. output could be successfully wound direct to give 10,000 volts, while with dynamos of over 700 kw. output 15,000 to 20,000 volts could be obtained direct. Mr. Howard had laid special stress on the freedom from faults in such high-tension generators, and had stated that such faults were fewer than he had found in low-voltage generators in England. One great advantage of the three-phase system over the two-phase was in the copper saved, but the advantage from the use of six-phase currents in the rotary converter was also great. Such currents could be obtained easily by transformation from three-phase currents. The question arose of whether the system of three-phase motors for traction purposes, such as had been developed by Mr. C. E. L. Brown, would not ultimately prevail. It gave very great simplicity in transmission and transformation. Respecting the sub-station question, it was not very important whether they were spaced one-quarter of a mile or three-quarters of a mile apart. In some calculations he had made on a proposed electric railway, he found that in spacing the transformer stations from four to seven apart made no difference to the cost.

Prof. R. B. OWENS, of the McGill University, described the details of several very large plants now being put down in the States, in which high voltages and low frequency were being used. As regarded the line loss from static discharges, that was not serious until 60,000 volts was reached, after which it increased very rapidly indeed. There was a tendency in certain cases in America to increase the inductance of the alternators to such a degree that at short-circuit they did not take more than three times the normal current, which did not harm them. Then all safety devices were dispensed with, and that had proved a great advantage, as even if the line were short-circuited, no harm was done to the machine.

Mr. WILSON raised further points on the synchronising question, and pointed out how far the engines affected the synchronous running. That was especially the case with triple-expansion engines, as the load was not equally divided between the cylinders at light loads.

Mr. ROBERT HAMMOND very much regretted Mr. Parshall's absence while his paper was being read. He deprecated the multiplication of sub-stations containing running machines, such as was advocated by the author.

Prof. A. B. W. KENNEDY drew attention to a curve of the variation in the price of copper which had been prepared by Mr. B. H. Thwaite, from which that gentleman concluded that the three-phase system had the advantage, and also that aluminium might come into use in place of copper. Prof. Kennedy said that while continuous currents were most advantageous for distributing purposes, there were certain town districts which would have to be supplied from the outside. He thought in this respect that single-phase transmission was worthy of consideration, as with a continuous-current supply on the rotary converter the starting trouble was overcome. The system could be arranged very simply. He proposed that a vote of thanks be given to the author of the paper, which had raised such an interesting discussion.

THE THEORY OF DISSOCIATION AS APPLIED TO GALVANIC CURRENTS.

BY PROF. A. VON OETTINGEN.

The following paper was read before the Chemical and Metallurgical Society of South Africa on Feb. 15. In introducing the author to the society the president stated that he did not call Prof. von Oettingen their distinguished guest because the council had just elected him an honorary member of the society. We are indebted to the *Journal* of the society for the text of the interesting paper, which reads as follows:

The theory of dissociation, which I endeavoured to briefly outline at the last meeting, has had very great influence on our conceptions of galvanic phenomena. This applies both as regards the conductivity of solutions and as regards the phenomena occurring at the electrodes. In other words, this theory is concerned generally with the electrical pressure caused by the contact of solid bodies with solutions and of solutions with one another.

We may distinguish three kinds of conductivity in different parts of a galvanic current as follows: (1) in solid conducting bodies; (2) in fluid electrolytes; (3) the transition or transfer of the current from solid to fluid bodies, or, inversely, from fluid to solid bodies.

1. In solid conductors the electricity itself travels from one solid particle to another, the particles themselves remaining motionless. This kind of conductivity is termed "metallic."

2. In fluid electrolytes the electricity travels solely by means of the ions, the positive electricity being associated with the cations and the negative with the anions.

3. When solid bodies are in contact with fluids the whole electric current is sustained by the cations from the negative electrode and by the anions from the positive electrode.

I do not propose to deal with the passage of electric currents through metallic bodies, but will confine myself to the phenomena attending their entrance into, passage through, and exit from fluid electrolytes.

The basis of all theories of electric currents is Faraday's law that in electrolysis the masses developed at the electrodes are equivalent, and that these equivalents are proportional to the amount of electricity conveyed by the current. This law indicates that when a certain intensity of current is employed chemical affinity has no influence, because the valency of any ion is such as will carry only a certain definite amount of electricity. Faraday's law has been confirmed by Helmholtz with currents of ·02 microampere, which would only yield one milligramme of hydrogen in 150 years. Helmholtz, likewise, in a speech delivered in London on April 5, 1881, first enunciated the idea of the electrical charges of the ions, which charges cannot be divided so long as atoms are indivisible. In metallic bodies such a limit for a minimum quantity of electricity does not exist, or is not known.

The conception that salts consisted of a combination of basic and acid radicles was first suggested by Daniell, but was not appreciated until Hittorf, after many observations, announced as a new fact that ions migrate with different velocities. By analysing the electrolytes near the electrodes and in the centre he was enabled to determine the relative rates of these velocities. Calling n the amount of migration of the anion and $1-n$ that of the cation, he concluded that the ratio of these two quantities is also the ratio of the velocity v of the anion to the velocity u of the cation. This relation he expressed by the equation,

$$\frac{u}{v} = \frac{1-n}{u}.$$

Hittorf also found that the fraction $\frac{u}{v}$ does not vary with

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the electric pressure nor with the temperature, nor, within certain limits, with the degree of concentration of the electrolyte. These statements apply only to the ratio $u : v$, each of the quantities u and v depending upon other laws.

Further advances were not made until means were devised of accurately measuring the conductivity of fluids. The discovery of the now well-known telephone method, an application of Wheatstone's bridge with alternating currents, is due to F. Kohlrausch. This *savant* made all observations of conductivity with due regard to molecular weights, and, in doing so, first expressed the conception of molecular conductivity. I shall give one illustration of the differences of the figures obtained in this way :

KCl. Solution.	Conductivity (at 25deg. C.). Specific.	Molecular.
3.N.	·250	82 7
N. 1	·0919	91·9
N. 2	·0479	95·8
N. 10	·01047	104·7
N. 100	·001147	114·7
N. 1,000	·0001198	119·8

Thus Kohlrausch found that the molecular conductivity increases with the dilution, whilst the specific conductivity is not quite proportional to the concentration; the figures for the conductivity of N. 10 KCl, for instance, are a little greater than for that of N. 1 KCl. Molecular conductivity invariably increases on dilution, and acquires a maximum value with infinite dilution. Calling this maximum L, and comparing different series of salt solutions, he stated

$$L = u + v,$$

that is to say, in very dilute solutions the conductivity is the sum of the velocities of the ions, because these carry all the electricity and must therefore by addition yield the total conductivity. At this time Kohlrausch did not consider dissociation, but regarded the ions only in Faraday's sense.

It is obvious that by Hittorf's equation, $\frac{u}{v} = \frac{1-n}{n}$, and by Kohlrausch's equation, $u + v = L$, the quantities n and L being observed, u and v may be determined.

(To be continued.)

ELECTRIC LOCOMOTIVES IN PRACTICE, AND TRACTIVE RESISTANCE IN TUNNELS, WITH NOTES ON ELECTRIC LOCOMOTIVE DESIGN.*

BY PETER MCMAHON, MEMBER.

(Concluded from page 701.)

After this, the author works out another design with 972 conductors in the armature, and calculates the results by the same way, and a third design with 1,134 armature conductors. Figs. 37 and 38 show the calculated performance diagrams of these two motors. These calculations, and the reasoning by which the author was led to make trial designs, are worthy of most careful study, and we regret that our limited space prevents us publishing them in full. Having laid down certain conditions, arrived at by theoretical reasoning, which govern the design of an economical locomotive, the author describes what success has followed the putting of some of these ideas into practice.

The motors of No. 3 locomotive, which is of the same type as No. 12 locomotive, were rewound with 810 conductors, or an increase of 50 per cent. on the old winding (the old armature, it may be remembered, had 540 conductors) and was arranged to work with a series-parallel controller. The results obtained by this change are perhaps best shown by an inspection of the actual "performance diagrams" in ordinary everyday working conditions. Fig. 48 is obtained from a trip between Stockwell and the City, and Fig. 49 gives the return trip from the City to Stockwell. The speed and current curves taken on the Elephant-Kennington sections are plotted in Fig. 50 for Nos. 3 and 12 locomotives, and show the effect of the alteration in the locomotive.

* Paper read before the Institution of Electrical Engineers.

In the addendum to his paper, Mr. McMahon gives a description and tests of some newer locomotives, Nos. 19 and 20, which, in view of the heavier trains, it was decided to make more powerful. The size of the locomotive cab was practically limited to the same overall dimensions as the old locomotives on account of local conditions, and it was therefore necessary to get larger motors into a cab of the same size. In the old locomotives the magnets are very close to the working conductor, and to get more clearance a wheel 31in. in diameter was adopted instead of a 27in. wheel. This also allowed an armature of larger diameter to be used. Each locomotive is fitted with two motors of the four-pole type, the armatures having slotted cores and drum winding. The series-parallel method of control is adopted, and in addition to storage reservoirs for compressed air for the Westinghouse brake, independent electrical air-compressors are used. The weight of the locomotive complete is about 12¼ tons.

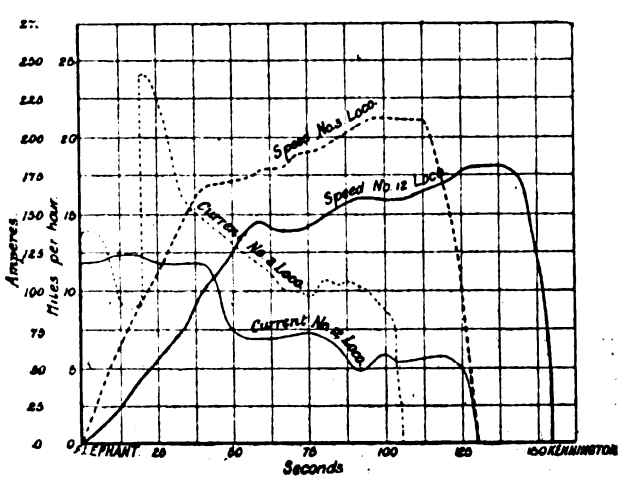

FIG. 50.—Diagram showing Difference between Series and Series-Parallel Control

The characteristic curves of the motors of locomotives Nos. 19 and 20 are given in Figs. 51 and 52, from which it will be seen that the tractive force per ampere is considerably higher than in the case of the old locomotives. The "performance diagrams" on the line for a complete round trip are given in the paper. These tests were made with a three-coach train, and as the locomotives were designed for a four-coach train service, they were not working under their most economical conditions. The results of these tests, together with the previous tests of Nos. 3 and 12 locomotives, are given in the following table in kilowatt-hours per "ton-mile." It will be noticed that while the energy per ton-mile is practically constant, there is an increase in the average speed.

Number of locomotive.	Kilowatt-hour per ton-mile.	Average speed in miles per hour.
12	·0515	13·62
3	·0558	15·60
19	·0552	15·86
20	·0552	16·65

No. 20 locomotive gives the highest average speed, and it may be mentioned here that when this locomotive was ordered the author was in a better position to specify the requirements than when the order for No. 19 locomotive was placed. The latter locomotive was nearing completion before the former was required, and when the plans of No. 19 were prepared, the author had not gone so far into the question of locomotive design.

Locomotive No. 21.—The design and details of this and the remaining 11 locomotives were based upon the result of the tests and deductions already mentioned.

The general appearance and leading dimensions of the cab are given in Fig. 57, from which it will be seen that the wheels are 31in. in diameter, and the wheel base is 5ft. 6in. The motors are so arranged that the floor of the cab is level, and the driver has considerably more room than in the old locomotives. The steel cylinders forming the air reservoirs are arranged one on each side of the cab, and have a total capacity of 18 cubic feet. Under the reservoir on one side are fitted the Westinghouse brake cylinder and brake gear connected therewith, and the electrically driven air-compressor; while on the other side,

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the switchboard containing the series-parallel controller, reversing switch, motor cut-out, and main switches and fuse are placed; the regulating resistances are fitted directly under the air reservoir on this side, close to the controlling arrangements. The drawing (Fig. 58) gives the general arrangement and details of the motor, which is of the four-pole type, with the field-magnet coils on the horizontal poles. The magnet is split across the diagonal corners, and the brackets carrying the motor bearings are divided in halves, so that each part of the magnet carries its bracket with it when the halves are separated to get the armature out. The armature is drum wound, with the conductors in slots. The characteristic curves of the motor are given in

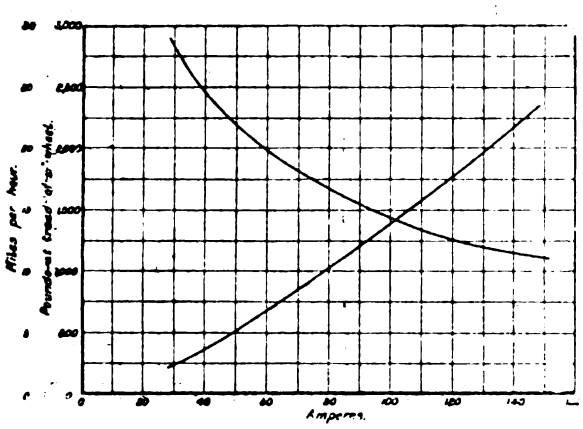

FIG. 51.—Characteristic Curve, No 19 Locomotive Motor.

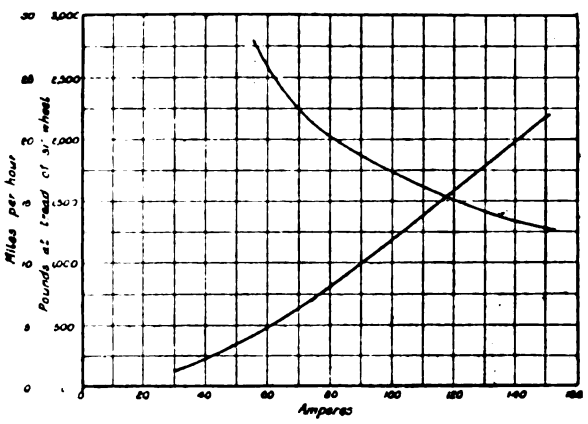

FIG. 52.—Characteristic Curve, No. 20 Locomotive Motor.

Fig. 59. A description of the controlling arrangement and connections is added below. The weight of the locomotive complete is about 12¼ tons.

A "performance diagram" of this locomotive hauling a four-coach train is given in Fig. 63, from which it will be seen that the time taken to run a level section 2,700ft. long is 130 seconds, the current being shut off 74 seconds after starting, the locomotive coasting for 41·5 seconds and the brakes being then applied. The watt-hour consumption for the section is 1,360. If the current is kept on until the brakes are applied the section can be run in 122 seconds, the watt-hours being 1,650. This, it will be seen, is very similar to the ideal motor, No. 6, referred to in the earlier part of the paper, where the time and energy under the same condition were 128·5 seconds and 1,267 watt-hours respectively.

Method of Control.—In electric traction with separate locomotives there are conditions slightly different from those where motorcars are used. In coupling-up the locomotive to the train the driver cannot always stop in the exact position to enable the coupling to be attached; and it is often necessary to move the locomotive through a mere fraction of an inch. Experience has shown that to avoid bad flashing on the controller contacts when a current of, say, 100 amperes is suddenly switched on and off before the motors have made a fraction of a revolution, the regulating resistance should be divided into a large number of steps. The plain rheostat switch used on the old locomotives answered this purpose admirably, and in adopting a series-parallel controller this object was kept in view. Further, the drivers were used to this class of switching gear, and a series-parallel controller, retaining the old form of rheostat switch, was developed. This series-parallel controller consists of two switches operated by a single handle, that part of the controller which puts the motors into parallel being moved only at predetermined points. Magnetic blow-outs, or other spark-killing devices, are not used, the motors being put into parallel practically without any flashing on the contacts, and not being put back into the series position again until the current is switched off the locomotive. The drawings (Figs. 60 and 61) show the construction and connections of this arrangement. It is not necessary to lock the paralleling part of the switch to avoid short-circuiting when a motor is cut out of circuit, this contingency being provided for in the switch used for cutting out a motor. The contacts for shunting the field at starting are shown alongside the parallel contacts.

This controller was first used on No. 3 locomotive in the latter part of 1897, and has since given excellent results, having run over 22,000 miles in everyday use. It is fitted to No. 20 locomotive, No. 19 being fitted with the Electric Construction Company's controller, similar to the type used on the Liverpool Overhead Railway. The reversing switch which reverses the direction of the current in the armatures is quite independent of the series-parallel controller, and is mounted on a separate base; there is no mechanical interlocking, as in practice it has not been found necessary. A main switch and fuse is also fitted on the same board.

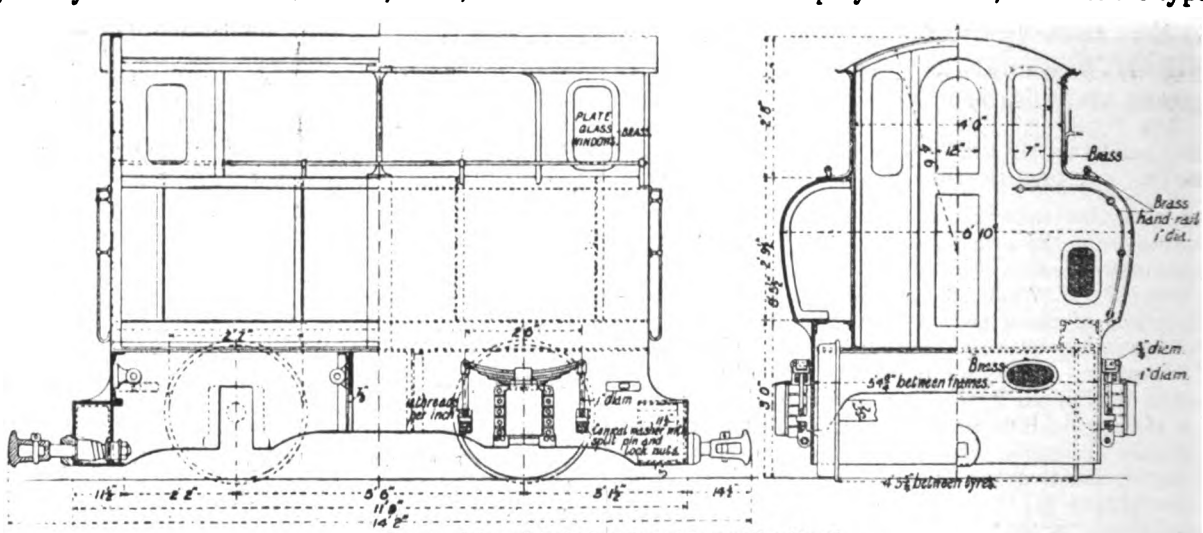

FIG. 57.—Side and End Elevation of Locomotive No. 21.

SUMMARY.

1. To determine the draw-bar pull exerted by the various locomotives and arrive at the tractive resistance per ton of train hauled, the dynamometers described were designed and constructed.

2. The motor and locomotive tests show that at starting only about 73 per cent. of the total tractive effort at the

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tread of the wheel is given out at the draw-bar, and that the loss at starting is directly proportional to the tractive effort.

3. After the locomotive commences to move, its losses decrease until a speed of about nine miles per hour is reached, which then becomes fairly constant. But the losses are greater for the higher currents.

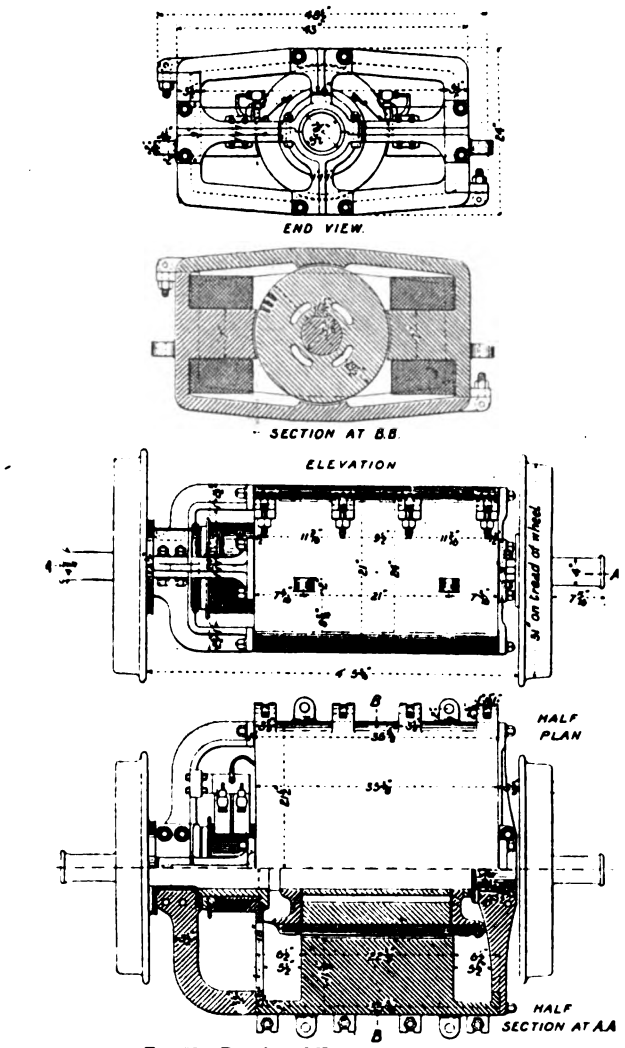

FIG. 58.—Drawing of No. 20 Locomotive Motor.

4. The results of the draw-bar tests show that the tractive resistance per ton of train is 40lb. at the moment of starting, and that it drops quickly to 10lb. at six miles per hour; between six and thirteen miles per hour the resistance remains fairly constant, and then continues to rise almost proportionally to the speed until a speed of 26 miles per hour is reached, when the resistance is about 21lb. per ton.

5. Curves have a very important effect on the tractive resistance. Tests show that on a curve of 540ft. radius the tractive resistance is doubled, and with sharper curves the resistance is still further increased.

6. A comparison of the performances on the line of Nos. 12, 15, and 17 locomotives shows that the tractive force per ampere has an important bearing upon the energy consumed for a given section. No. 12 locomotive, with its low tractive force per ampere, takes 26 per cent. more energy than No. 15 for the shortest section, while on the longest section this increase is reduced to 6 per cent. For longer sections still, probably No. 12 locomotive would be more economical than No. 15. The calculated performance diagrams for sections of 2,700ft., 4,000ft., and 5,280ft., with motors having different values of tractive effort per ampere, again goes to prove this fact.

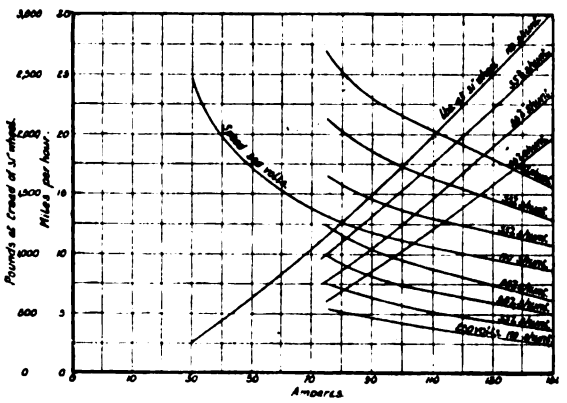

FIG. 59.—Characteristic Curves, No. 21 Locomotive Motor.

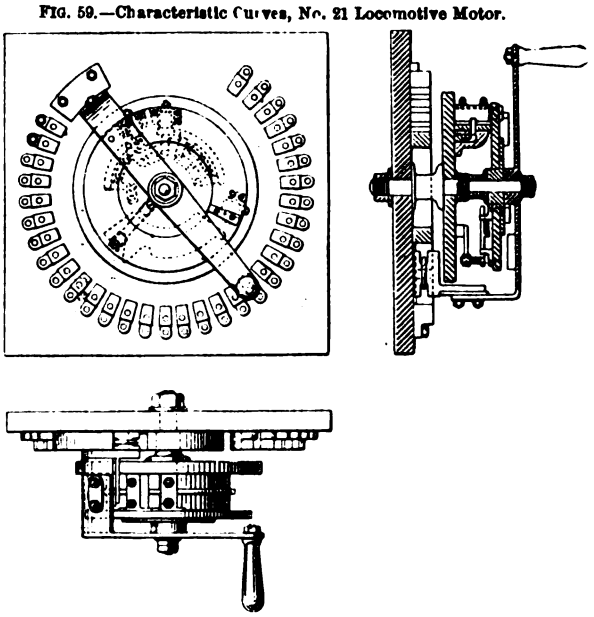

FIG. 60.—Drawing of Series-Parallel Controller.

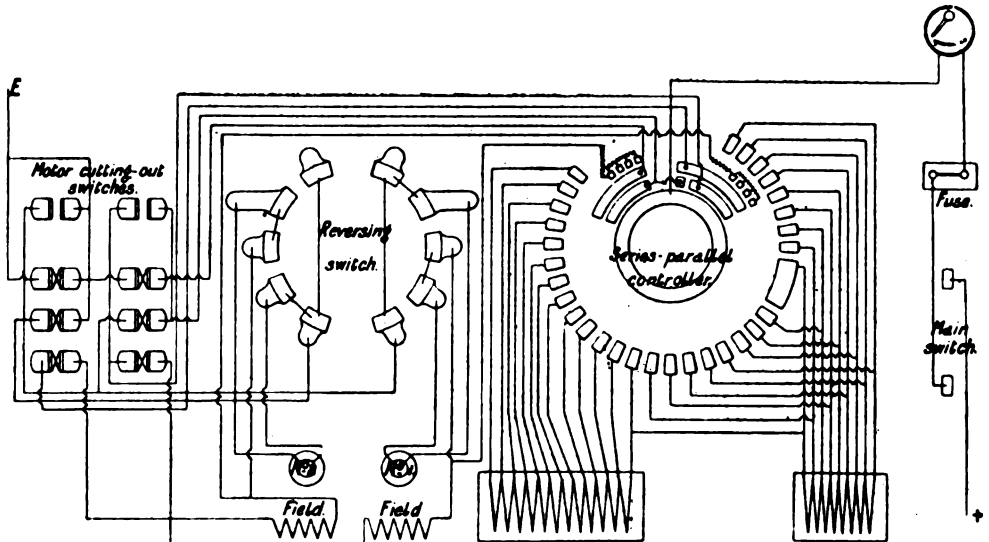

FIG. 61.—Diagram of Connections of Series-Parallel Controller.

7. Although there is a great difference in the energy

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drawn from the line by the three locomotives, Table No. XIII. shows that their efficiencies are not widely different. This table also shows the alteration in efficiency of No. 3 by rewinding and adopting the series-parallel method of control.

8. With plain series method of control the value of the starting current has not much effect on the total energy consumed for a given section, as shown by the experiments with No. 15 locomotive (Table I.). With the series-parallel method there is, however, a very great reduction in the energy consumed by adopting high starting currents. The calculated performance diagrams (Figs. 32 and 33), show that by altering the value of the starting current when the motors are placed in parallel there is a saving of 24 per cent. in time and 11·5 per cent. in watt-hours.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. Questions may be sent at any time. Answers must be written on one side of the paper only, and should be kept as concise as possible.

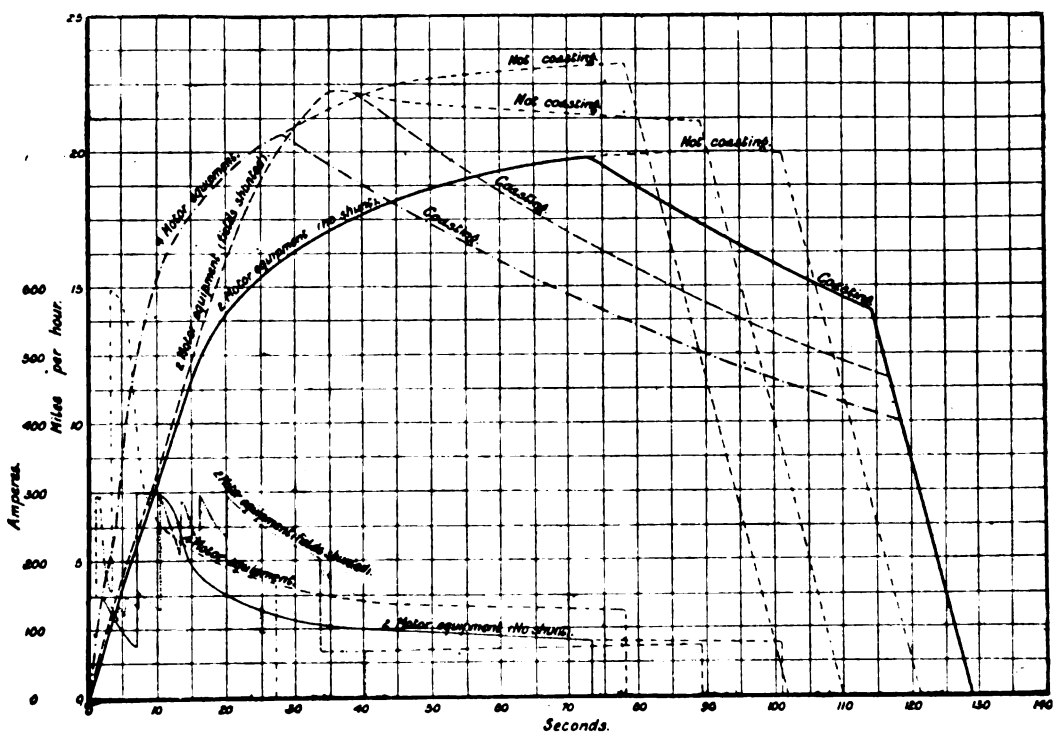

FIG. 63.—Performance Diagrams, Two Motor and Four-Motor Equipments.

9. Diagram Fig. 41 shows that theoretically a higher rate of acceleration at starting is the most economical method of running a short section. The highest rate taken is 1·46ft. per second per second, the lowest that it was possible to adopt being 0·417ft. per second per second. The latter rate requires 27·6 per cent. more energy than the former to run a 2,700ft. section.

10. Diagram Fig. 41 shows that the acceleration at starting should be uniform, and to arrive at this in the calculated performance diagram the motor fields were successively shunted during the starting period. The performance diagrams (Figs. 40 and 42) show the effect of shunting the field during the running and starting periods. For the same motor running a 2,700ft. section there is a gain of over 8 per cent. in favour of the latter method. Experiments with No. 15 locomotive show that by shunting the field during the running period the energy consumed was increased by about 50 per cent. without corresponding gain in time. Figs. Nos. 67 and 68 show the effect of shunting the field of No. 19 locomotive at starting.

11. By trying different numbers of conductors and armature lengths the kilowatt-hour consumption for a 2,700ft. section was reduced from 1,905 to 1,330, as shown by the various performance diagrams and Table XIV. The net result of the investigation resulted in the design of No. 21 locomotive.

12. Calculation (Fig. 63) and tests show that a high rate of acceleration and a fair amount of coasting is a more economical method of running a short section than very rapid acceleration, necessitating the use of large currents for a few seconds and coasting for a large percentage of the time. The reduction in kilowatts per ton-mile gained by very rapid acceleration is deceptive, and must be considered in connection with increased cost of plant and the cost per kilowatt-hour.

QUESTIONS.

173. Describe some practical method of measuring the efficiency of a transformer. Suppose that on connecting the terminals of the secondary to a wattmeter you obtain no reading, while at the same time an ampere-meter in circuit indicates a considerable value for the current, to what would you attribute this, and how would you remedy it?—C. J.

174. What devices do you consider the best on traction switchboards in order to (1) protect the machines from short-circuit; (2) to protect the board from lightning?—F. B. A.

[N.B.—If Mr. J. Howard, who wrote to us respecting some answers to questions, will forward his full address we shall have pleasure in sending to him a letter which has failed to reach him at Soho-road, Birmingham.—ED. *E. E.*]

ANSWERS.

Question No. 167.—What is the best arrangement for ensuring that a large motor connected to supply mains cannot be put in or out of circuit so rapidly as to affect the adjacent lamps?

Best Answer to No. 167 (*awarded* 10*s.*).—The best arrangement theoretically to prevent the switching on and off of large currents for motors from seriously disturbing the lighting arrangements is to have separate circuits for power and lighting supplied by entirely different generators, but except in small installations this is generally impossible, and motors and lights are worked indiscriminately from the same source. Assuming that a large motor is to be switched into the circuit, it is evident that if the full current of the motor is allowed to pass at the instant of closing the switch very serious diminution of voltage will be the result. The motor and its appliances must be so arranged, there-

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fore, that the full power of the motor is not demanded at once, but that the current which passes is small at first, and is slowly increased by small increments, the successive increments taking place at such intervals as will allow the voltage of supply to recover before the next increased demand is made. It is evident that the smaller the increments of current at each successive point, the more quickly may the following point be passed to. But, speaking roughly, the total time occupied in rising from the minimum current to the full working current will be the same whether the increments be large or small. So much, then, for switching the motor into circuit. A similar reasoning applies to the switching out. The current must not be diminished to zero instantly, or a dangerous increase in the voltage of supply would take place. Hence the diminution of current must again be by successive decrements at definite intervals of time.

There are then three points to consider—namely, the possibility of arranging (*a*) that the initial current passing through the motor shall not exceed a certain definite amount, and shall not increase by more than a certain amount at a time; (*b*) that these increments shall take place at such an interval as may be long enough to allow the supply to accede to the demand and recover its stability; (*c*) that the decrements of current on stopping the motor shall likewise be small, and shall not follow one another so quickly as to remove the total load in too short a time.

With regard to *a*, it is evident that the ohmic resistance of the motor, when standing still, is much too small to be sufficient to fulfil the condition laid down; it would allow a very large current to pass, which would no doubt gradually diminish to the safe working current of the motor, but would cause much too large a "jerk." As the motor resistance remains constant, it is evident that to diminish the starting current, the volts at the motor terminals must be diminished. In other words, the motor must have resistance inserted in the circuit in series with it; and the amount of this resistance must be such that, along with the armature resistance, it will be sufficient to allow the stated minimum current to pass. If the motor started light, this current might be sufficient to run it up to full speed, in which case all the resistance might be cut out at one operation; but as few motors are certain to start light always, it would not be always convenient to cut out the resistance at one step, as this would allow the "short-circuit" current to pass through the motor which had not started at once. Hence the resistance must be cut out gradually. This is done by dividing the resistance into a number of parts, and arranging that the parts shall be successively cut out of circuit by the motion of some convenient switch mechanism. This happens when the resistance is in the form of coils of wire, as is very often the case. When the resistance is in the form of a liquid, the effective length of liquid is reduced by the motion through it of some suitable dipper towards a point at the opposite end of the liquid to that from which it started, which point it finally touches, and so cuts out all the liquid from the effective circuit. Innumerable types of switches have been devised with more or less successful results. A description of them would be out of place here. The principle of them all is the same—namely, to *gradually* allow the motor to take its full current. In the case of a liquid or similar switch, the increments of current are infinitely small, because the resistance diminishes through all values from the maximum down to the armature resistance. But in other cases, where definite "steps" must be arranged, the question arises as to how many are required, and what their relation must be to one another to comply with the regulation that the increments of current may be conveniently small. For a discussion of this question of the ohmic sizes of successive steps reference may be made to question No. 161, answered in your issue of May 19, in which it was shown that each step when cut out should diminish the total resistance in a geometrical progression—*i.e.*, by a constant ratio. As to the number of steps, the larger this is, the smaller will be the successive increments of current. But a point is reached, depending on the conditions of working of the motor, after which the increase in the number of steps yields a very small advantage as regards diminution of increment. Each case therefore should be considered by itself, and arranged accordingly. So much for point *a*. Points *b* and *c* may be now briefly noticed.

As regards the diminution of current mentioned in *c*, it is clear that the same resistance which was originally inserted in circuit and then gradually cut out to start the motor may be used for stopping by having the steps gradually reinserted in the circuit. This will cause the resistance to increase in geometric ratio, the smaller coils being inserted first—*i.e.*, those cut out last in starting—and this, according to Question 161, is the correct method. This may be managed by moving the switch back again over the previous contacts in the reverse direction, or, in the case of switches where this backward motion is impossible, by moving the switch forward over a further set of contacts, connected up in the opposite direction to the same resistance as was previously used. The current will diminish to the minimum value allowed for starting, after which the circuit may be safely broken.

The only point remaining is the question of the interval of time allowed between the successive increments or decrements of current. It is quite possible to describe all the inventions, patented and unpatented, wise and otherwise, which have been evolved to do this "perfectly." It does not seem to be sufficient to assume that the men who start up large motors are capable of remembering to move the switch slowly: and hence the ideal which has been formed in the mind of the inventor is one which may be described by the somewhat irreverent phrase, "You touch the button, we do the rest"—"we," of course, being the inventor and his switch. And hence innumerable arrangements have in this case also been devised—dashpot, ratchet gears, worm gears, short-circuiting press buttons—a simple trigger motion which starts the whole arrangement and allows it to go on quite independent of the operator—spiral springs, flat springs, and numerous others of a like kind, all designed to start the motor sufficiently slowly.

To sum up, then, the requirements necessary for the conditions of the question are: to start a motor, resistance must first be inserted in series with its main circuit, and then gradually cut out in successive steps, divided up in a particular way. To stop, these should be reinserted one by one, and then all cut out at once. This insertion and removal of successive steps must be done slowly, the actual rate depending on the number of steps and the size of the motor in the particular case under consideration.—T. C.

Question No. 168.—The two mains from an alternating-current system of supply are carried into a house through two separate steel conduits. When many lamps are turned on, the drop in pressure is so great as to be altogether inadmissible. The same mains are then put together in a single steel conduit, when no such drop occurs. Explain this.

Best Answer to No. 168 (*awarded* 10*s.*).—The effect is entirely explained by the fact that the inductance of the circuit, and consequent inductive drop in volts, is many times greater in the first case than in the second. The inductance of a circuit is determined by the number of magnetic lines of force looped with it when unit current is

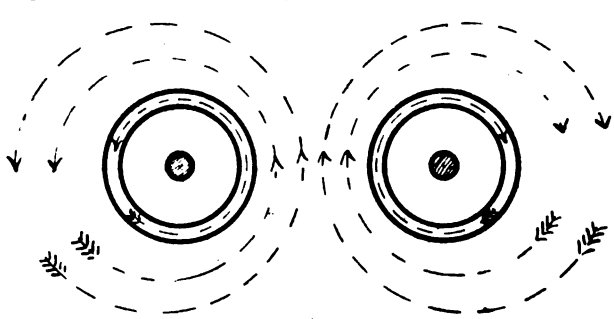

Fig. 1.

passing. Now, in the case of the two separate steel conduits, it is evident that there are two completely closed iron circuits as well as an air circuit (of more or less magnetic resistance, according to the distance between the two wires) looped with the wire circuit (Fig. 1). On the other hand, when only one conduit is used there is no complete wire circuit for the magnetic lines, but only one consisting partly of air and partly of iron (Fig. 2). A

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numerical example will best show the great difference between the two cases. Consider a circuit 100 yards long (200 yards of single lead) carrying 20 amperes at a periodicity of 100 per second, run in steel piping 1½in. internal diameter and ⅛in. thick.

1. *When Two Conduits are used* (Fig. 1).—We can neglect the air path in this case and consider only the two iron paths. Each path has a mean length in the direction of the flux of 1⅝in. × π = 5·1in.; therefore the maximum ampere-turns per 1in. length are $\frac{20 \times \sqrt{2}}{5 \cdot 1} = 5 \cdot 5$, which corresponds to a flux density of about 25,000 C.G.S. lines per square inch, and the total section of the two steel paths 100 yards in length is ⅛ × 100 × 36 × 2 = 900 square inches, giving a total maximum flux of 900 × 25,000 = 22,500,000 C.G.S. By the ordinary transformer formula this corresponds to 4·44 × 100 × 22,500,000 × 10^{-8} = 100 back volts due to inductance. These volts will be in quadrature with the volts at the lamp terminals. Suppose the lamp volts are 100, then the voltage required at the generator end of the line is found from the diagram (Fig. 3) to be 140 volts, or a drop in the line of about 29 per cent.

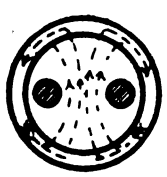

FIG. 2.

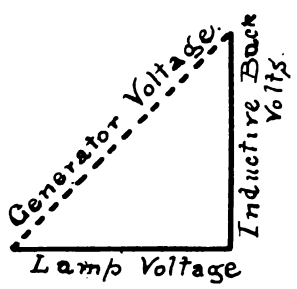

FIG. 3.

2. *When both Lines are run in One Conduit* (Fig. 2).—In this case the resistance of the iron part of the magnetic circuit can be neglected, and only the resistance of the air path between the two wires need be considered. Suppose the average distance apart of the two wires is 1in., and the average length of the air path from iron to iron is also 1in. Then the flux density in the air path is $\frac{20 \times \sqrt{2}}{\cdot 3132 \times 1\text{in.}} = 90$ C.G.S. lines per square inch. And the average section of the path is 1in. × 100 × 36 = 3,600 square inches, giving a total maximum flux of 3,600 × 90 = 325,000 C.G.S., which corresponds to a back voltage of 1½ nearly, and this would cause a quite negligible inductive drop compared with the 29 per cent. with the other arrangement.

This comparison shows that, except where very small currents or very low periodicities are in use, double conduit wiring with iron or steel conduits is quite out of the question.—Q.

Answer to No. 168 (*awarded* 5*s.*).—The effect of encasing conductors carrying an alternating current of electricity in separate iron pipes or conduits was noted some considerable time ago by central-station engineers, who have abandoned the practice altogether for underground work. It was found that when alternating-current conductors were drawn into separate iron pipes a drop in voltage became apparent upon these conductors of such magnitude as to be inadmissible, but when the two conductors (lead and return) were run in a single iron pipe the drop disappeared, or became so small as to be negligible. The result of these and other observations has shown that the arrangement of conductors which gives least trouble of this nature is the concentric cable with iron or steel armouring. The use of steel conduits for internal wiring has extended very greatly during the past two or three years, the usual practice being to draw both lead and return conductors into the same tube, except in the case of sub-mains, where it is often inconvenient to use a tube large enough to take in both conductors. It has been found that the use of separate tubes for these sub-mains on an alternating-current supply has resulted in a voltage drop, which has in most cases led to the use of one large tube to contain both conductors, or, better still, armoured concentric cable. This is exactly what had to be done in the case of underground mains several years ago. Now to investigate the cause of this drop when separate conduits are used, and why the drop disappears when both conductors are led in the same conduit, or when concentric cable is used. As is well known, a straight wire carrying a current tends to set up a circular field in its neighbourhood, and when the direction of the current is reversed the direction of flow of the magnetic lines of force is also reversed. This field is very much strengthened when the straight wire is surrounded by an iron envelope, as the iron intensifies the field in the same way as it intensifies the field in a choking coil. When an alternating current passes through a wire which is enveloped by an iron shield, it acts in exactly the same way, and is equivalent to a choking coil, the only difference being that instead of a coil of wire being wound round a straight iron core, the iron core is wound round a straight wire. The lines of force set up in the iron envelope flow in such a direction as to oppose the current and produce a back E.M.F. of self-induction in the same way as a choking coil. This causes a drop in the effective E.M.F., and consequently a loss of power. The question may be asked, where is this lost power dissipated or expended? As in the case of a choking coil, some of the power is choked back into the supply mains, but a considerable portion of it is utilised in magnetising and demagnetising the iron sheath, this quantity depending upon the thickness and permeability of the latter. Now, when two separate conductors encased in iron tubes are placed side by side the iron conduits act as screens, and each becomes a closed circuit in itself along with the conductor which it envelopes, or, in other words, the two conductors cannot act inductively upon each other, although placed side by side, and therefore the one cannot neutralise the induction of the other. When the two are placed in the same tube, however, they both act with equal force upon the common envelope, but with *opposite* magnetomotive force, so to speak, so that the magnetising force of the two conductors neutralise each other, and consequently no magnetic lines of force are induced in the iron tube whatever, and therefore no drop in E.M.F. takes place. To test the truth of this the writer made the following experiment. An ordinary choking coil was rewound so that half of the winding was in the reverse direction to that of the other half—*i.e.*, in one half the current passed round the coil in a right-handed direction, while in the other half the current passed in a left-handed direction. When the coil as originally wound was connected across 100-volt alternating mains, in series with a non-inductive resistance, the drop between the terminals was 43 volts, with the "half-and-half" winding the drop was reduced to 2·1 volts. This drop was mostly due to the copper resistance of the coil. This case is exactly analogous to the conductors in separate and in the same tube.—R. M. W.

Answer to No. 168 (*awarded* 5*s.*).—The explanation of this phenomenon is that the portion of the main surrounded by the steel conduit acts as a choking coil. From elementary principles we know that a straight wire carrying a current is surrounded by circular lines of force, which expand and contract as the current increases or diminishes. If an alternating current is flowing in it, then the current passes through its cycle of values many times in a second, and we can picture these circular lines of force expanding and contracting with great rapidity round the wire. If this wire be now enclosed in a steel pipe, the lines of force will be greatly increased in number, owing to the great permeability of steel as compared with air. The lines of force—or, as they are more correctly called, the lines of induction—circularly magnetise the steel pipe first in one direction and then in the other during one cycle of the alternating current. The increase in the number of lines of force round the wire greatly increases its electromagnetic inertia or inductance, and hence the back E.M.F. of self-induction becomes comparable with the applied E.M.F. and chokes back the volts. There will also be continual waste going on because of hysteresis and eddy currents in the steel conduits, the latter being large because the pipes are not laminated.

If V be the applied volts, V_1 the volts across the lamps, and V_2 the drop across that portion of mains in steel pipes, then by the three-voltmeter formula

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$$W = \frac{1}{2R}\left(V^2 - V_1^2 - V_2^2\right) \therefore V_1^2 = V^2 - V_2^2 - 2RW \quad (1)$$

where R is the resistance of the lamps (non-inductive) and W is the power spent in heating steel tubes and the mains inside them. When the current is small V_2 and W are small, and hence V_1 is little less than V. When the current is large V_2 is large, and so also is W, but R has been reduced. V_1, however, is less than the $\sqrt{V^2 - V_2^2}$, and may therefore be small. When both the mains are in one tube, since the current always flows in opposite directions in each main, the only effect on the iron conduit will be the difference of their magnetic effects, and so the choking effects will practically neutralise one another, and V_1 will only differ from V by the ohmic drop.—J. C. R.

BRISTOL ELECTRICITY WORKS ACCOUNTS.

The statement of accounts at March 25, 1899, under the Bristol Electric Lighting Order, 1883, has just been issued. The total expenditure on capital account up to date has been £192,653. 9s. We give herewith the revenue account, general balance-sheet, and statement of electricity generated, sold, etc.:

Revenue Account.

Dr.					£ s. d.
Generation of Electricity.					
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£4,900	14	2		
Oil, waste, water and engine-room stores	364	0	5		
Wages at generating station	1,908	0	6		
Repairs and maintenance: buildings, £452. 13s.; engines, boilers, etc., £139. 11s. 11d.; dynamos, exciters, etc., £6. 14s.; condensers, other machinery, instruments, and tools, £247. 6s. 9d.; accumulators and accessories, £18. 1s. 3d.; station lighting, £19. 7s. 5d.; less received for old material, £8. 12s.	875	2	4		
					8,047 17 5
Distribution of Electricity.					
Wages and other remuneration to linesmen, fitters, labourers	327	15	5		
Repairs, maintenance, and renewals of mains of all classes, including materials and laying same	366	19	2		
Repairs, maintenance, and renewals of transformers and other apparatus on consumers' premises, £42. 1s. 5d.; cost of lamps sold as *per contra*, £111. 14s. 11d.	153	16	4		
Repairs, maintenance, and renewals of apparatus at distributing stations	64	3	1		
Sundries	21	7	3		
					934 1 3
Public Lamps.					
Attending and repairs	622	14	10		
Carbons and renewals of lamps	290	6	1		
Sundries	15	4	0		
					928 4 11
Rents, Rates, and Taxes.					
Rents payable	453	5	0		
Rates and taxes	908	5	4		
					1,361 10 4
Management Expenses.					
Salaries—Engineer's department	822	3	10		
Secretary and clerical staff	654	6	0		
Stationery and printing	122	9	9		
General establishment charges	324	15	11		
					1,923 15 6
Law expenses, including stamp duty on mortgages					128 4 0
Special Charges.					
Fire and boiler insurance, employers' liability and fidelity guarantee premiums	167	16	5		
Costs of canvassing for new customers	13	2	1		
Interest on deposits by customers as security	5	15	0		
Compensation for damages	4	0	0		
Testing machinery, mains, etc.	38	11	2		
Gratuity to wife of W. Coleman (deceased)	26	10	0		
Surplus lands—repairs	13	14	11		
					269 9 7
Total expenditure					13,593 3 0
Amount carried to net revenue account					12,630 8 0
					£26,223 11 0

Cr.	£ s. d.
Sale of current, per meter—For lighting	19,766 1 10
Ditto, for motors	348 11 11
	20,114 13 9
Less discounts	1,407 17 0
	18,706 16 9
Rental of meters	875 1 1
Rentals of motors, £11. 4s. 8d; less one-half to depreciation account, £5. 12s. 4d.	5 12 4
	19,587 10 2
Less bad debts	9 4 6
	19 578 5 8
Public lighting—electricity supplied to public lamps, £5,373; attendance and repairs of public lamps, carbons, etc., as *per contra*, £928. 4s. 11d.	6 301 4 11
Incidents	10 9 4
Improvers' premiums—amount transferred from suspense account	56 0 0
Sale of incandescent lamps	145 16 5
Fees for insulation tests	6 16 6
Surplus lands—rents receivable	69 10 8
Charging batteries	10 3 10
Work on consumers' premises	5 3 8
Hire of small alternator	40 0 0
	£26 223 11 0

General Balance-Sheet.

Dr. **Liabilities.**	£ s. d.
Capital account—amount received, loans repaid	22,520 0 0
Loans outstanding	165 623 0 0
	188.143 0 0
Sundry creditors	3 760 7 7
Deposits by customers as security	186 10 0
Net revenue account—balance at credit thereof	2 916 6 3
Reserve fund account—balance at credit thereof	5,000 0 0
Depreciation account—balance at credit thereof	2 005 12 4
Suspense account—balance	338 10 0
	£202,350 6 2

Cr. **Assets.**	£ s. d.
Capital account—amount expended for works	192 653 9 0
Stores on hand March 25, 1899: coal, £185. 4s. 2d.; oils, waste, etc., £29. 16s. 8d.; general, £567. 4s 8d.	782 5 6
Sundry debtors for current supplied to March 25, 1899, £6,303. 17s. 2d.; other debtors, £226. 4s. 5d.	6,530 1 7
Cash in hand and at bank	2,384 10 1
	£202,350 6 2

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units		1,821,725
Quantity sold	Public lamps 329,462	1,362 786
	Private consumers by meter 1,033,324	
Quantity used on works		458,939
Total quantity accounted for		1,821,725
Number of public arc lamps		304
Number of public incandescent lamps		3
Total maximum supply demanded (kilowatts)		1,707

COMPANIES' MEETINGS AND REPORTS.

THE ELECTRIC EXPLOITATION COMPANY, LIMITED.

A winding-up order having recently been made against this Company, the statutory meetings of creditors and shareholders were held on Tuesday at the Carey-street offices of the Board of Trade. Mr. G. S. Barnes, senior official receiver, presided.

The **Chairman** said that the Company was registered on Jan. 4, 1894, with a nominal capital of £25,000, and was formed with the object of acquiring and dealing in certain inventions relating to the storage of electricity, and particularly the rights in patents belonging to Mr. Max Sussmann for an electric lamp which was specially adapted for use in mines. The company was promoted by Mr. V. C. Doubleday, and it appeared that during 1893 he and 12 other gentlemen financed Mr. Sussmann, and between them expended £2,400 prior to the formation of the Company. Upon the registration of the Company, Mr. Doubleday and Mr. J. A. Buchanan became directors, notwithstanding that they were interested in the sale. A prospectus was privately issued in February, 1894, and shares to the value of £367 were subscribed for, this representing the working capital of the Company at its inception. The purchase agreement was referred to in the prospectus, and it set out that Mr. Doubleday was to receive 750 shares and Mr. Buchanan 688 shares. It was not, however, precisely stated in the prospectus that two of the directors were interested in the sale, and it might be that the gentlemen named had rendered themselves civilly liable to repay money to the Company in consequence of that fact not being disclosed. Under the purchase agreement 20,000 shares were issued to the vendor, and of these 12,500 were divided between the gentlemen who had provided money for the patents, and the remaining 7,500 were issued

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to Mr. Sussmann, but were subsequently transferred to some of the same persons. Owing to the insufficiency of the working capital, £500 was borrowed from Mr. Buchanan upon the security of debentures, and a further sum of £250 was obtained from him in February, 1895 It appeared that during 1895 negotiations were entered into with Mr. Harry Seymour Foster with a view to the promotion by him of a company having for its object the acquisition of the whole of the Exploitation Company's inventions and patent rights, and in October, 1895, an agreement was entered into under which he agreed to form the Sussmann Electric Miner's Lamp Company, Limited, in consideration of the payment to him of £20,000 in cash or shares out of the £45,000 which it was intended that the Sussmann Company should pay for the inventions. The Sussmann Company was registered on May 6, 1896, and two days later an agreement was entered into for the sale of the patents for £45,000, the purchasers agreeing to allot deferred shares to the Company and to give them one-third of all moneys, royalties, or other considerations received from the sale of foreign patents. Mr. Doubleday stated that the issue of the Sussmann Company's prospectus resulted in applications for 19,000 shares, including 11,580 shares for which Mr. Foster obtained underwriting contracts. Having regard to an arrangement which existed between the two companies, the Sussmann Company was to retain £12,500 for working capital, and this left £7,500 only for the payment in cash under the purchase contract. Upon the settlement of the purchase Mr. Foster was paid £6,340 in cash and shares in the Sussmann Company to the nominal value of £13,660, and the vendor company received £650 only in cash and £24,350 in shares. The failure of the Company was attributed by the secretary to the limited subscription for shares in the Sussmann Company, which resulted in a very small sum being received in cash upon the sale of the property. The unsecured liabilities were estimated at £433, in addition to which there were claims on debentures £720, and the assets consisted chiefly of shares in the Sussmann Company, which were valued at £1,102, and which were subject to the debenture claims.

The contributories decided to leave the matter in the hands of the official receiver as liquidator, and the creditors' meeting was adjourned *pro forma* for a week.—*The Times.*

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Barrow-in-Furness.—The Corporation invite tenders for an engine and generator by 28th inst.

Madrid.—The Public Works Department invite tenders for electric tramways for Madrid. Tenders by June 14.

Blackpool.—The Corporation invite tenders for the supply of coal, oil, and carbons. Tenders by 10 a.m. on June 20.

Madrid.—The Post and Telegraph Department require 26,000 2in. cylinders for electric batteries. Tenders by June 13.

Hackney.—The Electric Lighting Committee of the Vestry invite tenders for trenching, troughing, cables, joint-boxes and jointing, and house services, by June 13.

Alcala la Real (Province of Jaen, Spain).—The Municipality require tenders for an electric lighting installation and the working of the same for three years. Tenders close June 25.

Huddersfield.—The Corporation invite tenders for the supply of copper rail bonds for electric traction. Specifications, etc., may be obtained from the Borough Surveyor, 1, Peel-street, Huddersfield. Tenders by 10 a.m. on June 12.

Belfast.—Tenders are invited by the Public Health Committee for the erection of a destructor of 12 cells, including all the works connected therewith, at Lagan Bank-road. Specifications, etc., may be obtained from the City Surveyor. Tenders by 10 a.m. on June 15.

Teneriffe.—Tenders are invited for the erection and working of an electric tramway between Santa Cruz and San Cristobal. The deposit required is about 776 214 pesetas (about £350). Specifications, etc., are to be obtained from, and tenders addressed to, Public Works Department, Madrid, by 1 p.m. on June 14.

Blackpool.—The Blackpool Masonic Hall, Limited, invite separate tenders for the following works in the Masonic Hall, Adelaide-street: electric lighting preparations; electric bells (preparations and fittings); heating apparatus. For particulars apply to Mr. J. A. Nuttall, architect, Birley-street, to whom tenders must be delivered, endorsed according to work tendered for.

Dudley.—The Electric Lighting Committee invite tenders for: (Section A) water-tube boilers, economiser, etc.; (B) steam dynamos, balancers, and switchboard; (C) cables and other street work; (D) arc lamps, etc.; (E) travelling cranes. Specifications, etc., can be obtained from Messrs. Wilson and Story, 66, Victoria-street, Westminster, upon payment of £2. 2s. for each section, to be returned on receipt by the Council of a bona fide tender. Tenders by June 17.

Stockport.—Tenders are required by the Gas and Electricity Committee for the supply of the following materials to June 30, 1900—viz.: (1) bolts and nuts; (2) brushes; (3) brass and meter fittings; (5) castings; (6) drysaltery; (7) retorts and fire goods; (8) glass, red and white lead; (9) iron and steel; (10) ironmongery; (11) lead pipe, tin; (12) mill furnishing; (13) oils and tallow; (14) purifier grids; (15) ropes and flax; (16) shovels, pick heads; (17) timber, English and foreign; (18) tubing; (19) wet and dry meters; (20) stationery; (21) lime. Particulars, etc., may be obtained from the engineer, Mr. S. Meunier, Stockport. Tenders by 14th inst.

Huddersfield.—The Corporation invite tenders for the electric equipment of their present steam tram service, also for works to be executed, plant and machinery to be supplied, as follows: Contract No. 1—(Section A) engines and appurtenances, overhead travelling crane; (B) direct-current generators, switchboard, station lighting, motors, cables, trolley poles, controllers, etc.; (C) cableways, overhead construction, trucks, and car bodies; Contract No. 2—(D) steam-boilers and accessories; (E) condensers, valves, heaters, pumps, etc.; (F) economiser, elevator, and conveyor. Any contractor may tender for the whole or part of the work included in Contracts Nos. 1 and 2. Specifications, etc., may be obtained from the Borough Engineer, 1, Peel-street Huddersfield. Tenders by 10 a.m. on June 12.

RESULTS OF TENDERS.

Salford.—The Town Council have accepted the tender of the Leeds Steelworks Company for the supply of 5,000 tons of steel tramway rails at a cost of £100,625.

Grimsby.—The Public Lighting Committee recommend the acceptance of the tender of Messrs. Hewins and Goodhand, of Grimsby, for the erection of buildings and chimney shaft at a cost of £11,525.

Islington.—Tenders have been received for installing the electric light in the Highgate-hill Infirmary. The electrician's estimate was £5,900. The tenders received range from £10,117. 10s. to £6,880. 16s.

Manchester.—The Electricity Committee of the Corporation have accepted the tender of the Westinghouse Electric Company, Limited, for the supply and erection at the Bloom-street generating station of four 1,800-kw. combined engine and dynamo machines.

Lancaster.—The following tenders for the erection of stores and workshop at the electricity works have been accepted: W. Harrison, masons' work; J. Greene, joiners' work; J. C. Johnson, slaters' work; H. P. Calvert, plumbers' work. All of Lancaster.

Reigate.—In our last issue it appeared through an error that the tender of the British Insulated Wire Company, at £8,516. 4s. 5d., had been accepted by the Council for the supply of mains and lamp-posts, while as a matter of fact the tender next on the list—viz., that of Messrs. Callender's Cable and Construction Company, at £8,767. 13s. 7d.—has been accepted.

Gloucester.—The Electricity Committee have recommended the acceptance of the revised tender, and that a contract be entered into with the Brockie-Pell Arc Lamp, Limited, for supplying and fixing 36 arc lamps in the four principal streets, with pillars, etc., complete, for £1,034. 16s., and to provide and fix the lowering apparatus to such lamps at an additional cost of £4. 15s. per lamp.

Enniskillen.—The following tenders have been received for lighting the town hall by electricity:

V. Coates and Son, Limited, Belfast	£640	0	0
W. H. Drennan, Belfast	806	5	0
M'Cauley, Clarke, and M'Laren, Glasgow	751	0	0
Hanley and Shanks, Cork	833	0	0
Sykes and Co., Dublin and Cork	957	7	7
J. King, Liverpool	1,428	0	0
Smith and Parks, Belfast	745	10	0
Egan and Co., Dublin	870	0	0
Laing and Co., London	1,012	0	0
Dobson and Curtis Bros., Dublin	738	0	0

BUSINESS NOTES.

Halifax.—Various tramway extensions are in contemplation.

St. Helens.—A trial of the electric trams is to take place within the next fortnight.

Grimsby.—The Public Lighting Committee have resolved to advertise for tenders for machinery.

Lynton.—The Urban District Council have signed an agreement with the electric lighting company for public lighting.

Wigan.—At the next meeting of the Town Council a resolution is to be proposed urging the necessity of the acquisition of the tramways.

Adelaide (S.A.).—The Government intend to purchase the horse tramways in and around the town and to work the lines by electricity.

Southam and Brockhampton.—An enquiry by the Light Railway Commissioners is announced into the proposed electric tramway scheme.

Commercial Cable Company, Limited.—The directors have declared a quarterly dividend of 1¾ per cent. on the capital stock, payable on July 1.

Havana.—The steamer "Mackay-Bennett" has been dispatched to take soundings in the Antilles for the proposed cable from Panzacola to Havana.

Factory Driving.—The Imperial Dry Plate Company, Limited, Cricklewood, have set up an electric plant to drive the machinery used for backing plates.

Prestbury.—There is likely to be much opposition at the coming enquiry before the Light Railway Commissioners into the proposed electric tramway scheme.

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Wallasey.—Application is to be made to the Local Government Board for a loan of £18,000 for tramways.

Brazilian Submarine Telegraph Company, Limited.—The directors have declared an interim dividend of 3s. per share, being at the rate of 6 per cent. per annum.

Didsbury.—Excellent progress is being made with the laying of the electric cable for the supply of Withington and West Didsbury. The supply is to be ready for August.

Austria.—According to a return just published there were 65 miles of electrically worked railways in Austria during the first quarter of 1899, and 37 miles in Hungary and Bosnia.

Chelsea Electricity Supply Company, Limited.—The books of this Company will be closed from 13th inst. to July 2 inclusive, on account of the payment of interest and interim dividends for half-year to July 1.

Wellingborough.—A meeting has been arranged for to-day between the Urban District Council and representatives of the Electrical Power Distribution Company in order to discuss the electric light question.

Peterborough.—A meeting took place on Tuesday between representatives of the British Electric Traction Company and the Town Council, at which the question of electric trams for Peterborough was discussed.

Bath.—The Bath and District Light Railways Company have given notice of intention to apply for an order to construct various lines of electric railways touching Bathford, Lansdown, Weston, Twerton, Oddtown, and Coombe Down.

London Gazette.—The last day for receiving proofs for dividends in the estate of F. Merson (trading as F. Merson and Co.), Leicester, is fixed for the 20th inst. Mr. W. Marsden Richards, 52, Belvoir-street, Leicester, is the trustee.

Whitehaven.—About 40 applications have been received by the Town Council for the vacancy caused by the resignation of Mr. C. M. Mayson, the electrician The final selection will be determined by the Finance Committee at their next meeting.

Weston-super-Mare and District Electric Supply Company, Limited.—This Company has been registered with a capital of £50,000 in £10 shares, and the object is to carry on the business of electrical engineers, tramway and light railway proprietors, etc.

Barrowford.—The District Council have made an application for an order for the construction of a light railway from the top of Barrowford to Nelson Station. Mr. Wright, electrical engineer, Burnley, has been retained to act for the Barrowford District Council.

Linthwaite.—Lieutenant-Colonel H. A. Yorke, R.E., has held an enquiry on behalf of the Board of Trade into the application of the Urban District Council to borrow £19,500 to defray the cost of the construction of a tramway under a provisional order already obtained.

Callender's Cable and Construction Company, Limited.—This company have just started to lay mains for the Gloucester Corporation; also a feeder from the electric light station to the Royal Consumptive Hospital at Ventnor, a distance of about 1¼ miles.

Gateshead.—The Corporation have lodged a petition against the provisional order granted by the Board of Trade, under the Electric Lighting Acts, 1882 and 1888, to the Electrical Power Distribution Company, Limited, in respect of the borough of Gateshead.

Newington.—Doulton conduits to the extent of about 50,000ft. of duct have been laid throughout the area of the electric lighting supply. They comprise three-way, two-way, and single-way conduits, the diameter of the ducts being either 4in. by 4in. or 3in. by 3in.

Oswestry.—The Town Council in committee have been discussing a report of the Watch Committee recommending that the electric light company's undertaking be purchased, and that a committee be appointed to negotiate terms with the company with power to arrange the price, etc.

Newton Abbot.—In the House of Commons on Monday the provisional order granted by the Board of Trade under the Electric Lighting Acts, 1882 and 1888, to the Urban Electric Supply Company, Limited, in respect of Newton Abbot, passed the examiners for the investigation of standing order proofs.

Darlington.—The clauses prepared by the town clerk to be inserted in the provisional light railways order in accordance with the instructions of the committee have been approved, together with the report of the borough surveyor as to the mode of paving certain portions of streets upon which the lines will be laid.

Faraday House.—The Electrical Standardising, Testing, and Training Institution undertakes to give a thorough theoretical and practical training in electrical engineering. The next entrance scholarship examination will be held on June 28, 29, and 30. Particulars of the work of the testing department appear elsewhere.

Witney Electric Supply Company, Limited.—This Company has been registered with a capital of £10,000 in £1 shares, and the object is to adopt an agreement with the Witney Syndicate, Limited, and with C. A. Musker, Limited, and to carry on at Witney, Oxfordshire, the business of an electric light and power company.

Erdington.—At the last meeting of the Urban District Council it was proposed that application should be made for a provisional order for the electric lighting of the district, and that the Highways Committee be empowered to engage such expert and professional assistance to advise them in the matter as may be necessary.

Bolton.—At the meeting of the Town Council on Wednesday, the Council sanctioned a proposal for the borrowing of £100,000 in order to meet the rapidly increasing demand for electricity. Electric tramways are being provided at a cost of over a quarter of a million sterling.

Festiniog.—At a recent meeting of the District Council reference was made to the fact that the district was so bountifully supplied by nature with water power that lighting could be cheaply provided by electricity. A suggestion of the committee to ask for a provisional order from the Board of Trade for electric lighting powers was subsequently agreed to.

New Company.—The firm of Nalder Bros. and Thompson has been converted into a private limited company, under the style of Nalder Bros. and Thompson, Limited. The management remains precisely the same as before; Mr. F. H. Nalder and Mr. E. Thompson are the managing directors, and between them hold the whole of the ordinary shares.

South Staffordshire Mines Drainage.—In Tipton district the gravity works for the drainage of bad areas in anticipation of the electric pumps have now been further pushed forward, and as some of the deeper and more difficult main drains are done, the smaller branches have been extended more quickly, and many of them did good service during the late storms.

Amalgamation.—An amalgamation has taken place of the firms of Tozer Bros. and Co., of 85, Gracechurch-street; Walter Kemsley and Co., of 44, Leadenhall-street; and of Budden Fisher, and Co., of 47, Lime-street, E.C., and they will in future carry on business at Leadenhall buildings, 96, Gracechurch-street, E.C., as Tozer, Kemsley, and Fisher, Limited.

Removals.—Mr. Charles Bell, of the Ericsson Bell Telephone Company and the North-Eastern Steel Company, Limited, has removed to the Baltic-chambers, 50, Wellington-street, Glasgow. Mr. J J. Henderson, Dundee (library and hon. secretary Dundee Institute of Architecture, and secretary National Registration of Plumbers), has removed to 7, Ward road (second floor).

Bridgwater.—At the adjourned quarterly meeting of the Town Council last week, the question was raised whether the decision come to at a previous meeting by a small majority, and when the Council was not fully represented, to proceed with the carrying out of the scheme for the electric lighting of the borough was binding; but the Town Clerk pointed out that everything was in order.

La Capital Traction and Electric Company (Buenos Ayres), Limited.—This Company has been registered, with a capital of £1,200,000 in £5 shares, and the object is to acquire concessions granted or to be granted by any authority in the Argentine Republic for the construction and working of tramway lines, railway lines, carry out the same, as producers and suppliers of gas and electricity, etc.

Merthyr.—Under the Merthyr Tydfil electric lighting provisional order the undertakers agree to dispose of their property to the local authority at the latter's option, after the expiration of a period of 25 years from the commencement of the order, and within six months after the expiration of every subsequent period of 10 years, the terms of sale to be the fair market value of the undertaking as a going concern.

Wolverhampton Tramways.—The Committee of Selection in the House of Lords have appointed the following peers to consider the Wolverhampton Tramways, Wolverhampton Corporation, and South Staffordshire Tramways Bills: the Duke of Northumberland (chairman), the Earl of Bradford, Lord Clonbrook, Lord Clanwilliam, and Lord Crawshaw. The committee met yesterday for the purpose of hearing counsel and taking evidence.

Western Isles Cable.—The cable ship "Monarch" has completed its work of establishing telegraphic communication between the Western Isles of Cauna, Rum, and Eigg and the mainland during the past week, and also laid a cable connecting the island of Lismore with Port Appin Lorn. Cauna is connected with Rum, and Eigg with the Point of Sleat, in Skye. A land wire crosses Rum in order to join the cables coming ashore on the opposite sides of the island.

Newcastle.—The Council refuse to consent to the construction of the Askew tramway under the Light Railways Act, and intend to oppose the granting of the provisional order. The National Telephone Company's application to lay a 3in. pipe for a telephone cable has been granted. The superintendent of the scavenging department is about to visit Liverpool to witness a competition of motor vehicles suitable for heavy traffic, such as the removal of dust and town refuse.

Grimsby.—The Local Government Board have sanctioned the Town Council's application for a loan of £43,500 for the electric lighting scheme in the borough. The private lighting is to be on the three-wire continuous-current system, with lamps running at or about 230 volts. The mains and feeders are to be for armoured cable, laid direct in the ground, or insulated cables drawn into iron pipes or casing, or laid in troughs filled with insulated material on the solid system.

Cheltenham.—The Rural District Council have decided, notwithstanding the withdrawal of the County Council from the opposition, to oppose the electric tramway scheme before the Light Railway Commissioners, in view of the attitude of the Prestbury representatives, who consider the main roads through their village to be too narrow for the proposed line. We learn that the opposition to this desirable scheme is now practically confined to one or two Prestbury landowners.

Coventry.—The annual report of the Electric Light Committee, adopted on the 6th inst., and covering a period of 15 months,

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shows an increase in the number of consumers from 100 to 135, and of lamps connected from 8,149 to 10,699. The number of units sold was 149,547 (79,583), and the revenue from sale of current and meter rental £3,597 (£1,959). The profit on working has been £333 (£106), whilst £333 had been spent on repairs and maintenance of mains (£80). Deducting the working profit of £333, the net charge on the rates was £1,629 (£1 558).

Dudley.—At Tuesday's meeting of the Town Council a letter was received from the Board of Trade stating that they had sanctioned the continuance of the use of steam on the Dudley and Stourbridge tramways, pending their electrical equipment, until one month from the 4th inst. The Mayor announced that the Electric Power Distribution Company had obtained their provisional order, but Dudley had been omitted therefrom. It was also stated that arrangements were being made for the erection of 17 electric arc lamps along the main thoroughfare of the town.

Bristol.—The Town Council have an agreement with the wiring company (a local concern) whereby persons desirous of taking the electric light can have their premises wired on a modification of the hire-purchase principle, the consumer to pay the Electrical Committee 1d. per unit of electricity consumed for the installation, with the option of purchase at the end of a term of years. The company will be paid by the committee at the same rate. The committee, it is stated, are satisfied with the character of the wiring syndicate, who have undertaken to raise a capital of £10,000

Cardiff.—A deputation from the Roath Presbyterian Church have asked the Electric Lighting Committee to extend their electrical mains to their new church, which will be ready next spring. Mr. N. Appelbee, electrical engineer, estimates the cost of laying mains up Castle-road, Albany-road, and Wellfield-road at £2,476. About 30 promises have been received, and the estimated revenue will more than cover loan charges and interest, as well as pay for the energy. The committee have decided to lay the mains up Wellfield-road, and to borrow the money forthwith.

Newport.—The borough engineer (Mr. R. H. Haynes) is preparing a report upon the question of adopting electric traction for the Newport tramways. A system, based on the Stuart system for fire-alarms, at different parts of the town, is under consideration, and tenders have been submitted by the Post Office Telegraph Department, and also by the National Telephone Company. The borough engineer has been asked to make an offer to the former of £100 per annum on a 15 years' agreement, or, failing that, the National Telephone Company's offer of a five years' agreement at £100 is to be accepted.

Shrewsbury.—At a special meeting of the Town Council the following report of the Watch Committee was adopted: "That this committee having had an interview with Mr. Hawtayne, the expert appointed by them, and having heard his report read, recommend that the electric lighting company's undertaking be purchased, and that a committee be appointed to negotiate terms with the company with power to arrange the price, and that a special meeting of the Council be convened to consider this report and to hear Mr. Hawtayne's report, and to give the necessary powers to such committee."

Longton.—The plan of reconstruction of the existing tramway lines in the borough and the mode of construction and statement of materials intended to be used therein, as submitted by the Potteries Electric Traction Company, Limited, has been approved, subject to the work being carried out in accordance with the detailed drawings and specification submitted to and approved by the Corporation, and to bitumen grouting being used, and the setts being obtained from one of the following quarries—viz., Dalbeattie, Mountcorrel, Croft, Mynford, or Newry, and subject also to certain stipulations with respect to the position of the rails.

Colchester.—The Town Council have decided to apply for sanction to a loan of £6,500 for additional electric lighting plant. The advisability of introducing a higher voltage system is being discussed. From 44 customers using 2,262 lights in December, 1898, the numbers increased to 60 customers with 3,333 equivalent eight-candle lamps in March last. During these four months the total number of units sold was 15,325, giving a revenue of £429. 14s. 10d. The working expenses were £280. 8s. 2d. Multiplied by 3, these sums will give receipts £1,289 and expenses £781 for the year. To the latter sum must be added interest and redemption, amounting to £852.

Aston.—At Tuesday's meeting of the Urban District Council a resolution was proposed as follows: "That in view of the Council taking some action in relation to their electric lighting order, and having regard to the right of the Council to purchase the tramways of the Birmingham and Aston Tramway Company on the expiry of the tramway provisional order, the question of the electric lighting of the district, as also the acquisition of the tramways of the above company in the district, be referred to the General Purposes Committee, with instructions to consider and report thereon, and for this purpose to employ such professional or other assistance as they may deem necessary."

Leeds.—The number of applicants for the position of traffic manager of the tramways of the city has now been reduced to six, the following selections having been made on Wednesday last: Mr. A. R. Fearnley, manager Bradford and Shelf Tramways Company; Mr. Frank Hatch, manager Dudley and Wolverhampton Tramways Company; Mr. Robert Kay, traffic superintendent Glasgow Tramways Company; Mr. John Lancaster, manager Blackpool Tramways; Mr. W. R. Spaven, tramway inspector in the service of the Leeds Corporation; and Mr. A. A. Tyler, manager London Southern Tramways Company. It is expected that the appointment will be made on Monday next.

Brighton.—The Pavilion Committee have decided upon fixing in the banqueting room a Blackman fan, which is to be worked by an electric motor. The cost is estimated at £120. Mr. W. Tilley had requested permission to run four additional omnibuses, to be propelled by electricity or other motor power, or to be drawn by horses. The committee have decided not to entertain any application for the licensing of additional omnibuses on the routes named until they are better satisfied with the working of the present services of omnibuses. It is said that if Mr. Tilley would put on more 'buses like those he has had on during the last few days, the committee would willingly grant him new licenses.

Lancaster.—The Rural District Council on Saturday last gave their consent to the scheme for constructing an electric railway from Fleetwood to Morecambe, and also to the proposed light railway from Knott End to Lancaster. The Lancaster Corporation object to the latter, and the Lancaster Port Commissioners to the former. A committee has been appointed to oppose the construction of the Knott End or any other light railway or tramway by any individual or company within the limits of the borough. The same committee will also report to the Town Council on the desirability of applying for powers to acquire, construct, and work any tramways or light railways that may, in the opinion of the committee, be necessary for the use of the inhabitants of the borough.

Wrexham.—The Town Council have adopted a report of the Lighting Committee recommending that the Council approve of the appropriation and conversion of the portion of the Willow depôt buildings and premises advised by the engineers as most suitable for electric installation works and purposes, but that the question of providing a refuse destructor be postponed for the present, reserving, nevertheless, the site adjacent to the electric works shown on the plans submitted, as selected by the consulting engineers, as best adapted for the erection of a destructor; also that Mr. Trentham and Mr. Peers be engaged as joint engineers for the works, and that they be instructed forthwith to prepare plans and estimates for the necessary works for supplying electricity in the compulsory area.

Liverpool.—At Tuesday's meeting of the City Council it was stated that the electric traction receipts during the four months were £18,463, and the number of passengers carried was 3,908,000. A memorial was received from the owners and residents in Croxteth-road, objecting to the extension of the Prince's-road electric tramway along that thoroughfare. This was referred to the committee. It was anticipated at the beginning of the year that there would probably be a deficit to the extent of about £800 a year on the working of the electrical department, and provision was made for that, but the electrical department is at the moment self-supporting, and therefore the rates of the borough have been relieved to the extent of the £800 set aside. A reduction will be made shortly in the charges for electricity.

Appointments Vacant.—The Gas, Water, and Electricity Committee of the Wallasey Urban District Council invite applications for the appointment of a junior electrical engineer. There is also a vacancy for an assistant electrical engineer at the Sheffield Corporation's tramway works, and a resident electrical engineer will shortly be required at Canterbury. The British Electric Traction Company, Limited, are prepared to receive applications from gentlemen able and willing to assist the managing director in the managerial department of the company. The Corporation of Birmingham require the services of a lecturer in electrical engineering and allied subjects. A mechanic and an inside works manager are also wanted for the country and abroad. Particulars of these and other vacancies, etc., appear elsewhere.

Doncaster.—A start has been made with the new electric light station in the Bath Field. It is expected that the electric light will be ready for next winter. The total cost is estimated at £30,000. Application has been made to the Light Railway Commissioners to lay about 7½ miles of tramways in Doncaster and suburbs at a cost of £70,000. It is expected that the order of the Commissioners will be issued and confirmed during the present session. It is proposed to utilise electric power generated at the station in Bath Field for the purpose of running the trams, which will practically follow the existing 'bus routes—to Avenue-road, Bentley, Balby, Hexthorpe, Hyde Park, and the Race Common—but the starting point will be in Station-road, which is 60ft. in width, and where the cars can stand for a short time without causing unnecessary inconvenience.

Electric and General Investment Company, Limited.—Subject to the completion of the audit, the directors have decided to recommend the payment of the following dividends, etc., for the year ending May 31, 1899: A dividend of 5s. per share on the ordinary shares, of which 2s. per share was paid on account in December last, leaving 3s. per share to be distributed, together with a bonus of 4s. per share. The trustees for the ordinary shares reserve fund propose to distribute out of the proceeds of investments sold and dividends received 2s. per share, making a total present distribution of 9s. per share. A dividend for the year of £30 per share on the founders' shares, with a bonus of £40 per share, is proposed. The trustees for the founders' shares reserve fund propose to distribute out of the proceeds of investments sold and dividends received, £20 per share, making a total present distribution of £90 per share. The dividends, if sanctioned by the shareholders, will be paid on 27th inst.

Parliament.—In the House of Commons during the past week the Glasgow Corporation (Tramways, etc.), Liverpool Overhead Railway, London Hospital, Dundee Gas, Street Improvements, and Tramways Bills were read a second time. The South-Eastern and London, Chatham, and Dover Railway Companies (New Lines),

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Belfast and Northern Counties Railway, Barnsley, and West Riding Junction Railway and Dock Bills were read a third time. In the House of Lords the South-Eastern and London, Chatham, and Dover Railway, South-Eastern Railway, Kensington and Notting Hill Electric Lighting, and the Midland and South-Western Junction Railway Bills were read a second time. The Weston-super-Mare, Cleveland and Portishead Tramways Company (Light Railways Extensions), Stratford-upon-Avon Railway, Moss Side Urban District Council (Tramways), Stretford Urban District Council (Tramways), and Withington Urban District Council (Tramways) Bills were read a third time and passed.

New General Traction Company.—An issue of 20,000 6 per cent. cumulative preference shares of £5 each has been made this week by the New General Traction Company, Limited, at the price of £5. 5s. per share. The Company was formed in March, 1896, for the purpose of installing systems of electric and other traction for light railways, tramways, etc., or in assisting in the promotion of new enterprises. Its capital is £370,000 in £5 shares. The Company has introduced electric power to tramways in Coventry, and has also built and equipped the Douglas Southern Electric Tramways, Limited. Extension powers have been obtained for the Coventry system, and an Act for the installation of tramways at Norwich. A tramway enterprise in America has also been taken over, and the additional capital is for the completion of these undertakings. The Company holds £395,800 of capital in the four enterprises named, and its net earnings for the three years to March last are stated to have been £4,923, £9,386, and £13,021 respectively.

County of London and Brush Provincial Electric Lighting Company, Limited.—This Company have decided to reduce the rates in the St. Luke and Clerkenwell and Holborn districts for the first hour's average daily consumption of the maximum demand from 6d. to 4d. per unit. All current consumed in excess of one hour's average daily use to be charged at 2d. per unit. Under this reduced scale the average rate for eight hours' daily use is 2½d. per unit. The following comparative table of rates shows the average prices of current for various periods of use per day:

	New rates	Old rates.
Two hours' average use per day ...	3d. per unit ...	4 l. per unit.
Three ,, ,, ,, ...	2⅔ l. ,, ...	3½ l. ,,
Four ,, ,, ,, ...	2½d. ,, ...	3 l. ,,
Six ,, ,, ,, ...	2⅓ l. ,, ...	2⅔ l. ,,
Eight ,, ,, ,, ...	2¼d. ,, ...	2½ l. ,,

The settlements under the rebate system for this supply will be made quarterly instead of half-yearly, as heretofore.

Dundee.—At a recent meeting of the Tramways and Electricity Committee of the Town Council the convener reported with reference to a request by the Post Office authorities for a reduction in the rate charged for electrical energy, urging that it should not be acceded to. The committee agreed to the recommendation, and refused to sanction any reduction in the present rate. The accounts of the electricity department show a revenue, including £943. 17s. 8d. carried forward from last year, of £8,823 14s. 9d., leaving a profit of £1,945. 16s. 9d. The price of electric energy has been fixed at 6s. 8d. per 20 units, and 4d. for every unit above 20, with the additional provision that consumers taking more than 10,000 units should be supplied after that figure had been reached at the rate of 3d. per unit. The public lamps will be charged at the rate of £16. 10s., instead of £20 as previously, this being a reduction of £3. 10s., and electricity supplied for motive purposes is to be supplied at 2d. per unit instead of 2½d. as heretofore. On account of the large capital expenditure (£35,000), no reductions are to be made for current supplied for private lighting. The Dundee tramways have now been taken over by the Corporation.

Gloucester.—The City Council have decided to borrow £10 000 for work in connection with the electric lighting. The Electricity Supply Committee have approved of Mr. Hammond's appointing Mr. W. J. Bache (Leeds Electricity Works) as engineering clerk of works. Mr. Henry Cottrell, of Withington, Lancs., has been appointed building clerk of works. The following scale of charges for the supply of electricity is recommended: (1) 7d. per unit for any number of units up to the equivalent of 100 hours' use per quarter of the maximum demand recorded by the demand indicator; 2d. per unit for all consumption during the quarter beyond the above. (2) For the hire of meters, and to provide and supply the necessary demand indicators without any extra charge: for the equivalent of five lamps of 8 c.p., 1s. per quarter; 10, 1s. 6d.; 20, 2s.; 30, 2s. 6d.; 50, 3s.; 60, 4s.; 80, 4s. 6d.; 100, 5s.; 150, 7s. 6d.; 200, 10s. Mr. Hammond's report states that he had informed the managing director of the Brockie-Pell Arc Lamp, Limited, that the committee preferred the Brockie-Pell lamp, but considered the total cost of the lamp, switches, etc., somewhat excessive as compared with the cost of the Crompton-Pochin and some other good lamps, and would like a pillar similar to a special design obtained by them; and that the company were willing to supply pillars according to such design at the price named in their tender, and to modify some of their prices, so as to reduce their tender for providing and fixing 36 arc lamps in the four principal streets with pillars, etc., complete, from £1,132 3s. to £1,034. 16s. Mr. Hammond also reported as to a special arrangement for lowering the lamp, which would save the cost of the usual high steps, and effect a considerable annual saving in labour, and stated that the company would provide and fix such appliance for an additional charge of £4. 15s. per lamp. A plan showing the suggested positions of eight arc lamps was also submitted and approved.

Lynn.—At a special meeting of the Town Council on Thursday week the following report of Prof. Robinson was adopted: "In accordance with your instructions, I have considered the question of extending the mains and public lamps so as to replace the whole of the existing public gas lamps. I have prepared a plan which shows in blue lines the streets where electric mains are laid and public lights provided, the cost of which is included in the £25,000 referred to in my last report, and which, as you remember, covers the whole cost of works now in hand, exclusive of wiring public buildings. I have shown in red lines on this plan the mains and service lines that will be required to replace the rest of the gas lamps. The cost is as follows: 55 lamps (pairs of 16 c.p.) in streets with new mains at £46, £2,530; 125 lamps (pairs of 16 c.p.) in streets with short branches or service lines to lamps at £17, £2,125—total, £4 655. As you are aware, there is a balance on the present loan of £2,000 available. Further loan required, £2,655. There are courtyards and alleys which are not at present lighted by gas. I have considered the question of providing service lines to light these by electricity. About 65 more lamps (pairs of 16 c.p.) would be required, the cost of which, with their service lines, would be about £12 each, or £780 in all. A further loan, therefore, of £3 500 would cover the whole cost. The cost of the extension of the mains and providing public lamps for the road to South Lynn Station will be £700, which is included in the before-mentioned figures. I give this item separately, as you wished to discuss the desirability of laying this main. Siemens's contract includes a sum of about £1,100 for making 150 house services. This was a point you enquired about." It was resolved that the plans submitted for extension of the electric light mains be approved, and the work carried out. Also that the town clerk make application to the Local Government Board for power to borrow the sum of £2,500 required for the carrying out of the said extension of mains.

PROVISIONAL PATENTS, 1899.

MAY 29.

11148. Improvements in dynamo-electric generators and motors. Sidney George Brown, 22, Holland-road, Kensington, London.

11160. An improvement in electrolytes for deposit of metals. Pascal Marino, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

11172 An improved apparatus for controlling electric currents, especially applicable for charging secondary batteries or accumulators. Veritys, Limited, and Louis John Stoelf, 11, Burlington-chambers, New street, Birmingham.

11177. Improvements in wireless telegraphy. Guglielmo Marconi and the Wireless Telegraph and Signal Company, Limited, 24, Southampton-buildings, Chancery-lane, London.

11189. Improvements in electrical machines. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Actien-Gesellschaft Elektricitätswerke vormals O. L. Kummer und Co., Germany.)

MAY 30.

11227. Improvements in the ventilation of electrometers, dynamos, and the like. Joseph Platt Hall and George Archibald Robertson, 70, Deansgate, Manchester.

11244. Improvements in compounds for battery solutions. Henry Blumenberg, jun., 78, Fleet-street, London.

11249. Improvements in electric devices for propelling and controlling vehicles. Rudolph Melville Hunter, 45, Southampton-buildings, Chancery lane, London. (Complete specification.)

11253. A multiple-series electric incandescent lamp-holder and plug. Walter Nahum Coldwell and George Edward Coldwell, 34, Woodbridge-street, London.

MAY 31.

11325. Improvements in or relating to electric traction. Adrien Bochet, 78, Fleet-street, London.

11341. Improvements in the commutators of dynamo-electric machines. Walter Langdon Davies, 24, Southampton-buildings, Chancery-lane, London.

11314. Improvements in brush-holders for dynamos and like electrical machines. Frederick William Golby, 36, Chancery-lane, London. (Ignatz Paprian, Germany.)

11315. Improvements in cartridges to be fired by electricity. William Friese-Greene and Percy Edwin Knell, 55, Chancery-lane, London.

11349. Improvements in electrodes or plates for secondary batteries. Louis Georg Laffer, 37, Essex street, Strand, London. (Complete specification.)

JUNE 1.

11371. Improvements in apparatus for lighting miners' safety or other enclosed lamps by electric currents. John Warrington and Edward Brown, Goosehill, Normanton, York.

11418. Improvements in electric arc lamps. Bernard Henry Pomeroy, 55, Chancery lane, London.

11422 An improvement in electrolytic apparatus. John Gustaf Adolf Rhodin, Birkbeck Bank chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

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11434. Improvements in accumulator batteries. Pascal Marino, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

11443. Improvements in electric batteries. William Phillips Thompson, 6, Lord-street, Liverpool. (Edgar Giglio, Egypt.)

11446. Improvements in systems of electrical distribution. Charles Felton Scott, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Nov. 4, 1898, being date of application in United States.)

11447. Improvements in or relating to electric cables. George Edward Heyl-Dia, 6, Lord-street, Liverpool.

11449. Improvements in apparatus for switching on and off lamps in electrical illuminations, particularly in advertising. Alfred Frank Biddle, 11, Burlington-chambers, New-street, Birmingham.

11456. Improvements in contact boxes for electric tramways and the like. Claude Kennedy Mills, 23, Southampton-buildings, Chancery-lane, London. (Edouard Bonnet, Jules Paufique, and George Linière, France.)

JUNE 2.

11506. Improvements in carbons for electric arc lamps. John Ambrose Fleming, the Pender Electrical Laboratory, University College, Gower-street, London.

11511. A new or improved apparatus for the electric transmission of writing or manual signs or figures or the like. Joseph West, 22, Glasshouse-street, Regent-street, London.

11513. An improved self-acting mule with electrical driving gear. Waldemar Bretschneider and Carl Wilhelm Lauth, 11, Southampton-buildings, Chancery-lane, London.

11539. Improvements in apparatus used in wireless telegraphy. Guglielmo Marconi and the Wireless Telegraph and Signal Company, Limited, 24, Southampton-buildings, Chancery-lane, London.

11553. Improved electric tumbler switch. Heinrich Julius Ferdinand Voigt and Jacob Adolf Haeffner, 6, Lord-street, Liverpool. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1898.

10511. Apparatus for producing mechanical energy from alternating electric currents. Heyland.

11640. Accumulators or secondary batteries and apparatus for their manufacture. Heimel.

12365. Portable electric lamps for use in mines and other places. Walker.

12471. Electrically-propelled motorcars. Coudat.

12810. Magnetic measuring instruments. Russell.

13137. Apparatus or holder for carrying carbons or electrodes for use in electric welding, brazing, and the like purposes. De Tunzelmann.

14566. Electrical resistance devices. Lake. (Stralsunder Bogenlampenfabrik Gesellschaft mit Beschränkter Haftung.)

15149. Electric arc lamps. Lake. (Stralsunder Bogenlampenfabrik Gesellschaft mit Beschränkter Haftung.)

15346. Secondary batteries or electric accumulators. Courtenay. (Faure.)

19014. Apparatus for starting electric motors. Burke.

23827. Art of electric dyeing and apparatus therefor. Burton.

24307. Process for the electrolytic extraction of zinc and other metals from ores or waste containing them. Fell. (Strzoda.)

27526. Thermo-electrical building bricks or blocks. Matthias.

1899.

1024. Dynamometrical apparatus. Bouron.

5111. Electrically-operated gas-tap and apparatus for lighting at a distance. Schünemann and Rieder.

5190. Telephone switchboards. Overshiner.

5572. Insulators for carrying electric line wires. Hüllstrung.

5839. Battery box and tray for motor road vehicles. Condict. (Date applied for under International Convention, Sept. 3, 1898.)

6025. Electrical incandescent lamps. Fenny. (Allgemeine Elektricitäts-Gesellschaft.)

6347. Electric brakes for railway and tramway vehicles. Wise. (Actien-Gesellschaft Elektricitätswerke vorm. O. L. Kummer und Co.)

6420. Electrical resistance boxes and like apparatus and switches therefor. Gambrell and Gambrell.

6582. Electrical furnace with peripheral heating by means of electrical resistances. Lance, De Bourgade, and Schmitz. (Date applied for under International Convention, Aug. 29, 1898.)

6693. Holders for electric incandescent lamps. Thompson. (Meyberg.)

7494. Electrically-controlled valve gear for gas and other motors. Boult. (Payne.)

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1899.	Corresponding week 1898.	Increase or decrease.	Total receipts for half-year. 1899.	1898.
		£	£	£	£	£
Birmingham Tramway Co.	May 27	4,509	4,150	+ 359	82,264	75,406
Blackpool and Fleetwood Tramroad	,, 27	1,435	—	—	6,483	—
Bradford City Trams	Feb. 5	145	—	—	6,733‡	—
Bristol Tramways and Carriage Co.	May 26	3,816	2,653	+1,163	—	—
City and South London Railway	,, 28	912	1,012	- 102	23,270	22,678
Dover Tramways	,, 27	214	147	+ 67	3,260	2,492
Dublin U.T., elec. cars	,, 26	1,357	947†	+ 410	20,173	16,130†
Dublin S.D. Electric Tramways	,, 26	1,056	574	+ 481	14,693	9,443
Halifax Corporation Tramways	Mar. 29	312	—	—	10,712*	—
Liverpool Overhead Railway	May 28	1,825	1,412	+ 413	30,139	30,712
South Staffordshire Tramways	,, 26	948	601	+ 347	13,264	12,445

* Since June 30, 1898. † Including horse cars. ‡ Since July, 1898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	23½-24½
Bournemouth and Poole Electric Supply, Limited, Ord.	10	13½-13¾
—— 4½ per cent. Cum. Pref.	10	10½-11½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	18½-19½
—— 6 per cent. Cm. Pf., 30,001-40,000 (all paid)	10	14-14½
—— 6 per cent. Cm. Pf., 40,001-60,000	10	13½-14½
—— 5 per cent. Perpetual Debenture Stock	100	127-130
Brush Electrical Engineering, Limited, Ordinary	2	1¾-2½
—— Non. Cum., 6 per cent. Pref.	2	2½-2¾
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	103-106
Callender's Cable Company, Debentures	100	114-117
—— Ordinary	5	13½-14½
Central London Railway, Ordinary	10	10½-11
——	8	8½ 9
—— Pref. Half-Shares	8	8½-9½
—— ,, ,,	5	5½ 6
Charing Cross and Strand	5	11-12
—— 4½ per cent. Cum. Pref.	5	5½ 6½
Chelsea Electricity Company	5	8 9
—— 4½ per cent. Debentures	100	114-116
City of London, Ordinary	10	15½-16½
—— 6 per cent. Cumulative Pref.	10	15-16
—— 5 per cent. Debenture Stock	100	125-130
City and South London Railway, Consolidated Ordinary	100	67 69
—— Ordinary	8	4½-5½
—— 4 per cent. Debenture Stock	100	132-134
—— 5 per cent. Pref. Shares	10	14½-15½
—— ,, ,, '96	10	14-15
County of London and Brush Prov. Elec. Light Co., Ord.	10	11-12
—— 6 per cent. Cum. Pref.	10	14-15
—— 4½ per cent. Prov. Certs.	—	54-56
Crompton and Co.	3	3½ 4½
—— 5 per cent. Debentures	—	99-102
Crystal Palace District, Ordinary 5 per cent. Stock	100	133 138
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2-2½
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	96-98
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5½-5¾
Electric Construction, Limited	2	2½-2¾
—— 7 per cent. Cumulative Pref.	2	3-3½
—— 4 per cent. Perp. 1st Mort. Deb.	100	103-106
W. T. Henley's Telegraph Works, Ordinary	10	25-26
—— 7 per cent. Preference	10	18-20
—— 4½ per cent. Debentures	100	112-115
House-to-House Company, Ordinary	5	7½-8½
—— 7 per cent. Preference	5	9-10
Imperial Tramways, Limited	6	24½-25½
India Rubber, Gutta Percha, and Telegraph Works	10	21-23
—— 4 per cent. Debentures	100	101-105
Kensington and Knightsbridge Ordinary	5	12½-13½
London Electric Supply, Ordinary	3	3½-4½
—— 6 per cent. Pref.	5	6½ 6¾
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	106-108
Metropolitan Electric Supply, Limited, Ord., No. 1-62,500	10	16½-17½
—— ,, ,, No. 62,501-85,000	10	15½-16½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-121
National Telephone, Ordinary	5	4½-5
—— 6 per cent. Cum. First Pref.	10	11-13
—— 6 per cent. Cum. Second Pref.	10	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	4½-5½
—— 3½ per cent. Deb. Stock, Red.	100	100-103
Notting Hill Electric Lighting Company, Limited	10	16-17
Oriental, Limited, 1879	1	1½-1¾ xd
—— £5 Shares	5	7½-8 xd
—— £4½ Shares, New	4½	6¾-7 xd
Oriental Telephone and Electric Company	1	¾-1
Oxford Electric, Lim., Ord., Nos. 1 to 90 and 407 to 10,310	5	6¾-7½
Royal Electrical Company of Montreal	1½	165-185
—— 4½ per cent. First Shares Mortgage Debentures	100	106-107
South London Electric Supply, Ordinary	3	4½ 4¾
St. James's and Pall Mall, Limited, Ordinary	5	17-18
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	37-41
—— 5 per cent. Bonds	100	106-108
Waterloo and City Railway, Ordinary	100	105-108
Westminster Electric Supply, Ordinary	5	14½-15½

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NOTES.

The West London Tramways.—We understand that the Duke of York has been invited to open the West London electric tramway system, the main section of which is expected to be ready in a few weeks.

Vienna Tramways.—During the coming summer a trial will be made with electric traction on the new tramways. Two trains, consisting of two motors (one on each end) and two trailers, will be used. The motors will be fitted with the stearing gear requisite to enable them to run the two trains coupled together. The third-rail system will be used on a trial section about 2½ miles in length.

Society of Arts.—We would remind our readers that the conversazione of the Society of Arts is to take place at the Natural History Museum, Cromwell-road, S.W., on Tuesday, the 20th inst. The reception will be held by Sir John Wolfe Barry, K.C.B., F.R.S., and other members of the council from 9 to 10 p.m. The Royal Artillery Band and the Red Hungarian Band have been retained for that evening.

Mexican Telephone Project.—President Diaz, of Mexico, has refused to charter a long-distance telephone company on the ground that the service would injure the business of the Mexican telegraph system. The stockholders of the Mexican Telephone Company, who held their annual meeting at the Astor House, New York, decided to try to secure rights to use the telephone, not only in Mexico, but between the United States and Mexico.

Erratum.—We regret that in our last issue, owing perhaps to the hot weather, an unfortunate error crept into a report of the remarks made by Prof. A. B. W. Kennedy on Mr. J. Swinburne's paper on "Methods of Electrical Transformation." Our report states that Prof. Kennedy "believed that the trouble was largely due to the introduction of mineral water into the rubber for mechanical reasons." Of course this should have read "mineral matter."

Imperial Institute (City Branch). — We are officially informed that the City branch of the Imperial Institute, at 112, Cannon-street, embraces among other of its features an enquiry office, which is in telephonic communication with the commercial information office of the Imperial Institute at South Kensington. Enquiries relating to industrial, commercial, and other matters connected with the Colonies, India, and foreign countries are received, and promptly dealt with.

New York Automobile Club.—Residents of New York city who own automobiles have taken steps, says *Electricity* of New York, to organise an automobile club, which will be the first of its kind in the United States. It will be formed on lines similar to the clubs of London and Paris, and it is understood that desirable owners of mechanically-propelled pleasure vehicles of every type, from steam and gasoline to compressed air and electricity, will be eligible to membership.

Royal Meteorological Society. — Arrangements have been made for the following papers to be read before the members of this society on Wednesday next, the 21st inst.: "Heavy Falls of Rain recorded at the Observatories connected with the Meteorological Office, 1871-1898," by Robert H. Scott, D.Sc., F.R.S.; "Average Height of the Barometer in London," by R. C. Mossman, F.R.S.E., F.R.Met.Soc.; "A New Self-Recording Anemoscope," by Joseph Baxendell, F.R.Met.Soc.

High-Speed Electric Motorcars.—At a recent show of automobiles in Paris an electric motorcar owned by Mr. Tenatzy was exhibited. With this car the owner claims to attain a speed of 65 miles per hour. We are informed by the *Daily Telegraph* that at the trial in question the car tore up and down the avenue like a silent shell from a cannon. We can believe that it did tear up and down if a speed of 65 miles was run, but we cannot credit the statement that at this speed the car was silent.

Jungfrau Railway.—The heirs of Mr. Guyer-Zeller intend to complete the Eier section and to rest content with that. It is stated that the enormous difficulties, technical as well as climatical, coupled with the uncertainty of forthcoming dividends, are sufficient reasons to preclude them or anyone else from proceeding any higher up the mountain. The contemplated station will be, anyhow, nearly 10,000ft. above sea-level, and the top of the Eier glacier, another 2,000ft., is easily reached from there even by those who are not expert mountaineers.

Birthday Honours.—Amongst the names included in the birthday honours list, to which we referred last week, is that of Mr. Ernest Cassels, on whom the order of K.C.M.G. has been conferred. Mr. Cassels's great work was carried out in Egypt, where he has been responsible for a great deal of railway development, and also in connection with the important barrage at Assouan. Mr. Cassels was likewise very largely responsible for the Central London Railway, which will soon add so greatly to the travelling facilities of the Oxford-street route.

Pacific Cable.—Commenting on the statement that the Imperial Government had intimated a willingness to reconsider the Pacific cable scheme on the basis of utilising the credit of the United Kingdom in the provision of the capital necessary, the Canadian papers declare, says a Reuter's telegram on Monday, that such action will not be in harmony with the spirit of the Cable Committee's resolution, and express the hope that the British Government will assume its share of the maintenance and construction of a State-owned cable on the basis agreed to by Canada and Australia.

High-Voltage Lamps.—In the current issue of the *American Electrician* descriptions are given of several recently opened electricity works in England. In an editorial comment on these, it is stated that the direct-current three-wire system, with 450 between the outers, is not largely used in America, and that its extensive adoption in England is worthy of being followed in the States. Our contemporary puts the case very clearly as to the advantages of our English practice, and concludes that the use of high-voltage lamps in the States is kept back by the fact that they are worked at low efficiency in order to obtain long life.

Ventilation of Battleships.—We understand from the *Western Independent* that it has been decided that important modifications are about to be made with respect to the method of ventilating battleships, and that electrical motor-engines are to be placed on board to supply direct ventilation through ordinary pipes for each of the great compartments. This, says our contemporary, will mean a considerable diminution of work in the ship-fitting department at Devonport, which is executed by shipwrights specially chosen to carry out this particular kind of work. It is also stated that it was seriously proposed some time ago to drain the engine, boiler, and principal store rooms by means of electrical motor power, but for the present it has been abandoned.

Electric Railway Extension.—The City and South London Electric Railway has taken somewhat longer to extend than was anticipated. A short time ago the company made an announcement with regard to season-ticket holders that assumed the new line would be opened

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in July, but we now learn that it will be at least three months before it will be in readiness for work. It is not merely an extension of the line from King William-street to Finsbury-pavement. A tunnel under the Thames has been constructed, so that the line is really a new undertaking from the Borough Station, or very near it, northwards. The company are erecting new buildings and introducing a new electric installation in what used to be the garden of Mr. Spurgeon's Orphanage at Stockwell.

Exposition of Electrical Arts.—Referring to the proposed national exposition of electrical arts to be held in Chicago during the autumn carnival, the *Inter-Ocean* says that a company has been incorporated to manage the enterprise, and the promoters announce the display will surpass in every way the one which is now drawing crowds to Madison-square Garden, New York. It is proposed to have on exhibition everything known to the electrical world, from a dynamo to an electrical flatiron, automobiles, instruments sending wireless telegraphy, and indeed every modern electrical device. It is added that one of the principle objects of the company is to have exhibits to satisfy popular curiosity as well as the questionings of scientific men who will be in the city among the carnival crowds.

The Storage of Automobiles.—A curious fact is, says the *Electrical Review* of New York, brought to light by one of the gentlemen connected with the Automobile Club in that city. It is that no livery stable will store an automobile on account of the horsemen's prejudice against these vehicles. Consequently the owner of an automobile has to provide a private storage place for it, at considerable trouble and expense. This sort of opposition to improvement is reminiscent of the early days of the steam-engine, when several of them were destroyed by labourers jealous of the new invention. If the livery stablemen were wise they would begin now to put in stalls and charging accommodation for electric vehicles to replace the horses and carriages that a few years' progress will send to the limbo of forgotten things.

The Behr Lightning Express.—The Joint Committee of Manchester and Liverpool men who met to consider Mr. Behr's scheme for a lightning express railway between Manchester and Liverpool, has reported in favour of a more rapid system of travelling between those two cities. We note, however, that the committee refrained from endorsing Mr. Behr's arrangements, so that the matter really stands much where it did before the committee met. Mr. Behr with his indomitable energy must now succeed in persuading Parliament in the advantages of his scheme, also that he has the requisite financial support to enable him to carry it through if the necessary authority is given to him to acquire land. The estimated cost for the construction and equipment of this line is about a million and a half.

All that is Wanted.—We have recently come across the following interesting advertisement: "Wanted, a gas engineer-driver; wages 20s., rise 25s., with cottage. He must be a fitter, electrician, and gas engineer, to look after a small boiler and generator. The hours are 70 per week, and on Monday 15 hours would have to be put in without time for meals. He would have to look after the dynamos and accumulators, and all the lights throughout the mill. He will also be required to take charge of a gas-engine and pumping plant, and to keep the water intake clear of weeds." A correspondent who forwards us these particulars states that the man in charge has to work 12 hours per day without a "brake." We presume that he has had experience of the work, and that the long hours and short pay have seriously affected his orthography.

Stranding of the "Paris."—Referring to the forthcoming meeting of the British Association at Dover, the *Dover Express* says that correspondence is in progress between various authorities, the result of which will probably be that a discussion will be arranged in connection with the autumn meeting of the British Association for the purpose of clearing up certain problems emphasised by the stranding of the ss. "Paris." It is also stated that the enquiry will embrace several aspects of the affair, and it is believed that as a result an investigation will be made under the auspices of the association into the behaviour of the compass in steel ships. Information is also being prepared, says our contemporary, with the object of eliciting opinion upon the use of electricity for lighthouse illumination. The *Dover Express* is of opinion that no more appropriate site for such an enquiry than the port of Dover could be conceived, and it is hoped that a delegation from the French Association will lay before the meeting fresh facts as to the experience of French mariners on this subject.

German Cable.—From a letter addressed by the German Post Office authorities to *Dingler's Polytechnisches Journal* we learn that the new German Transatlantic cable will not, as was previously believed, touch our shores. It will start from Borkum, go thence straight to the Azores, and from there to New York. The Telegraph and Maintenance Company will do the whole of the manufacturing and laying. The latter company have the monopoly as far as landing cables on the Azores is concerned. At present no German works could undertake a contract of that magnitude, but big cable works are now in the course of erection at Nordenham. The excellency of the work previously done by the English company is given as one of the reasons in the letter quoted. It is also pointed out that the Deutsch-Atlantische Telegraphengesellschaft is not over-capitalised at one million sterling, as compared with the Pacific Cable Company, the capital of which is £1,850,000, seeing that the length of the new line will be more than half of that of the Pacific cable. The charge per word will be 1s.

The Telephones.—A private conference in support of the nationalisation of the telephones was held last week in one of the committee rooms of the House of Commons, Mr. Faithfull Begg, M.P., presiding. There was a good attendance of members of the House of Commons and of representatives of the Liverpool, Manchester, Leeds, Bristol, and Nottingham Chambers of Commerce, as well as of the Stock Exchanges of Manchester and Liverpool. The following resolution was unanimously adopted: "That the proposed municipalisation of telephones is undesirable both from a municipal and a public point of view; that this conference would prefer that the entire telephone system of the country should be under direct Government control, as the best means of satisfactorily providing for the harmonious development and conduct of telephonic communication in the future; that it is therefore hoped the Government will see fit to reconsider the Telegraphs (Telephone Communication) Bill, and will make such arrangements as will enable the whole system of telephones to be acquired and worked by the State."

London Telephone Service.—At a meeting of the London County Council to be held on Tuesday next the Highways Committee will recommend the Council to pass the following resolutions: "(*a*) That, in the opinion of the Council, the telephone service in the London area of the National Telephone Company should be managed by the Council, the Corporation of the City of London, and the local authorities of districts outside the administrative county of London but within the London

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telephone area; (*b*) that, in the opinion of the Council, application should be made to the Postmaster-General, by the Council, the Corporation of the City of London, and the other local authorities of districts within the London telephone area of the National Telephone Company, for a license under the Telegraphs Act, 1892, for the establishment of a telephone service in respect of that area; (*c*) that the clerk of the Council, in conjunction with the town clerk of the City of London, draft an application to the Postmaster-General for the license above referred to, and that such draft application, when prepared, be submitted to the Council for approval."

Mr. Maxim's New Switch.—We gather from the *Scientific American* that Mr. Hiram S. Maxim has lately patented a new means of operating the switches of electric cars. The working of the new method is explained as follows: The draw-bar of each car is an inextensible rod running the whole length of the car, with a coupling at each end. This rod is held in a central position by two spiral springs, and is connected to the switching device of the car in such a manner that, no matter in which direction the bar is moved as relates to the car, it switches in the current which moves the car in the same direction. Therefore each car follows the drawbar automatically, and the motor of each car does just sufficient work to propel that particular car. This device, says our contemporary, is of great simplicity and is easily understood, as it requires no coupling or connection between the various cars of the train except the coupling itself. Although the method appears to be one of great simplicity, it seems to us that it would entail considerable complication in actual practice. The idea, however, seems to be very good.

Electric Lighting Orders.—On Friday last, in the House of Lords, the Earl of Morley called attention to the common form clauses of Electric Lighting Provisional Orders Bill. It appears there are 19 Bills dealing with 90 orders. Each order consists of 36 pages, of which 30 contain common form clauses; and, from the great bulk which these Bills assume it would seem, he remarked, how necessary it was that the Electric Lighting Orders (Common Form Clauses) Bill should be pressed forward in the other House. He went on to remark that the examination of these Bills after they had received the Royal assent involved great labour, not to speak of the enormous amount of printing which was involved. If the Bill could not be passed this session, he suggested that the Board of Trade should group a large number of orders in single Bills, and schedule the common form clauses at the end of each Bill. Lord Balfour, in the absence of the Earl of Dudley, said the Board of Trade were deeply impressed with the strength of the case put forward by the Chairman of Committees. It was their intention to pass the Bill this session if possible. Failing that, the alternative suggestion of the Earl of Morley was well worthy of the consideration which he had no doubt it would receive.

Telephone Wires.—We understand from the daily Press that the Telegraph Department of the German Empire has decided, owing to the high prices of copper, to limit its needs of that metal, and until further notice to use iron wires exclusively for its telegraphic lines; whilst for the telephones, instead of copper wires, aluminium, or iron wires with copper covering, are to be employed. We do not think that the German Government is well advised in taking this step in the substitution of iron wires for copper, except in the case of very local circuits. The extra speed obtained from the use of copper should, in the long run, make it a cheaper material than iron if the matter is considered in a broad-minded spirit. How far aluminium will serve to replace copper wire in this respect is yet to be proved, as at present in America it is, we believe, used only for large power transmission work. It must be remembered in this connection that with telegraph and telephone wires which are suspended overhead, the mechanical properties of the wire need careful consideration. It is quite conceivable with an increased section of the aluminium wire cable, that a want of uniformity in its manufacturing and in its tensile strength would make it unable to withstand the heavy strains resulting from falls of half-melted snow.

Electricity and Mining.—We learn that the installation of an electrical power plant has just been completed in what is known as the Waitekauri Cross mine in New Zealand. The requisite power is generated a distance of about two miles from the mine by two compound-wound dynamos, which are driven by belts off massive flywheels on either side of a 3ft. Pelton wheel. The turbine is supplied from two water-races connected at the penstock, the down pipe being 2ft. in diameter. The current is conveyed to the mine by two pairs of cables on fluid insulators fixed on cross-arms to the poles. The winding hoist is fixed in an underground chamber at the head of the underlay shaft now being sunk on the reef. The electric motor is a compound four-pole iron-clad type machine of 40 b.h.p. The winding drums are arranged in tandem, and each is capable of raising one ton, plus the weight of the winding rope, up an incline of 60deg. at the rate of 300ft. per minute. The chamber, main adit, tip-head, and office are illuminated by electric lamps. A triplex-action electric pump, which is geared to run at four distinct speeds to suit the different depths and volume of water met with in sinking, has also been provided; but this pump, says the New Zealand *Mines Record*, is not at present required, as there is very little water to contend against.

Chemical Terminology.—We give the following abstract from the *Journal* of the Chemical Society to show how electrolytic processes are being used in organic chemical research work, and also how unintelligible the terms used in such work are to the average engineering reader. The abstract is of an article by Messrs. C. Schall and S. Kraszler on the electrolytic preparation of dithionbisulphides which appeared in the *Zeitschrift für Elektrochemie*. The authors found that the electrolysis of aqueous solutions of potassium methyl, isobutyl, or isoamyl xanthates yields the corresponding bisulphides at the anode. When an aqueous solution of diethyl-ammonium diethyldithiocarbamate is electrolysed, a deposit of tetrethylthiuram bisulphide, $S_2(CS{\cdot}NEt_2)_2$ is formed on the anode, whence it is washed ether. The anodic deposit obtained from potassium phenylthiocarbazide, $NHPh{\cdot}NH{\cdot}CS{\cdot}SK$, consists of diphenylthiocarbazide, $CS(NH{\cdot}NHPh)_2$. An aqueous solution of potassium ethyltrithiocarbonate, $SEt{\cdot}CS{\cdot}SK$, yields the hitherto unknown dithionbisulphide, $S_2(CSEt)_2$, in the form of a yellow, uncrystallisable oil which readily decomposes. With aniline, it yields thiocarbanilide, sulphur, mercaptan, and hydrogen sulphide; phenylthiocarbimide was also found, probably owing to the intermediate formation of phenyldithiourethane.

A Large Electric Crane.—We notice in the *Electrical Review* of New York a good illustration of a powerful cantilever shipbuilding electric crane, recently erected at the shipbuilding yard of Messrs. William Cramp and Sons, of Philadelphia. The crane in question is driven by a single electric motor of about 150 h.p. It is mounted on a steel trestle of special design, 60ft. high, giving a total

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height from the ground to the underside of the cantilever arm of 92ft. The crane has a clear travel up and down the trestle of 725ft., and has a lifting capacity of 15 tons at 60ft. out on either arm, or five tons at 95ft. out on either arm. The total length of the two cantilever arms over all is 202ft. The gauge of track along which the crane runs on top of the trestle is 20ft., and the entire crane has a speed up and down the trestle, with loads, of from 500ft. to 700ft. per minute against the wind. It will hoist its maximum load 125ft. per minute, or five tons 350ft. per minute, or 1,000lb. 700ft. per minute, and has a trolley travel along the cantilevers of 800ft. to 1,000ft. per minute. This crane, which is known at the Cramp Works as the "Battleship Crane," covers two battleship ways. The crane, as well as the trestle, were designed and built for the company by the Brown Hoisting and Conveying Machine Company, who are now constructing two more similar cranes, to be erected in other parts of the same shipbuilding yard.

Workshop Instruction.—We notice in a recent number of the *London Technical Education Gazette* that the Woolwich Polytechnic has taken up strongly the organisation of courses in workshop arithmetic and mechanics, and also another series in experimental work in electricity and magnetism. The principal kept in view the following points in arranging the courses, which are intended largely for lads attending evening continuation classes, as well as for teachers in Board schools: (1) That the students attend evening continuation schools quite voluntarily, and for this reason the work must be made interesting to them, otherwise they will not attend regularly; (2) in order to make the work interesting the students must be taught to think for themselves, and this must be done in such a way that their efforts are reasonably successful; (3) the students should be given work, the usefulness of which they can appreciate. The class on electricity and magnetism was placed under the care of Mr. Edser, and the following experimental apparatus was made by each of the 18 teachers, who attended the course most regularly on Saturdays: a magnetometer, galvanometer, a cell for determining the electric current by the decomposition of copper, Wheatstone bridge, astatic galvanometer, and a potentiometer. Similar classes to these will be recommenced in September next, when a number of other polytechnics will take this kind of instruction, the value of which is, of course, great.

Portable X-Ray Apparatus.—On Monday last, at a meeting of the Röntgen Society, Major Beevor opened a discussion on a portable X-ray apparatus, with a view to obtaining the opinions of experts as to the best construction that could be devised. According to a newspaper report, he said that for some months he had been experimenting with the various machines now in use, and had come to the conclusion that Mr. Pidgeon's modification of Wimshurst's apparatus would fulfil all the necessary requirements in the field. With the aid of Messrs. Baird and Tatlock he had constructed an apparatus which, enclosed in a box 2ft. by 18in., and weighing about 15lb., gave as good results as a 10in. or 12in. Ruhmkorff coil, and this had the advantage of giving an almost continuous current, thereby obviating the flickering of the X-ray effect upon fluorescent screens. By interposing Leyden jars he was able to produce sparking or interruption of the current, which gave equally good photographic results. With reference to the use of coils with their batteries and accumulators in warfare, he said that natives absolutely refused to carry sulphuric acid. In the Tirah campaign he bought 36lb. of this acid at Rawal Pindi, and got it as far as the railway head, but there it stayed. When the troops were in the heart of the Tirah Valley he had to go round the field hospitals and collect whatever small quantities he could, and this was all that he had to work his Grove battery with. He did not believe that either in Egypt or India they would ever induce natives to carry sulphuric acid, and it was impossible to disguise it as something else, because the railways insisted on its being declared.

A Calcium Carbide Manufactory.—The following is an abstract, made by Mr. Carl Hering, of a long description of the calcium carbide plant at Meran, in Austria The article in question appears in *L'Eclairage Electrique*, and was written by Mr. Keller. In this plant, which is the first of the kind to be installed in Austria, water power is used, and the original station has five three-phase alternators of 1,200 h.p. each directly coupled to the turbines; this power is transmitted at 10,000 volts, and about 2,000 of it is used for the manufacture of the carbide by the Gin and Leleux process. In the concluding portion he gives detailed figures of the cost of production at that plant, claiming that the results obtained in Europe are much better than those of the American plants. Such efficiencies as 13lb. to 15lb. per horse-power per day are purely imaginary, as 5·5lb. would be quite satisfactory. Theoretically it requires 1,900lb. of lime and 1,230lb. of carbon to produce a ton of the carbide; in practice, however, 2,050lb. and 1,420lb. respectively are required. The cost of a ton of lime at that factory is about 16s. and of the carbon about 32s. One electrode will be sufficient for 10 tons of the carbide, and it costs £6. 12s., or about 13s. per ton. The electrical energy per ton of the carbide is 6,400 horse-power hours, which at £2 per electrical horse-power year is equal to a little over £1. 16s. per ton. The accessory machinery, the loss in the lines, etc., corresponds to about 200 h.p., or about 4s. per ton, the production of that factory being about 6·5 tons per day. Labour at 3s. to 3s. 4d. per day amounts to about 15s. per ton. Amortisation amounts to about £1 per ton, and the general expenses to about £1 per ton; the maintenance of the plant is given at 6s. per ton. The total cost at that factory is £7. 5s. per ton.

Personal.—Our humorous contemporary, the *Bailie*, of Glasgow, referring to Mr. W. Maclay, the well-known convener of the Lighting Committee of that city, who has taken a very active interest in regard to lighting generally, as well as in the financial considerations which are inseparable from municipal trading, gave some time ago a biographical sketch and portrait of that gentleman. A member of the Town Council and a magistrate, our contemporary reminds its readers that for eight years Mr. Maclay has been associated with a variety of schemes before the local parliament, including public health, watching and lighting, statute labour, municipal buildings, gas, and electricity. The *Bailie* adds: "Having taken so keen an interest in educating himself, it was only fitting that he should exhibit the warmest sympathy for others less fortunately placed in that respect. The Cathcart School Board consequently claimed his services for nine years, and honoured his work and devotion by electing him its chairman. A member of the Chamber of Commerce and of the Master Court of the Incorporation of Bakers, he is well and widely known in business as well as in municipal circles. Of a scientific turn of mind, he is presently vice-president of the Geological Society. Altogether our friend is an admirable example of that class of self-made men who have by hard study and business aptitude not only done honour to themselves, but have contributed to the material wealth and expansion of our great city. A modest man withal, of a somewhat retiring disposition, his work is perhaps better known in

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the committees of the Council-chamber than on the house-tops. A worthy citizen of St. Mungo, the *Bailie* doffs his hat and wishes him that health and happiness which his qualities, services, and nature deserve."

Nikola Tesla.—We notice in the *Western Electrician* an account of a lecture given by Nikola Tesla before the Commercial College, Chicago. Our contemporary remarks that Mr. Tesla's speech was rather disjointed, partly owing to the nature of his address, which was punctuated with expressions and side remarks, and partly through his apparent difficulty in expressing his ideas. "There is no one," Mr. Tesla said, "who does not speculate about the questions of his existence, asking whence he comes, whither he is going, and what in reality he is. Soul and matter and their relations have eternal interest for human beings. On the other side, there is always the desire to comprehend the marvellous manifestations of nature in all its phases. Let us talk of all these." We quite agree with our contemporary, if the following remarks are correctly reported. For instance, we are told that Mr. Tesla talked of the possibility of depriving a piece of iron of all its heat and energy until it had reached the absolute zero and the minimum of motion. "When the motion has ceased entirely," he said, "when the ultimate stage of condensation is reached, the matter would disappear. There may be going on in the infinite depths of space a process of appearance and disappearance of matter. We are working to test this by trying to reach the absolute zero. It may take centuries before we can reach this absolute zero, if ever, for the difficulties are very great." Again, Mr. Tesla referred to an experiment in which he said he converted a column of gas into a solid body by the application of electricity in a certain manner. The gas became rigid and vibrated like a steel wire. We can quite conceive that the lecture was exceedingly difficult to follow, but we think that Mr. Nikola Tesla would enhance his reputation more by delivering a lecture which was clear and comprehensive rather than by delivering himself to utterances which were evidently intended to mystify those to whom he was speaking.

The Sir Gabriel Stokes Jubilee.—The Chemical Society, in their address to Sir George Gabriel Stokes, M.A., D.C.L., LL.D., D.Sc., F.R.S., as Lucasian Professor of Mathematics in the University of Cambridge, refer eulogistically to the 50 years which he has held a position so honourable to the university. Allusion is also made to the profound influence he has brought to bear on the teaching of physics. This influence has of necessity extended into those departments of chemical science which are directly dependent upon, or are associated with, physics. The society gratefully acknowledge the services Prof. Stokes has rendered to chemical physics by his researches on hydrodynamics, by his contributions to the theory and practice of spectrum analysis, and by his optical investigations. His memorable contribution to the society's *Journal*, "On the Application of the Optical Properties of Bodies to the Detection and Discrimination of Organic Substances," made more than a third of a century ago, has, they point out, borne fruit a hundredfold, and to-day the refractometer and the spectroscope are as indispensable to the chemist as is his balance. The address concludes as follows: "We are glad to recognise that your interest in our special field of enquiry, springing from that catholicity which is your characteristic, has in no wise abated, for there is hardly a chemical subject bordering upon those branches of physical research which you have made more especially your own that has not been elucidated and benefited by your kindly criticism and advice. There are many workers in our society who thankfully acknowledge the ready help which you have rendered to them by your counsel and suggestions. That you may long continue to enjoy, in health and prosperity, the esteem and respect with which you are universally held by those who labour for the advancement of knowledge and the spread of learning, is the heartfelt wish of every member of that body on whose behalf we now address you."

Long-Distance Transmission.—Prof. W. L. Robb read an interesting paper before the National Electric Light Association of New York at the end of last month on "Rotary Transformers and Storage Batteries as Related to Long-Distance Transmission." No doubt certain of our contemporaries will write the paper down as unfit to be read because Prof. Robb has used the word "rotary" instead of Prof. Silvanus Thompson's "rotatory." In spite of this, however, the communication is worthy of careful reading, as the author spoke from experience obtained with a Hartford transmission plant. In this installation the water power is obtained from the Farmington River, about 11 miles from Hartford, and as at present developed is capable, under the most favourable conditions, of delivering at the switchboard in Hartford about 1,200 e.h.p. The power is generated by two 600-kw. alternators, and transmitted to Hartford on the three-phase system under 10,000 volts pressure. The water power is supplemented by an auxiliary steam plant in Hartford. The output of the steam plant is about 1,600 h.p., and is used to supplement the water power when the river is low. For distribution purposes, two systems are used in the central portion of the town. A three-wire direct-current system at 220 volts is employed, all the cables being placed underground. In the suburbs, alternate current on the two-phase system is employed, but here again a three-wire distribution of 220 volts had been adopted. The cables in the different outlying districts are sometimes placed overhead. Three rotary transformers supply direct current to the three-wire direct-current system. One has a capacity of 400 kw., and is located at the steam plant. Two have a capacity of 250 kw. each, and are placed in a battery substation which is situated in the very heart of the business section of the city, and about three-fourths of a mile from the steam plant. The storage battery has a capacity of 2,500 horse-power hours at a five-hour rate of discharge. The 250-kw. rotaries and the battery were installed in the fall of 1896, and the 420-kw. rotary in the fall of 1898. All three rotaries and the battery supply currents to the same three-wire system. The rotary transformers are of the two-phase type, and are so designed that by cutting in or out turns of the primary of the static transformers the voltage of the rotaries may be varied between 230 and 360 volts. This wide range of voltage is necessitated by the fact that the rotaries are at times run directly on the line, and at other times used in charging the battery, frequently at high charging rates. This wide range of voltage that can be obtained from the rotary does away with the boosters, otherwise necessary in charging. Two of the rotaries are started and brought into synchronism by induction motors built on their shafts; the third is brought into synchronism as a direct-current motor, the current necessary for this being supplied from the direct-current system. When the rotary transformers were running in parallel, considerable trouble was found at first with them, owing to the pumping action which was set up between them. This was entirely overcome by the introduction of short-circuited copper bars in the pole-pieces of the machines. Since this has been done there has been no trouble whatever in this direction. The author explains by diagrams the great service the accumulators have rendered to the undertaking in evening up the load on the machines, and also in keeping the voltage constant.

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MUNICIPAL ELECTRICAL ASSOCIATION.

BRISTOL CONVENTION.

The fourth annual convention of the Municipal Electrical Association commenced at Bristol on Wednesday last in the Museum Lecture Theatre.

MR. HERBERT ASHMAN, LORD MAYOR OF BRISTOL.

Mr. HERBERT ASHMAN, the first Lord Mayor of Bristol, took the chair, and in a well-delivered speech welcomed the association to the city of Bristol. Speaking on behalf of the Corporation and the citizens generally, he said it was an honour to Bristol that the Municipal Electrical Association had chosen that city as its meeting-place at such an early period of the existence of the association. The precedence over larger towns so given was appreciated by all, and he trusted that the members would enjoy their stay. Of all the municipal works in Bristol they were perhaps most proud of their electricity works, and for the success of these works Mr. Faraday Proctor, the president, and Councillor George Pearson, the honorary solicitor of the Municipal Electrical Association, were largely responsible. The Lord Mayor proceeded to give instances of the rapid way in which municipal electrical undertakings had advanced. Thus, while only £56,942 had been raised on loan for such works in 1891, in 1896 the amount reached over £2,000,000, while at the present time the capital so raised reached £5,000,000 in the United Kingdom.

MR. E. T. RUTHVEN-MURRAY, HON. SEC., MUNICIPAL ELECTRICAL ASSOCIATION.

Mr. FARADAY PROCTOR, on behalf of the association, thanked the Lord Mayor for his kindly welcome, and said that no one had done more to advance the successful carrying out of the present convention. After this Mr. Proctor took the chair, and delivered the following address:

Presidential Address.

We are met together to hold our fourth annual convention, and, according to custom, I have as your president the honour of addressing you before we proceed to the real business of the meeting: the receiving and discussing of papers contributed by members of the association on subjects relating to or affecting municipal electrical enterprise. As this association has very little past history, there is correspondingly little food for remarks upon the subjects of its completed works. I therefore propose to just touch upon some of the matters now in hand or requiring early attention.

The primary object of this association is to guard and promote the interests of municipalities in connection with electrical matters in general, this being brought about chiefly by the interchange of ideas and experiences. At such meetings as the present we have the opportunity of discussing each other's ideas and generally enlarging our own, as well as enlarging or directing the minds of the public in general. We have a very full programme before us: it is a matter of regret that a longer period than three days cannot be allotted to the ordinary business of our meeting. Great good results from the meeting together of councillors and engineers interested in the development of electrical enterprise; this alone is full recompense for the energy spent in the working of our association. There are now 83 municipalities operating electric lighting works, and of these 61 have joined this association, including most of the principal cities, the total membership being now 208.

The growth of this association fairly represents development of municipal working. When our association held its first convention three years ago, 134 local authorities had powers to work electrical undertakings, whilst now there are 235. During the same period the number of

MR. FARADAY PROCTOR, PRESIDENT, MUNICIPAL ELECTRICAL ASSOCIATION.

companies with such powers has only increased from 64 to 81. The total capital expended by local authorities having works in operation is now about £5,000,000, of which sum £4,500,000 is at present represented by our association. The scope of municipalities as traders is being more keenly discussed now than it ever has been before, but no matter what limitations may be made, it seems certain that municipal enterprise will continue to increase as regards what may be termed the large monopolies—water, gas, tramways, electricity, and telephones. The action of the Government in connection with telephone matters foreshadows what would probably result if large schemes for electric power distribution are also sanctioned. If later on such schemes should be allowed to proceed, it appears likely that the companies would ultimately combine and form a huge monopoly like the National Telephone Company. In the case of public requirements municipalisation seems to spring up as the natural course between the formation of huge monopolies and ruinous competition. Even where companies do not combine healthy competition is not secured, owing to the working being such as we have in the case of insurance companies, where a ring is formed, a tariff drawn up, and an end put to competitive tendering. When company work reaches the stage now arrived at as regards insurance, it is time that such work be municipalised or taken up by the Government. In the case of insurance I would advocate a Government department—the risks would be better divided and sufficient experts could be more easily retained. It is desirable that all public streets should be under the

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complete control of the public authority, including any works that are executed under their surface, more especially if the occasional or frequent disturbance of the paving is necessary in connection with such works. Under the main arteries of a large city, subways should be constructed for the passage of pipes and cables. Were all these under one control it is likely that such would be formed, but while the responsibility for the streets is divided between the local authority and two or three companies it cannot be expected that such arrangements will be made. Where works are restricted to the district of one local authority, they should be in the hands of that authority. If they are spread over the whole country, as in the telegraph system, it should be in the hands of the Government. If the works extend to the districts of two or more local authorities, they should, as far as is reasonable, belong respectively to the different authorities.

It is often argued that a corporation or vestry cannot manage a commercial undertaking as well as a private company, and that there is not the same continuity or even intensity of interest; if this is so, would it not point to the desirability of a change of system regarding the appointment or term of office of the councillors or vestrymen. Speaking impartially as a consumer of electricity, I would say if the members of the corporation cannot manage the electric lighting get rid of the members, but leave the electric light; but is it so? A company is not usually managed by the individual directors, though it may be by one of them, and a change on the board does not alter the tactics of the whole company so long as the actual managers remain. The same applies to working under a municipal committee, the actual management is, or ought to be, carried on by the permanent official. It is possible, and even likely, that some slight change may occur in the committee every year or two, but the leading members usually remain for much longer periods. The weakest point in the municipal management of electricity works at the present time is the unstability of the so-called permanent official, more appropriately termed the engineer. It is more important to a corporation than to a company that its official should remain during an extended time, for the very reason that changes are more likely to occur on the committee than on a board of directors, and yet how often these changes are allowed to occur in the case of electrical undertakings. The cause of this continual moving about is not difficult to trace. A few years ago, whenever a scheme of electrical equipment was required, a consulting engineer would be engaged who would probably be retained for some years after the permanent engineer had taken up his duties. The most common practice now, judging from the technical Press, is to advertise for the permanent official at once, and require that he be capable of designing and drawing up specifications for the works. The salary attached to such an appointment would naturally be greater than that of an engineer engaged for superintendence only; consequently many engineers will apply for the post advertised who have been appointed on the old lines, although they perhaps have at the time the whole responsibilities of the design of new works without such extra services and responsibilities being recognised. The common practice in many towns is that an official shall not receive increased emoluments unless he is in possession of an offer of an appointment elsewhere. Reference has been made to the fact that consulting engineers are not now so often engaged to arrange the preliminary portion of an undertaking as hitherto. In many instances this is ill judged, as in the case of undertakings where there is no reasonable prospect of great development at an early date the services of a permanent official with really good qualifications cannot be reasonably obtained. It would, therefore, be much better that an experienced consulting engineer should be employed.

The more difficult instance is that of a municipality owning an electric lighting undertaking and a tramway to be converted or constructed for electric traction. The tramway engineer, if such exists, wishes to keep the whole of the works in his own hands, and the consulting engineer cannot shut his eyes to the fact that if he advocates a system distinct from the existing electrical undertaking he will probably be engaged to carry the scheme into effect. But if he expresses a decision in favour of combining the electric traction with the electric lighting works, his share in the organisation of the new system is likely to be very much less, and his fees will be affected in a similar manner. On the other hand, if the municipal electrical engineer be consulted he may be slightly prejudiced in favour of a combined system, but not necessarily so, as there should never be more than one chief electrical engineer in the same area, and thus the electrical section of the works, whether they be lighting, tramways, or power distribution, should in any case come under the one man. The solution of the difficulty seems to lie in the direction of the employment of the consultant on a prearranged scale, such not being dependent in any way upon the combination, or otherwise, of the systems. A scale of fees, based upon the miles of track to be equipped, would be as fair and workable as the existing payment by commission on the amount expended. At the same time this would not be conducive to excessive expenditure, as is the case with the existing scale. The same principle might with advantage be applied in connection with other works such as buildings, with a view to economy as regards capital outlay.

Turning to the question of revenue charges, there is a great deal to be learned from a careful analysis of the working of undertakings which cannot be abstracted from any existing tables or other publications. We are all required to make returns to the Board of Trade, showing the results of our annual working on similar lines, but these returns do not go far enough to be of much value to the engineer as regard details, and unfortunately the Board of Trade do not tabulate and publish the returns so made. In returns published certain works are shown as having attained excellent results in one or other detail of costs, but there are no direct means of discovering how the results are arrived at. In one case fuel may cost next to nothing, and in another it may be charged at too high a price. Either of these errors may arise when fuel is obtained from the corporation gasworks. The question being how much of the expense can be fairly allotted to the gasworks and how much to the electrical. Under the heading of management there may be next to no charge for accountancy, expenses, etc., these being under the control of the city or borough accountant's department, and perhaps charged in with rates and taxes or not charged at all. In one instance where an undertaking made a record during its first year of operations, the results were aided by charging practically the whole of the chief's salary and a considerable portion of the assistants' to capital on account of extensions that had been carried out. On the other hand, there are many instances where the supervision of capital works is entirely charged to revenue. It is an unfortunate fact that the record-making stations have not generally been those whose supply is praised for its regularity, and the detailed records kept are very meagre. The log sheets as a rule contain little information of real value, whereas they should be the principal source of information and subject of analysis. The council of this association has made one fruitless attempt to get a table compiled that would meet the want felt. Another attempt will shortly be made, when it is hoped that the general body of members will respond not only by supplying data regarding their own works, but by offering suggestions for the improvement of the forms issued. There is doubtless a considerable amount of labour involved in collecting the information required, but this is slight compared with the benefits derivable. A task which this association should take in hand at an early date is that of drawing up a scheme for the appropriation of charges under the headings appearing in the Board of Trade returns, and such sub-headings as seem desirable.

Though we cannot look back upon great achievements an important reduction of fire insurance rates has resulted from the efforts of the association, but taking into account the very small amount of inflammable material used in up-to-date works, the rate ought to submit to a further considerable reduction. Insurance companies would do well to turn their attention more carefully to the question of the wiring of private premises. This association, instead

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of drawing up wiring rules, as was originally proposed, has joined the Institution of Electrical Engineers in this matter, but little has been said as to the method of ascertaining whether attention is paid to the rules in individual instances. When reading a paper before the Bristol Insurance Institute, about six years ago, I advocated the appointment of an inspector, or inspectors, by insurance companies jointly, such inspectors to supervise electrical installation work during progress, the fees being paid by the different companies in proportion to their respective interests in the buildings inspected. Such appears to me to be the most reasonable way of safeguarding at once the consumer and the insurance company. At the present time, the usual practice is for the cheap wiring installer to persuade the consumer that the insulation test taken by the corporation (or supply company) is sufficient guarantee of good work, whereas it affords little or no protection whatever, and is often taken merely to fall in with the Board of Trade regulations, which require the suppliers of electrical energy to be satisfied that there is not excessive leakage on a consumer's premises. The Board of Trade, as you are all aware, has recently introduced a Clauses Bill before Parliament with reference to electric lighting. The avowed object of this Bill is merely to save the frequent reprinting of exactly identical matter by codifying model clauses. There are, however, some alterations from the existing model form. For instance, there is a rearranged clause excluding the month of August from all consideration in the service of notices upon the Postmaster-General, though why Post Office holidays to the extent of one month should be allowed for in an Electric Lighting Bill is not quite clear. On first hearing of the existence of this Clauses Bill a sub-committee was appointed to consider the same and report to a special general meeting of this association if necessary. It was subsequently thought desirable to approach the Board of Trade with a view to certain amendments. Although they have been approached by the town clerk of one of our largest cities, by this association direct, and by a member of Parliament, the Board of Trade decline to receive a deputation or consider any amendment of the Bill, as they consider the slightest alteration would probably lead to its rejection for this session. They have at the same time pointed out that all amendments may be made in each of the special orders as hitherto. The passing of this Bill would make it much more difficult to get any desirable amendments authorised by Parliament, whilst there would be little gained by anyone. It were well, therefore, that the Bill should be thrown out until such time as it can be presented in a complete condition, dealing with all matters requiring reform. In the meantime we should all carefully consider the matter that we may be prepared to deal with the whole question when it comes up again. Partly from lack of time it was in the present instance considered expedient to let the lesser items drop, devoting our energies almost exclusively to the insertion of a stand-by clause.

The question of the period allowed for the repayment of loans is one requiring early attention. There is a great diversity in the practice in different places, and the term authorised varies to an extent which is extraordinary when taken in conjunction with the fact that the loans are for works having a similar character of permanency. For instance, for depreciation and sinking fund Glasgow sets aside at more than 20 times the rate per cent. provided by the Belfast Corporation. The most usual period allowed by the Local Government Board is 25 years, this being a very much shorter period than is usually authorised by other authorities. The average annual amount set aside for electrical works by provincial municipalities being two and a half times greater than that provided by the different metropolitan authorities, it would be well that the Act should define the period over which any loans authorised are to extend, having regard to the permanent nature of the undertaking, and to the arrangement that the value of the works shall be maintained from revenue. In deciding the period of repayment, the Local Government Board take into consideration the life of the particular article in which the capital is to be expended; but this is surely an erroneous principle, as it makes provision for the replacing of worn-out material from further capital, a method which certainly cannot be commended, and is not, I believe, practised. Provided the works are properly maintained, the whole system must have one degree of permanency. There ought, therefore, to be no difficulty in coming to a decision as to the term of years applicable to the repayment of loans for all electricity works used for similar purposes. Whatever term be authorised, the first repayment should not fall due during the first year or two years after the loan is contracted, for it is the evident intention of all parties concerned that the undertakings be self-supporting, and under the present system of making the first half-yearly or annual repayment within a year of the money being raised there must be a call upon the local rate, since the first instalments fall due before any revenue can be earned.

I have one other matter to bring before you, in which I trust you will all take a personal interest. At the suggestion of your past-president (Mr. Wordingham) a benevolent scheme has been prepared. Through the kindness of the Institution of Civil Engineers we have modelled our scheme upon that of the older institution. The fund to be raised is for the assistance of persons who have been members of this association, or of their families. The fact that such a fund is not immediately required to be drawn upon renders this the most appropriate time for its inauguration. While we are young and vigorous we should lend such support as our means will permit to a fund in the interests of those who labour in the same field as ourselves. The particular branch of the profession to which we belong, even at this early stage of its existence, is overcrowded. It is difficult to enter, as, in addition to a scientific education, an apprenticeship to engineering should be served before entering a generating station even in the capacity of a pupil or improver. Not only does this mean the payment of a premium twice during the course of training, but, what is much more serious, the occupation of a considerable number of years, at the end of which the individual is at best only qualified for a position of charge engineer. For this position the salary at first would not exceed £2 a week, perhaps even less, and therefore there are likely to be many in the ranks who cannot make adequate provision for misfortunes which may come to them. Under the scheme at present arranged an annual subscription of 5s. will secure one vote at all meetings. I should much like to be able to announce before the close of our meeting this morning that every member present had undertaken to subscribe at least 5s. annually—which sum, I would point out, is only about 1d. per week. Though the disbursements are limited, the source and amount of subscriptions and donations is in no way controlled.

In conclusion, I beg to express the desire that from our gathering this summer you may all reap instruction, pleasure, and health. There is, I think, no more fitting opportunity than the present for me to mention that the thanks of the association are due not only to those whose hospitality we are accepting, but to others who have extended invitations which we would most gladly have taken advantage of, had time allowed, amongst whom I may mention the Corporations of Cardiff, Exeter, Newport, and Taunton.

Councillor W. C. DIXON, of Bradford, proposed a hearty vote of thanks to Mr. Faraday Proctor for his presidential address, which he characterised as one of the most interesting ever delivered to the association. He was glad to note that out of 83 municipal electricity works no less than 63 were represented on their list of members. Councillor Dixon strongly approved of the suggestion that subways should be constructed under the principal streets, as in this way the constant waste of money over taking up and laying down pavements would be saved. He thought that municipalities generally did not get quite the value for their money that private firms did, but in this respect the municipal electrical undertakings were the exception that proved the rule. The proposition was accepted with acclamation.

The PRESIDENT then called on Councillor George Pearson to read in abstract the following paper:

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Municipal Trading.

BY COUNCILLOR GEORGE PEARSON, CHAIRMAN OF THE ELECTRICAL COMMITTEE OF THE BRISTOL CORPORATION.

The question of municipal trading occupies now, and has for some time past occupied, some considerable share of public attention, but by no means more than the importance of the subject justifies, and in writing upon this subject to-day a writer must be prepared for considerable criticism, both from critics anxious for truth as well as from those who are not. I purpose, therefore, examining carefully the history of the question as evidenced by the reports of the Local Government Board, and giving so far as possible some figures, which I trust may be found fairly reliable. The earlier loans were granted under the Public Health Act, 1848, and £2,956,178. 6s. 8d. was borrowed under this Act up to the year 1858. From the year 1858 to 1870 the Secretary of State sanctioned under the Local Government Act, 1858, loans to the extent of £7,208,507. 1s. 3d., and under the Sewage Utilisation Act, 1867, £154,859, making a total amount of loans to Aug. 19, 1871, of £10,319,544. 7s. 11d. From Aug. 19, 1871, to Dec. 31, 1871, a further sum of £267,562 was advanced, making a total to Dec. 31, 1871, of £10,587,106. 7s. 11d., and as showing the views of the Local Government Board of that date on the amount of the loans I quote the following sentence from their report of the year 1871-72: "The increase in the amount of these loans from £260,905 of 1858, the year in which the Local Government Act was passed, to the £1,212,890 of 1871 is very remarkable." At the present date figures such as these would pass without comment.

COUNCILLOR GEORGE PEARSON, HON. SOLICITOR, MUNICIPAL ELECTRICAL ASSOCIATION.

In the year 1872 the Public Works Loan Commissioners were authorised to lend upon the recommendation of the Local Government Board to urban and rural sanitary authorities, and the rates of interest were fixed for loans of 30 years, £3. 10s. per cent.; for loans of 40 years, £3. 15s. per cent.; for loans of 50 years, £4 per cent. The loans at this date were not tabulated as has since been done, and it is impossible, therefore, without unduly lengthening these remarks, to divide the figures as has been done hereafter as to loans for trading or quasi-trading and loans for the preservation of the public health. In the year 1878-79 the Local Government Board first called attention to the nature of the loans, and pointed out that in the three years ending 1877-78 a sum of £4,943,761 had been paid off the outstanding loans. The increase in borrowing for gas and water undertakings continued through the year 1879-80, and this year is interesting to the association I am now addressing, because it is the first year in which the Local Government Board reports corporations having obtained power to borrow for the manufacture and supply of electric energy. The Corporations obtaining these powers were Leicester, Nottingham, Over Darwen, and Liverpool; the period of repayment fixed was in each case restricted to 10 years.

In the report for the years 1890-91, the Local Government Board for the first time gave the total amount of the outstanding loans of local authorities. The amount up to the year ending March, 1899, was £195,442,397, but no particulars are given of the remunerative and unremunerative debts. The Local Government Board in their report for the year 1892-93 for the first time gave a statement of the loans in the form tabulated below, from which we can ascertain the various purposes for which the loans then outstanding were incurred, to which I have added the corresponding figures from the report of the years 1897-98.

But this return is deficient in one important particular, as it gives no figures showing the annual repayment of principal due for the time being, but I think we may with safety assume such repayment would not be less than 1 per cent. per annum. Averaging the whole of the loans, this would show an annual contribution to the sinking fund of £2,432,000. I regret I have no authoritative figures on this point.

—	Report 1892-93, year ending March, 1891.	Report 1897-98, year ending March, 1896.
Waterworks	£38,325,912	£45,144,657
Harbours, piers, docks, and quays	31,466,462	32,898,399
Highways, street improvements, and turnpike roads	28,275,890	30,277,678
Sewerage and sewage disposal	19,969,077	25,302,900
Schools	18,616,269	24,930,434
Gasworks	14,991,197	17,162,143
Poor-law purposes	7,056,166	8,136,457
Markets	5,380,982	5,808,700
Parks, pleasure grounds, commons, and open spaces	3,992,137	5,238,610
Advance to Manchester Ship Canal Company	—	5,127,980
Public buildings, offices, etc. (not included under other headings)	4,315,707	5,082,029
Artisans' and labourers' dwellings improvements	3,814,035	4,487,573
Lunatic asylums	3,686,662	4,391,072
Bridges and ferries	4,053,596	4,369,106
Land drainage and embankment, river conservancy and sea defences	3,147,417	2,942,772
Cemeteries and burial grounds	2,492,185	2,734,962
Electric lighting and supply	56,942	1,942,773
Tramways	1,317,555	1,604,412
Baths, wash-houses, and open bathing places	950,308	1,568,843
Police stations, gaols, and lock-up houses	1,122,548	1,297,674
Hospitals	669,234	1,285,653
Private improvement works	940,969	1,150,299
Thames Tunnel (Blackwall)	—	1,006,582
Public libraries, museums, and schools of science and art	489,693	805,995
Fire brigades	489,741	737,966
Slaughter-houses	121,631	167,932
Allotments	14,164	57,591
Lighting	46,095	30,778
Cattle Diseases Prevention Act, 1866	76,239	13,544
Small holdings	—	6,421
Other purposes	5,330,545	7,497,927
	£201,215,458	£243,209,862

Let us consider the growth of municipal trading, which will be best seen from the growth of municipal indebtedness, by means of which municipal trading has been rendered financially possible. The loans to municipalities outstanding in the year 1875 amounted to £92,820,100. These outstanding loans had grown in the year 1895 to £235,335,049, an increase of £142,514,949, being an increase at the rate of 153·5 per cent. for the 20 years. This increase of local indebtedness exceeded the decrease of the national indebtedness by £30,568,133. The figures I have read show the extent to which public funds have been used by local authorities in municipal trading. Taking gas, water, dock works as three of the largest classes of municipal trading concerns, we find that the debt existing in the year 1895 (not the sum originally raised, which would, of course, be much larger, the present reduced figures being brought about by the operation of the sinking fund arrangement made in respect to each of these loans), stood at £93,680,425, being about £860,325 more than the total local indebtedness in the year 1875. The foregoing figures show the great growth in municipal trading by showing, in some degree, the growth of municipal capital invested in it during the last 20 years, and those figures do not remain stationary. I see from the report of the Local Government Board for this year that in the year ending March, 1896, the National Debt has sunk to £648,474,143, as against £656,998,941 in the year 1895, a decrease of about £8,000,000 in the year, whilst the local indebtedness has grown to £243,209,862, as against £235,335,049 in the year 1895, being an increase of about the same amount, and the debt in respect of the gas, water, and dock works has grown in the year 1896 by £1,524,774, and stood in the end of that year at £95,205,199, being £2,385,099 more than the entire municipal indebtedness of the year 1875. The electric light figures are very instructive as showing the growth of municipal trading in electric current. Up to the year ending March, 1895, £1,378,818 only had been invested in these undertakings by local authorities, whilst I find in the tables published in *Lightning* that 50 local authorities own their electrical undertakings, and from the figures there given I estimate the capital authorised to be invested up to the year ending March, 1897, at £4,000,000, and think by this time the sum has grown to nearly £5,000,000. At first sight the amount of the local indebtedness may appear large, but an analysis of these figures shows that having regard to the work done this is not the case. A large sum may more appropriately be called commercial investments by municipalities, for we find in March, 1896,

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TABLE A.

Name of undertaking.	Capital. Total capital, inclusive of borrowed capital, provided by corporation.	Capital. Amount of capital borrowed.	Capital. Amount of capital borrowed which has been paid off.	Capital. Balance of capital borrowed which was outstanding at March 31, 1898.	Capital. Amount in sinking fund or loans fund at March 31, 1898, in respect of capital borrowed	Income. Average annual income for the five years ended March 31, 1898, or if the undertaking commenced during that period, from date of commencement.	Income. Average annual working expenses for the period mentioned in previous column.	Income. Average annual net profit for the same period.	Average annual amount paid during the same period in respect of principal and interest on capital borrowed.	Average annual amount set apart for depreciation.
	£	£	£	£	£	£	£	£	£	£
Waterworks	48,434,890	46,546,391	5,140,486	41,570,880	1,332,508	2 644,937	902,612	1,744,361	1,699,322	15,211
Gasworks	20,175,764	19,254,350	3,457,329	15,796,500	1,075,802	4,517.126	3 336,918	1,180,208	772,535	37,333
Tramways	3,213,654	2,689,384	499,377	2,190,007	104,969	435,942	302,670	133 392	90,705	8,488
Electric lighting	3,416,711	3,108 533	108,848	2,990,582	101,642	304,499	168,755	137.320	126,659	3,747
Markets	4,770,301	4,211,695	1,361,518	2,923,191	219,339	454,304	204,826	249,908	155,681	460
Baths, etc.	1,498,079	1,194,407	275,967	914,280	77,453	99,256	119,414	4,871	46,829	2,268
Cemeteries and burial grounds	1,052,873	990,667	390,170	600,497	53,294	69,418	61,808	13,048	37,567	—
Working-class dwellings	718,634	633,475	56,711	576,764	95,067	12 514	3,842	8,672	21,837	—
Piers, quays, etc.	4,797.489	4,676,829	361,522	4,315,307	143,029	324 780	197,495	127,535	175,427	13,660
Miscellaneous	74,200	74,200	68,976	5,224	494	35,610	21,257	14,353	709	—
Total	88,152,595	83,379,931	11,720,904	(a)71,883,232	3,203,597	8,898,376	5,319,597	(b)3,613,668	3,127,271	81,167

(a) The apparent discrepancy in column 5 is due to the fact that sums to the amount of £14,561 are included in column 3, particulars in respect of which required for columns 4 and 5 cannot be given; and sums to the amount of £238,766 are included in column 5, particulars in respect of which required for columns 3 and 4 cannot be given.

(b) The apparent discrepancy in column 9 is due to the inclusion in column 8 of a sum of £34,889, respecting the excess of working expenses over income in certain undertakings.

The provision of waterworks was answerable for a debt of	£45,144,657
Harbours, piers, docks, and quays	32,898,399
Highways, street improvements, and turnpike roads	30,277,678
Gasworks	17,162,143
Markets	5,808,700
Advances to Manchester Ship Canal	5,127,980
Artisans' dwellings	4,487,573
Cemeteries	2,734,962
Electric lighting	1,942,773
Tramways	1,604,412
Showing a total of	£147,189,277

to have been invested in works more or less of a productive character, earning in the majority of cases an income competent to repay the instalments of principal becoming due in addition to the interest payable in respect of the loans. Bristol had on March 25, 1898, an indebtedness of £3,290,521. 18s. 8d. made up of the following amounts:

Urban District Council loans	£780,465	2	7
Borough fund	342,839	7	10
Docks	2,167,217	8	3
Total	£3,290,521	18	8

It would be unfair to assume that this indebtedness represents an unremunerative fund, the interest and sinking fund of which falls on the shoulders of the ratepayers. The large liability in respect of docks is, in a degree, though not entirely, self-supporting, and the debt of about £200,000 incurred for the purpose of the manufacture of electrical energy represents an absolutely remunerative investment of capital, which to-day yields a profit, in addition to paying the interest on the principal borrowed, and also the yearly instalment of principal repaid in respect of this loan.* Some further figures on this subject have recently been issued by the Local Government Board in the shape of a return of the water, gas, tramway, electric lighting, and other reproductive undertakings carried on by municipal boroughs, and I cannot do better than give a copy of the summary note to this return, which I do herewith. (See Table A.)

All friends of municipal trading will thank Sir Henry Fowler for moving for this return, although his motives were not, I think, to prove the case of municipal traders, as is done by it. An average annual profit of £3,613,668 on a capital of £88,152,595 is not a bad return. It is impossible to go into details in a paper such as this, and I would therefore recommend all who disapprove, as well as those who approve, of municipal trading to carefully examine this last return of the Local Government Board and examine the figures of such towns as Manchester, Birmingham, and Leeds. It will doubtless be contended by our opponents that the consumers were charged more by the corporations than they would have been by the companies. This I do not believe. Speaking as a man of a fair experience in public work, I say I have never found the average ratepayer backward in complaining; if he has a fault it is on the other side, and it does not appear from this report that there has been any unreasonable desire on the part of municipalities to sacrifice the rich to the demands of the working classes. The most profitable undertakings are undoubtedly gasworks. I am pleased to see the profits on the waterworks are not so large, because there can be no doubt that the blessings of a good, plentiful, and cheap water supply far outweigh the advantages of a large money profit to the ratepayers, and I am pleased that those responsible for the municipal management of these undertakings have not been slow to recognise this fact. I give these figures for the purpose of showing the misleading nature of the remarks of writers who, taking the gross figures of the local indebtedness, point to it as an evidence of national decadence rather than of municipal enterprise. The figures really represent, on the one hand, the evidence of a growing municipal trading enterprise, and, on the other, the growth of the municipal determination that the health of the people shall be better preserved, that the lives of the poor shall be rendered brighter, the education of the young shall better fit them for the battle of life, and that the paths of the "failures" in life's struggles shall be made less rugged than they have hitherto been.

That Parliament reflects the growth of public opinion will, I think, be seen from the powers from time to time conferred upon municipalities both for trading and also for joint action in the provision of common requirements, and these latter powers are fully set out in the Public Health Act, 1875. By Section 26 of that Act it is enacted as follows: "Any local authority for the time being supplying water within their own district may, with the sanction of the Local Government Board, supply water to the local authority of any adjoining district on such terms as may be agreed on between such authorities, or in case of dispute may be settled by arbitration in manner provided by this Act."

By the same Act it is provided in Section 28 that: "The local authority of any district may by agreement with the local authority of any adjoining district, and with the sanction of the Local Government Board, cause their sewers to communicate with the sewers of such last-mentioned authority in such manner and on such terms and subject to such conditions as may be agreed on between the local authorities, or in case of dispute may be settled by the Local Government Board."

By Section 279 of the same Act it is provided, "Where on the application of the local authorities of any urban or rural districts, or of any of such authorities, it appears to the Local Government Board that it would be for the advantage of such districts, or any of them, or any parts thereof, or of any contributory places in any rural district or districts, to be formed into a united district for all or any of the purposes following—that is to say, (1) the procuring a common supply of water; or

* Bristol is to-day repaying the principal of its loans at the rate of about £60,000 per year, and this sum represents a rate of about 11d. in the pound on the ratable value of the city.

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(2) the making a main sewer, or carrying into effect a system of sewerage for the use of all such districts or contributory places; or (3) for any other purposes of this Act the Local Government Board may, by provisional order, form such districts or contributory places into a united district, all costs and charges of and incidental to the formation of a united district shall, in the event of a united district being formed, be a first charge on the rates leviable in the united district in pursuance to this Act."

By Section 285 there is a general sweeping clause as follows: "Any local authority may, with the consent of the local authority of any adjoining district, execute and do in such adjoining district all or any of such works and things as they may execute and do within their own district, and on such terms as to payment or otherwise as may be agreed on between them and the local authority of the adjoining district; moreover, two or more local authorities may combine together for the purpose of executing and maintaining any works that may be for the benefit of their respective districts, or any part thereof. All moneys which any local authority may agree to contribute for defraying expenses incurred under this section shall be deemed to be expenses incurred by them in the execution of works within their district."

From these clauses it will be seen that municipalities have little to fear in their attempts at joint action from the trammels of Parliament or of the Local Government Board, and that the course of their trading and also of their joint action in the provision of their common requirements is fairly clear.

Having shown to some extent the amount of municipal trading now being carried on, as evidenced by the amount of capital invested in it, I will now consider the limits within which (for the present) municipal trading should, I think, be confined, but before doing so I must say that I purposely avoid any remarks in support of the right of municipalities to trade, although that point has been recently questioned, because I consider that when £150,000,000 of municipal funds have been invested in municipal trading enterprises, it appears to me rather late in the day to discuss the propriety of investing money in such undertakings at all. I think municipal trading should be confined to the provision of those necessities of civilisation which are so large as to be beyond the power of individual effort to supply, and which do not form part of any Government department. The effort of the individual will generally produce more economically than either a company or a local authority; but as between a company and a local authority there is, economically speaking, very little to choose, and corporations can claim to be free from the misappropriation of capital, which appears to be incidental to the formation of so many of the companies which from time to time come under our notice, and therefore the cheapness of the price of money when raised on the credit of a local authority as against the dearness of money when raised by a company, must always enable a local authority to trade on a smaller gross profit than a company, and therefore requires less to be abstracted from the pockets of the consumers to secure success to the undertaking, whatever it may be. I am, therefore, of opinion that the supply of water, gas, electrical energy, and trams should be in the hands of the local authority. Cleansing, ashing, and watering should also be done without the aid of a contractor; but I would not suggest, except under exceptional circumstances, that all municipal works—such as erection of buildings and other matters of that kind—should be undertaken by the municipality; but when, for any reason whatever—and there are many reasons I know—there is a lack of outside competition, then these works can be done generally more economically and always better by a municipality than by a contractor; but here I must protest against the efforts now being made by the directors, managers, and others connected with some of the largest public companies to masquerade under the guise of the "private individual," and to claim his attributes. No one more appreciates what England owes to the energy, the enterprise, and the skill of her sons than myself; but England owes much less to her companies. It is impossible to conceive anything more crushing on the energies of the individual than the existence of huge companies with large capital at their command, whose very existence too often depends on the crushing out of existence of the small individual manufacturer and the securing to themselves monopolies in their own branch of trade. If we require evidence of this we have only to consider the recent growth of "unions" and "syndicates," formed for the purpose of securing monopolies in particular trades, and I am not aware that the promoters of these "unions" and "syndicates" ever dealt too tenderly with the energetic private individual, or, indeed, dealt with him at all, except to secure that he was crushed out of existence. All that municipal traders ask is a fair field and no favour. Let us have no artificial supports to municipal trading; indeed, let us have no supports which are not given to companies under similar circumstances, and we ask in return that companies shall be placed in the same position, and not be permitted whilst preserving their own monopolies to exclaim against and attack the monopolies of corporations.

Having said this much on the general question, let us examine some of the many reasons given for and against municipal trading, and in doing so I cannot do better than call attention to the admirable summary of the advantages and disadvantages of municipal trading given by the editor of *Lightning*, in his issue of Dec. 22, 1898:

Advantages in Favour of Companies.

"1. The gentlemen who manage a company are chosen for their knowledge of the business, and also because they may have considerable stake in the company."—I do not agree with this, and I have no hesitation in saying that directors are very seldom chosen on account of their knowledge of the business, and in this view I am supported by the view of Mr. C. J. Stewart, late senior official receiver under the Companies' Acts, who, addressing the London Chamber of Commerce on Feb. 22 last, said: "There are three causes of company failure—excessive capitalisation, proceeding to allotment on insufficient capital, and the incompetency of directors. One of the worst evils of the present mode of forming companies is the nomination of the directors by the promoters. The path of puppet directors is made easy to them, and a company consequently often starts with a directorate unskilled in business and bound hand and foot to the promoter." I will not add anything to that severe comment on this point.

"2. The *personnel* of the directors is not likely to be changed."—To an extent this is correct, but by no means to the extent suggested.

"3. The chairman will remain the same."—I do not think there is any more chance of a chairman of a committee of a council being changed than a chairman of a board of directors.

"4. The number of directors will be few compared with the number of the committee of a corporation."—This is correct, but the error is corrected by the appointment of sub-committees on the various branches of the work.

"5. Directors are paid for their services, and therefore they are more likely to attend to their work than the members of a corporation who give their services gratuitously."—This I do not agree with. My experience tells me that councillors give even a more unremitting attention to the business of their committee than the average director gives to the work of his Board.

"6. It is no uncommon thing to find that the policy of corporations is reversed from one meeting to another, as a different set of members may happen to be present; in fact, I have known of the policy being reversed at the same meeting because some members have left and others come in."—Speaking from an experience of many years of public work, this is not so. Details of management may be varied, but policies are not changed without careful debate; indeed, discussion errs on the side of excess, if it errs at all.

"7. The members of a corporation committee are liable to be influenced by the fact that they have to curry favour with their constituents, and it is noticeable what a different view the same man may take just after November 1 and just before December 1." This may be true of a few, but the general body have no such fears.

"8. It is no uncommon thing to find in a corporation that men bear spite against some other member of the corporation, and will advocate a policy directly against that of their opponent, not because they think their opponent's policy wrong, but simply because it is his policy. It requires no stretch of imagination to see that these things do not conduce to the well-being of a commercial undertaking."—I have known this done once, but then only by a few, the general body of a council are no more likely to be influenced by mean and contemptible motives such as these than a body of directors.

"9. Companies are credited with paying their officials more than corporations, and in giving them inducements to make the concern a commercial success. The mere fact that a manager has a few shares in a company is a considerable inducement for him to look after the commercial side of the question. I am aware of no corporation which pays its manager by results. Length of service is the greatest inducement for advancement in pay with corporations."—I know from experience that as a rule there are few company engineers who would not willingly join the service of a corporation, and I believe that the possession of a few shares in a company would not make the difference between an engineer doing his best in the interest of the undertaking with which he is associated, or omitting such duty. I have a higher opinion of our electrical staff than to believe anything of the kind.

"10. There is every tendency in a corporation undertaking, as in a Government undertaking, to make the heads of the departments machines. Of course, it may be urged against this that the results do not prove it, but at present there are young men in charge of these undertakings who are keen, possibly too keen; and this influence has not yet been felt, but it will be felt there is no doubt."—No reply is required to this, because it is admitted that the result does not prove the statement—this being so, why make the allegation?

"11. Again, the members of a corporation cannot deal with

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the employment of labour on such advantageous lines as a company. There is certain to be tremendous pressure put upon them by trade unions, and one or two cases have come under my notice which would have been fatal to the management of the works had the engineer been a less strong man than he was."—Companies and corporations are to a great extent in the same boat in this respect, and I shall wait until my experience teaches me the truth of the statement in respect of which I have very great doubts.

Disadvantages of Companies.

"1. Companies undoubtedly cannot borrow money at so low a rate as corporations."—Of this there can be no doubt.

"2. Companies have not the fixity of tenure corporations have."—The same remark applies to this.

"3. Companies rarely have any street-lighting. This is a disadvantage in two ways: first, because a good street-lighting load is an admirable adjunct and a most paying addition to a station; and secondly, because a good street-lighting system is a grand advertisement for the light. Local authorities will never pay a company as much for street-lighting as they will pay themselves. Fancy a local authority paying a company £40 per annum each for 200 arc lamps; and yet this is done. No wonder under these conditions the station pays—it would be difficult to prevent it doing so; but it is a little hard to see where the ratepayers benefit. The above is by no means an isolated case."—If companies have no street-lighting, it is, as a rule, their own fault. I have known a company stifle the demand for street-lighting, because they have a good demand for private lighting at a high price, and therefore did not care for street-lighting at a low price. I have never known £40 per lamp paid for lighting. Bristol charged a high price, as events proved, and we altered it and now charge £23 per lamp, which I hope, at no distant date, to see very materially reduced.

"4. A local authority, as soon as a company starts work, seems to imagine that their interests are not one, but are antagonistic. Local authorities have thrown enormous difficulties in the way of companies supplying light, and have hence increased the capital cost of the undertakings. The restrictions put upon such work by corporations are enormous, and frequently it is no uncommon thing to find a local authority insisting on reinstating the roads themselves after a company's work is done, and charging twice as much per yard as they ever intend to spend. Can 'Lamplighter' point out a single instance where a local authority has given the same facilities to a company for doing the work, and the same assistance in carrying it out, as they would have given had their own officials undertaken the work?"—The experience of the writer must have been unfortunate indeed. I do not believe any corporation committee would be so dishonest as to charge "twice as much per yard as they ever intend to spend," having regard to the fact that they have no possible pecuniary inducement to commit such a crime.

In addition to these reasons the costs of the promotion of companies, the speculations in lighting orders, as evidenced in the recent case of the City of London Electric Lighting Company, Limited, and the watering of capital, all lead to the increase of the costs of a station in the hands of a company, and therefore increase the demands on the consumer to provide a dividend, and the two evils combining—viz., the increase of the capital, and the heavier interest payable in respect of it—must always enable a corporation to trade with success on a less profit than any company can hope to do.

There is another risk which the opponents of a municipal trading ignore. It is the attempt to fetter the action of a self-governing community. We are all proud of our local self-government, and I form one of the large majority of my fellow-countrymen who are prepared to see (although I know there is no risk of seeing) a great deal of local mis-government rather than give up one atom of the rights we possess to govern ourselves, in local affairs, in our own way, so long as we respect the decision of Parliament in Imperial affairs. This is, in my opinion, a very strong reason why we should in questions of trading be left to exercise our own discretion as to the degree, whether great or small, in which we may think fit to indulge in it, and, further, there is the risk that what may be fixed as the maximum allowed may really become the minimum carried on, and by saying to a municipality this is the point beyond which you shall not go, you instil into the minds of all municipalities that to that point all ought to go.

It is to be regretted that in discussing this question the opponents of municipal trading have been somewhat unmindful of the facts that members of the various municipal councils throughout the country have nothing to learn from the average company promoter or director, either in honesty or intelligence, and yet we have had to read remarks such as I have given below made as to our intelligence, our honesty, our motives, and our acts: "Opportunities which are opened for indirect jobbery are so great that it is impossible that they should be resisted." "No company officials would dare such jobs as have been perpetrated by corporations and officials." "Many when once in office are willing to do almost anything to retain their position and check their dealings, which in many instances form part of electioneering tactics." "A lot of little men are elected councillors because they can spout or shout party cries and become party tools." "In companies there is not the same tendency to corruption and officialism as in municipal-managed concerns." "Men who are competent to manage such undertakings are not found on municipal bodies (objects of men), either public notoriety or the exercise of great patronage tending towards private gain." "The vicious principle of municipal trading." "Councils adopt the dog-in-the-manger policy, holding orders and not using them." "Municipalities divided into two classes—rooks and pigeons. Pigeons unable to learn by experience, rooks desire to set up Tammany halls in the large English towns, and become 'bosses' in the Yankee sense of the term." "Begins in Tooley-steet and ends in Tammany."

These are some of the flowers of rhetoric with which this discussion has been adorned, and by whom, may I ask? Generally by representatives of companies, gentlemen in the pay of companies who seek by these remarks to create a prejudice against members of municipal councils, forgetful of the history of the company promotion of this country, to say nothing of company management. Turn to the papers of the day and read our law reports—are they filled with reports of municipal maladministration, either by officials or councillors? We all know they are not; every reader knows they are filled with one long list of company actions of one kind or another, exposing every kind of public folly and company dishonesty, either in their inception or management. I would appeal to those who speak on behalf of companies not to forget these facts, and they will, I think, then give municipal councillors credit for the general moral cleanliness and freedom from dishonesty which is the admitted characteristic of our English public life. I will not further follow our critics in this direction; if I were inclined to do so, it would not be difficult to retort with equal vigour and greater truth.

When I first turned my attention to this subject I was told that our action must end in a loss, and that we could never make a profit. Now the tune is changed, and I am now told that it is wrong for a municipality to trade at a profit. I never believed the first statement, and I do not believe the second, to say nothing of the fact that the question has been long since settled by the Legislature. Nothing but the hope of success would induce me to trade at all, and I know no means so certain to kill municipal trading as to prohibit municipalities trading at a profit; and in my opinion that fact is at the root of the suggestion which is made by the opponents of municipal trading.

I think municipalities should trade on level terms with companies; they should have the same rights and the same liabilities as companies, and no town should be placed in a worse position, economically speaking, because its council thinks fit to carry on a business than it would if the same business were carried on by a company. Personally, I have no fear of the result of the most exhaustive examination of the accounts of corporations and companies so far as their electric undertakings are concerned, and nothing but the desire to avoid anything that may savour of a personal criticism prevents me taking advantage of this occasion to make some comparisons. All I ask when this is done by any of my critics is that one class of comparison shall be avoided: do not speak of the profits of companies before the payment of debenture interest, dividends on shares, and the creation of the necessary reserves; and of the profits of municipalities after, as I recently saw done when it was seriously stated that sinking funds, payments of interest on loans, and moneys applied in the creation of a reserve fund paid out of earnings, were not profits, but that you could only speak of profits of a municipal undertaking after these payments had been deducted. Folly in criticism cannot surpass this last effort of a gas-subsidised critic.

There is another class of critics of whose sincerity I have the greatest doubts. They usually take the line that the risks of trade ought not to be taken by municipalities on account of the risk of loss, and ask that these risks should be laid on the shoulders of the private speculator, and ask us to believe that this suggestion is made in the interests of municipalities and not of themselves. In the course of a moderately long experience I have never met any man anxious to take a thorn out of my side and put it in his own, and when I hear these suggestions made I am inclined in the first instance to doubt the sanity of the person making them, and after satisfying myself on that point I never entertain any doubt on the subject of his honesty. Those who make this suggestion do so because they know that any risks they take will be more than covered by their precautions, the costs of which will come out of the pockets of the consumer.

In conclusion, I may ask, who are the men who are leading this attack on municipal trading; and next, what is their object? The gentlemen whose names are to be found amongst the leaders of the attack are generally to be found acting as directors of or engineers or solicitors to the large electric companies, whose interests are considered to be more immediately

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attacked, and I think their object is not so much the public good as their own private gain. It is not to benefit the public, but place them at the mercy of any great trading monopoly which may succeed in establishing itself in their midst. I am inclined to think those who attack municipal trading do so, not with the object of "preventing the risking of ratepayers' money," or "the injury to traders," or even the "checking of private enterprise," or even of "preventing the arrest of the national progress," as the petition of the Liberty and Property Defence League would lead you to believe. I am inclined to think you must look further for their true object, and I think you will find in the letter of the Earl of Wemyss, written to the *Times* on Jan. 24 last, when an angry nobleman, in a moment of inadvertent candour, said: "Let us then hope that we may see this joint committee of the two Houses of Parliament appointed, and that it will put a stopper on municipal ambition and the speculating of municipal authorities with the ratepayers' money." This is the real object, to put a stopper on municipal trading, and the public will then be at the mercy of any company getting command of their municipal area. The only way of meeting these vast commercial corporations is trading by municipal corporations, and I cannot do better than close my remarks by quoting the words of the Right Hon. Sir Edward Fry, when speaking on the subject of "secret rings" and "corners," when he said, "that they remembered the times when there were three crimes recognised by law—namely, 'forestalling,' 'regrating,' and 'engrossing.' These crimes had relation to the creation of certain monopolies. They had now been swept away, and competition was allowed to an almost unlimited range. The introduction of joint-stock companies had brought great masses of men and great masses of capital together. Formerly it was man against man; now it was companies against companies. These great combinations often presented features which scarcely commended themselves to the most cultivated conscience. At what point these combinations were to stop must be for every man to decide for himself, but there was a limit short of the limit which the law allowed—a limit of conscience. There was growing up against these bodies of combined men another idea, the idea that we must have trading by municipal bodies. The communistic idea—the social idea—was coming into conflict with the idea of the absolute right to combine for the purpose of self-gain. To what extent municipal or socialistic trading would go on was a question of great difficulty. He only indicated his own opinion that if competition were pressed to an extreme by these vast combinations, it must naturally expect to be met by another closs of institution."

These moderate and thoughtful words may well form the subject of the careful consideration of all those who are inclined too readily to condemn trading by municipalities and induce them to consider whether the best—indeed, the only way of fighting—these great combinations of producers is not by forming (by the aid of their municipal councils) great combinations of consumers.

The PRESIDENT then invited both members and visitors to discuss Mr. Pearson's excellent paper, and called on Mr. S. Z. de Ferranti to open the discussion.

Mr. S. Z. DE FERRANTI said that he was not a municipal trader, and yet his very existence depended on the municipal undertakings represented at the convention. He had read Councillor Pearson's paper very carefully, and found his arguments very powerful ones. It made him almost regret that such an eloquent pleader should hold ideas with which in certain respects he could not agree. Municipalisation carried to excess was nothing but rank socialism, and tended to restrict individual effort. He, personally, did not think that commercially there was much to choose between public companies and municipalities as managers of undertakings, but did think that it would be well to confine municipal action to essential non-profit-earning works. Such an undertaking as the water supply could well be left in the hands of corporations, and the success of electric lighting had also been a great aid towards municipalisation. He thought that wherever large capital was required municipal trading might be a good thing, but that where a great amount of labour had to be employed it was better to have private enterprise. In fact, he should draw the line at such works as necessitated the employment of much labour.

The MAYOR OF HALIFAX did not agree with Mr. Ferranti on the labour question. In Halifax, when a tramway company wished to obtain powers to construct trams, it was a mass meeting of workers which had insisted on the Corporation taking up the matter. No doubt they acted in their own interest, but in this case the result had proved to be most beneficial, as the tramways showed a good profit the first year. The success of the tramway venture was largely due to the work of their late electrical engineer, Mr. T. P. Wilmshurst, and he trusted that that gentleman would be able to render equally good service to the town of Derby.

Councillor W. A. TODD, of Bristol, said he had general objections to municipalisation, but not when it was connected with the supply of water, gas, and electricity. It was as employers that corporations were defective, as the policy was apt to change with the results of the November elections. New men brought arbitrary change of policy, which was very bad for an undertaking. As regarded the employés, they were apt to get too powerful for the same reason, as the committees changed, and hence it was not easy to keep a good and effective control of the staff. In this way an inefficient man who did his work to the best of his capabilities, was apt to continue to hold a position for which he was unfitted. As regarded the last speaker's remarks about mass meetings he strongly deprecated the idea that a policy determined by mass meeting would be generally right. In the case of the Halifax tramways the result might have been good, but in the majority of cases it would be the reverse. He would put a limitation on municipalisation by leaving out all works of supply that an individual could conduct.

Bailie MACLAY, of Glasgow, expressed his sympathy with Councillor Pearson's view. He thought that every monopoly in a town should be owned by the municipality, so that the profit, if any, should go to the community as a whole. He was pleased to hear Mr. Ferranti admit that companies and corporations were equal as regards mismanagement.

Councillor S. LLOYD, of Bristol, agreed with the last speaker that monopolies should be worked for the benefit of the people, and thought this was best secured by their being in municipal hands. He regretted that Bristol did not own its water and gas supplies or its trams, and that in consequence the streets were broken up and disfigured without any due control from the Corporation.

Alderman CALVERT, of Huddersfield, said he should answer the question as to what undertakings should be municipalised by saying that whatever works necessitated the breaking up of the streets should be owned by the municipalities. He agreed, however, that the officials of companies were, as a rule, under better control than municipal officials, and that changes of policy were also less likely to occur with companies. He then referred to the price paid by the Sheffield Corporation for the electric light undertaking as an instance of the results of deferring the acquisition of such works.

Alderman RICHARDS, of Bedford, gave details of the history of the electric lighting undertaking at Bedford, at which town a company tried to get powers. He argued that while the works did not at present pay the sinking fund account, they should not be considered a burden, as at the end of the period the town would own an efficient undertaking without a capital account. The whole of the street work should in his opinion be done by the local authorities.

Mr. W. A. CHAMEN, of Glasgow, explained that he had had experience on both sides, and preferred working for a municipality. It was said that he had now 78 masters, but they were never all of one mind. He thought the question should be raised as to how far a municipality was justified in hiring out motors and plant, as was being done at Bradford. He would also ask Mr. Ferranti if he would not state clearly what he did think on the general subject?

Alderman GRIME, of Blackpool, expressed his opinion that local authorities should own and control all undertakings dealing with the necessities of life.

Mr. JENKINSON, of the National Free Wiring Company, believed in the municipalisation of gas and water supplies, electric light undertakings, and the tramways, but had serious doubts as to the temperature of the future abode of the municipalities which took to selling electric light fittings and to wiring consumers' premises.

Mr. S. Z. DE FERRANTI, in answer to Mr. Chamen, said that he came to the meeting to be instructed rather than to express his private views. Personally, he thought that it would be very unwise for a municipality to take up the manufacture of dynamos. The general principle of the

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municipalisation of the supply of necessities of life did not hold, and as an example he quoted the supply of bread. He thought it must be left to the common sense of the nation to decide how far municipal action should go.

Mr. J. J. STEINITZ, of West Ham, held that municipal authorities should not trade for profit, but that they should supply at cost price. One great difficulty in municipalisation was that of joint action. As an instance of this, West Ham had been trying for 25 years to get permission to use the London main sewer for their sewage disposal without success. If two companies had been concerned, they would have agreed long ago. He did not agree with Councillor Pearson that better work was done by corporations than by companies. With municipalities a large amount of time was taken by contention, which was avoidable with a company. He thought that the reason for the little street-lighting done by companies in London was that local authorities did not mind charging themselves for extra light when this was supplied from their own works, but that that would not sanction the increased expenditure if the money had to be paid to a company.

Councillor W. C. DIXON, of Bradford, pointed out that municipal authorities always waited till an industry had been found to pay, and that they did not undertake pioneering work. The labour question was one on which municipalities would do well to unite. At Bradford they had no trouble with their own employés, but it was raised by outside agitation from other towns who wished to dictate how the work was to be done.

Mr. A. H. GIBBINGS, of Bradford, considered the question of the hiring out of electric motors to be quite a side issue when once municipal action had been decided on.

Councillor BUTTERWORTH, of Derby, saw no reason why corporations, which had already supplied lamps in many cases, should not undertake to equip houses and to sell fittings if the same was not done economically by private enterprise.

Councillor GEORGE PEARSON, in reply, said that Mr. Ferranti had used the word "socialism." Personally, he never gibbed at words, and did not mind municipal trading being called socialism so long as the follies of extreme socialism were avoided. He would limit municipal action to those necessities of life which could not be supplied by the individual. When he found two men always competing for a municipal contract, always tendering near each other, and perhaps sharing the contract afterwards, he thought it time for the corporation to undertake the work itself. He quite admitted the labour trouble, but had found that the commonsense of the working class tended to prevent undue influence being exerted by outsiders if the men were properly consulted. They, of course, had to fear ultimately the very large combinations of labour, but thought that municipalities would be able to deal equally well with these as companies were. He considered that the proceedings of Parliament this session had tended towards the enforcement of united action on local authorities, and that in future fights such as had occurred over water-supply areas would be stopped by enforcing the various authorities to pool their interests and work together.

Bailie MACLAY, the convener of the Electricity Committee of Glasgow, then read the following paper:

Appropriation of Profits and Repayment of Loans.

BY BAILIE MACLAY, CONVENER OF THE ELECTRICITY COMMITTEE OF THE GLASGOW CORPORATION.

My last paper on the "Appropriation of Profits and Repayment of Loans" created an amount of interest for which I was unprepared, and it was subjected to pretty severe criticism by those who advocate the application of the profits of municipally-managed gas and electricity undertakings in reduction of rates and taxes. Careful reconsideration of the subject, giving all due weight to the opinions of the speakers who followed me and of the public Press, does not at this day materially alter my conclusions as then expressed, and though I am prepared to admit that it would be sound policy for the Corporation of Glasgow to vote on a special occasion, say, a sum of £5,000 or £10,000 out of the gas or electricity profits to be applied to effect some local public improvement for the benefit of the general body of ratepayers, I contend that it is neither good nor sound finance systematically to keep up the price of gas or electricity in order to transfer annually large sums in relief of rates. It is well known that some corporations have for many years taken large sums out of gas profits. The mere fact that in the electric lighting provisional orders the power to do this is restricted to a profit of 5 per cent. shows that the Legislature had become aware that an excessive amount had been taken out of gas consumers, which called for safeguards in the case of the more brilliant illuminant. Much was made of the fact that it is the ratepayers who are responsible for the debts of gas and electricity undertakings, but it is forgotten that these undertakings, when efficiently managed, are so eminently profitable that the risk of any recourse to the rates is infinitesimal. Further, the consumers pay for reserve and sinking funds, which will in the course of time leave the ratepayers in possession of remunerative undertakings absolutely free of debt—going businesses—in a word, excellent assets. Is not this giving the ratepayers generally an interest, and a good interest in the profits of a department, in return for their pledged credit in borrowing transactions?

The most serious charge made by my critics was that the Corporation of Glasgow had in some way evaded Board of Trade regulations, and had created a number of small reserve funds that they were not entitled to have. I was at a loss at first to know what funds were aimed at, but I suppose my critics were striking at the depreciation written off the lands, buildings, machinery, and plant items in the capital account.

BAILIE MACLAY, CONVENER, GLASGOW ELECTRICITY COMMITTEE.

In reply, I have simply to say that the members of the Corporation of Glasgow would be sadly wanting in ordinary business capacity if they allowed either their gas or electricity accounts to be stated without an adequate amount for depreciation and renewal of all wasting or wasted assets being debited against revenue. I think the charge of evading Board of Trade regulations is absurd, and in this connection I have simply to say that the Glasgow Corporation electricity departmental books and accounts are audited and approved by one of the most eminent firms of chartered accountants in Scotland. A full abstract of these accounts stated on Board of Trade lines, and setting forth all depreciation and sinking and reserve funds, is sent to the Board of Trade annually. The Board of Trade have not offered any observations on the accounts, and I feel justified in saying emphatically that certain of my critics gave utterance to an unfounded charge which closer examination of the facts before speaking would have dissipated. I believe that there is a growing feeling in English municipalities in the direction of letting "every herring hang by its own tail," and probably Glasgow's example will be followed more and more every year. Undoubtedly the transfer of large sums from remunerative undertakings tends to hide from the ordinary ratepayer any extravagance or failure to economise in purely spending departments. Many councillors would resort to any shift rather than incur the odium of raising a rate. The departmental system of management under the Corporation of Glasgow prevents a "hotch-potch" being made of rates and revenue, and a healthy rivalry grows up between departmental committees, which in the end tends to make rates, taxes, and charges correspond somewhat with the "value received" by ratepayers and consumers.

Councillor PEARSON, in opening the discussion, said that he agreed with Bailie Maclay as to the advisability of the financial arrangements at Glasgow; he only doubted whether they had the power to do what they had done. All corporations would be only too glad to have a 1 per cent. redemption fund if allowed. They at Bristol had tried to follow on the lines of Glasgow as regarded depreciation, and had this year put down £2,000 for depreciation in the hope that the Government inspectors would pass it. The statutory 10 per cent. reserve was not enough, and, if allowed, they should continue the provision of a depreciation fund.

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Dr. PANTON, of Bolton, advocated a more uniform period being established for the repayment of electric lighting loans. He thought that ratepayers should share the profits only so far as they had been called on to make up deficits in the early years of the undertaking. After that prices should be reduced, and the profits kept small in that way.

Mr. A. B. MOUNTAIN, of Huddersfield, said that personally he had found more trouble arise from the allocation of profits than over the meeting of deficits. Twenty-five years was much too short a time for the repayment of loans, and he thought that a uniform period should be arrived at.

Mr. H. L. P. BOOT, of Tunbridge Wells, complained of the different practice in various towns as to establishment charges. Thus 36 towns paid nothing in this respect, while others paid varying sums. His undertaking was charged heavily, and got practically nothing for it. He thought some fair way of proportioning the charges on the different corporation departments should be arrived at. He proposed to bring the matter up at the members' meeting on Saturday.

Alderman BRAY, of Plymouth, agreed with the last speaker. The electric department at Plymouth were charged £500 on account of the general establishment expenses of the Corporation, which in the present stage was a heavy tax on them. He found that it was levied on the receipts of the tramways as compared to the receipts of other departments.

Alderman POTTER, of Taunton, strongly advocated the formation of a depreciation account. They had found such an account of great service when they had to change their arc-lighting plant. He held that the consumers who had paid high prices for electricity in the early days of an undertaking had a right to the profits afterwards being used to reduce prices, and that these profits should not go to the ratepayers.

Bailie MACLAY, in reply, said that the ratepayers in Glasgow had not taken any risk as they had not paid deficits. The Gas Committee had done this, and had been repaid afterwards when the electricity works had earned a profit. Even now the electric consumers were a very small proportion of the whole ratepayers, and it was not right that the profit derived from the few should go to the general rates.

This closed the morning meeting, after which the members adjourned to the Royal Hotel, College Green, and partook of a well-served lunch as guests of Councillor George Pearson. There was no speechmaking afterwards, except the usual loyal toasts. A vote of thanks was, however, passed to Councillor Pearson for his hospitality.

The members then proceeded to Cheltenham.

Starting from Bristol about three o'clock in three special private saloon carriages, the members reached Cheltenham about half-past four, and were met on the platform of the station by Mr. Alderman Norman (the mayor), and the party proceeded in brakes to the electric light station, where they were met by the engineer (Mr. Hamilton Kilgour) and his assistants. In this issue we shall but briefly refer to the visit. Considerable additions have been made to the station, and considerable alterations are in progress, and these, when completed, will make it perhaps one of the most interesting stations in the kingdom. As is well known to our readers, there is much originality in Mr. Kilgour's methods, and fortunately he has one of the finest positions in the kingdom for the display of arc lighting. The roads leading into the town, and, in fact, those situated in what may be called the principal streets of the town, except one or two of the streets in the older quarters, lend themselves admirably to arc lighting, and every advantage has been taken of this natural assistance. Most of these streets are lighted from the centre, and when the lamps are alight at night no prettier site can be presented to the view, the long and almost straight vistas of roads being lined on every side by trees in full spring foliage. One feature with regard to the street-lighting is that the lighting is effected by means of alternate-current arcs, a system which is not generally adopted, but which in the hands of Mr. Kilgour has been eminently successful. The sub-stations are well arranged, and altogether the details are such as would bear the strictest examination. The old testing-room has been found to be too small, and at the present time a new testing-room is being fitted up where all the apparatus used undergoes a preliminary test. Just one remark may be made here with regard to the transformers. Up to a certain time these gave some trouble, but being run for a considerable period, and at the end of that time being carefully sealed so that when placed in working position they would be air-tight, the troubles which up to that period had been given by the transformers ceased. The members visited as much as was possible of all that concerned the electric light organisation at Cheltenham during the time at command, and were invited to partake of substantial creature comforts by the Mayor and Mr. Kilgour. Needless to say, the visit was highly satisfactory, both from an intellectual point of view and also from a social point, and we have no doubt that a good many of the questions mentioned in the presidential address were discussed by the various groups, and that some united action upon some of them will be taken. The best thanks of the members were given to the Mayor and Mr. Kilgour and others for the successful visit and the hospitality enjoyed.

LEGAL INTELLIGENCE.

LEEDS ELECTRIC TROLLEYS.

The case of Blackwell *v.* Greenwood and Batley, Limited, came before Mr. Justice Bruce, sitting in the Queen Bench Division, this week, without a jury. It was an action brought by the plaintiff to recover from the defendants, of Albion Works, Leeds, £608, balance of account for the price of goods sold and delivered. Mr. Cohen, Q.C., and Mr. Manisty were counsel for the plaintiff; Mr. Cripps, Q.C., and Mr. Muir Mackensie represented the defendants.

It appeared that the defendants admitted the plaintiff's claim, but alleged that they were entitled, by way of a set-off, to deduct £525, and brought into court the sum of £82 as being sufficient to meet the plaintiff's claim. The counter-claim set out that in June, 1896, the Corporation of Leeds invited tenders for the supply of 25 electrical motorcars to be used in a system of electrical overhead haulage, to be constructed in accordance with the terms of a specification and general conditions of contract which had been prepared on behalf of the Corporation. Part of the system included the supply for each motorcar of a trolley, which was to be of the swivelling-arm type of the latest design, as manufactured for the Bristol Tramways Company. Each trolley standard was to have a base fixed to the roof of the motor-car, and the conditions presented by the Corporation required that there should be a suitable arrangement on the roof of each car of adequate strength for attachment to the trolley base. On June 6, 1896, the defendants informed the plaintiff, who supplied trolleys to the Bristol Tramway Company, that they (defendants) were tendering for the supply of the motorcars, including the trolleys to be attached thereto. Between that date and June 21, 1896, plaintiff went through the specification and general conditions of contract, and became fully acquainted with the nature and design of the trolley which was required, and the conditions subject to which it was to be supplied. Plaintiff was then requested by defendants to send them quotations of the prices at which he could supply and fix the trolleys, and to supply particulars and plans of the trolley which was to be made. This the plaintiff did, and on June 22 the defendants sent in to the Corporation a tender undertaking to build and supply 25 motorcars complete, in accordance with the specification and conditions, and guaranteed to uphold the same in perfect order and condition for a period of 12 months for the sum of £14,000. The defendants' tender was accompanied by the plaintiff's plan, which he had made. The tender was accepted, and on July 27 a formal contract was signed by the defendants. On Nov. 17 an order for the complete trolleys to be supplied for the motorcars, as quoted by the plaintiff, to meet the specification, conditions, and plans, was sent and accepted by him (plaintiff). The cars and trolleys were made and used until August, 1897, the trolley standard on one of the motorcars broke, injuring three passengers named Mrs. Fell and Mr. and Mrs. Heaton.

Defendants alleged that the trolley was defective, inasmuch as the standard met the base at right angles, when it should have been curved where it met the base. Actions for damages were commenced by the injured passengers against the Corporation, and the latter body claimed damages from the defendants in respect of the defective trolley which caused the accident. Plaintiff was given notice of this claim, and defendants told him that they held him responsible for any damages they might sustain as the result of the accident. The plaintiff denied all liability for the fracture of the standard, and defendants paid the damages and costs which the Corporation had to pay—viz., £483. 16s., and a further sum of £42. 3s. 1d. incurred by them (defendants), and these sums they claimed to set off against the plaintiff's claim.

The case was adjourned.—*Leeds Mercury.*

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THE PRESIDENTIAL ADDRESS.

The President of the Municipal Electrical Engineers is in a happier position than most presidents, in that his predecessors have not worked up all the subjects of entrancing interest. If we might venture to say so, the keywords to this address will be found in the remarks referring to the opportunity given by such meetings "of discussing each other's ideas and generally enlarging our own, as well as enlarging or directing the minds of the public in general." Mr. Faraday Proctor then proceeds to indicate the ideas which present themselves as ripe for mutual discussion and confidences. His address is therefore a series of texts, the teachings of which will be brought out clearly in the rubbing of shoulders and exchanging of thoughts. It is not our intention to express views upon all these texts, but there seems one or two of almost transcendent importance. The most important question is that connected with the regulations of the Board of Trade as regards the repayment of loans. There is no doubt that the general opinion of all engaged in municipal electrical work, whether on the side of the council or on the side of the staff, is that the restrictions in this direction are far too onerous. The general opinion seems to be that all parties would be satisfied if the repayment of capital was postponed for a period of from three to five years. The compulsory repayment of interest and of a proportion of the capital from the very first year of an undertaking is a heavy obligation falling either upon the rate-payers or upon the earlier consumers. In our view of the case, these earlier consumers should be treated as generously as possible, for no matter what the regulations be, the burden of the obligation falls more heavily upon them than upon anybody else, while a company, if it can, pays its shareholders a dividend at the earliest opportunity. There is really no compulsion that it should do so, and it is not expected to repay any proportion of its capital. Neither does it, as a matter of fact, unless the money has been earned, do much towards depreciation of the plant. Here all the considerations are favourable to a company, while all the conditions are vastly unfavourable, upon those particular points, to a municipality. We are not troubling here to discuss the question as to whether it is right or wrong to municipalise these undertakings. We accept for the moment the fact that municipalities have by the Legislature been allowed to undertake certain work, and we are content, if they are allowed to undertake that work, that the Legislature should provide that the work be undertaken in a businesslike manner. There are some of the minor details in connection with this with which we are not in accord with the president, but upon the particular point that the repayment of capital should be postponed for a short term in the earlier stage of the undertaking, we are in complete accord. It is to be hoped that the representations which will undoubtedly be made by those interested in this question to the Board of Trade will be effective. Another point, perhaps, may be regarded as of still greater importance to those actually employed by municipalities in electric

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light undertakings, but we look upon it as of secondary importance to the question we have just referred to. This question is the position which the employés hold with regard to their councils. Mr. Proctor points out that under existing conditions the council in many cases is altogether uncertain whether it can command for any length of time the gentleman who is responsible for the organisation of its work, and he then points out the reason for this uncertainty. We are quite sure that these conferences will at no very distant date thoroughly enlighten the councils that desire to be enlightened upon this subject, and it will be seen that the average salaries which are being paid to the responsible engineers are such that the abler men will be constantly looking out to better themselves, and this will cause a less keen interest, unless the men approximate to the angelic condition, than would be the case if they were thoroughly satisfied with their condition and with their position. Mr. Proctor only in a moderate manner suggests the employment of consultants. There are exceptions to every rule. In our opinion it would be far better in the majority of cases to place the responsibility of the initial work of the undertaking upon the shoulders of the consultant rather than to proceed in any other manner. This ground, however, is not solid, and there are many strong reasons for holding a contrary opinion. Still, we hold that, when all those reasons have been carefully examined, the conclusion above stated is the one which will obtain general acceptance. Many other questions which are referred to in this address are of considerable importance, but we must leave them to be dealt with in the future, and wish every success to the conference which is being held at the time these lines are written.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. Questions may be sent at any time. Answers must be written on one side of the paper only, and should be kept as concise as possible.

QUESTIONS.

175. What type of dynamo would you advise for general electro typing and plating work? What voltage should it be designed to give?—R. T. D.

176. What are the duties and responsibilities of a clerk of works to an electricity works?—H. N. T.

ANSWERS.

Question No. 169.—Define permeability. Describe some practical method of determining the permeability of a given sample of iron.

Best Answer to No. 169 (*awarded* 10*s.*).—The "permeability" of a substance is the reciprocal of its magnetic "reluctance"—*i.e.*, of its resistance to the passage of magnetic lines of force through it. It is the ratio between the number of magnetic lines, B, per unit area produced in it by a certain magnetising force, H, and the magnitude of that force. It is usually represented by the Greek letter μ, hence $\mu = \frac{B}{H}$. H, the magnetising force, represents the number of lines per unit area in air, hence B of air = H, therefore the permeability, μ, of air = 1. The permeability of all non-magnetic substances is taken as unity, there being no difference from air discernible in their resistance to the passage of magnetic lines through them. With the magnetic substances, however, a great difference is found, B being very much larger. In a particular case, B of a piece of annealed wrought iron was found by Hopkinson to be 10,000 with a magnetising force, H, of 5. The permeability of this sample was therefore = 2,000 at this particular stage of its magnetisation. The permeability of the same sample when B = 11,000 was 1,692, H being 6·5. With a sample of cast iron at the same densities, 10,000 or 11,000, the magnetising forces required were 188 and 292, and the permeabilities 53 and 37 respectively for those densities. Wrought iron is therefore more permeable than cast iron. It is seen also that the permeability of a substance varies with its degree of magnetic saturation—*i.e.*, B and H do not alter in pro portion. After a certain point, when the substance is said to be "saturated," any increase of B requires an enormous increase of H, and therefore the permeability becomes very much less, and, in fact, it becomes practically impermeable

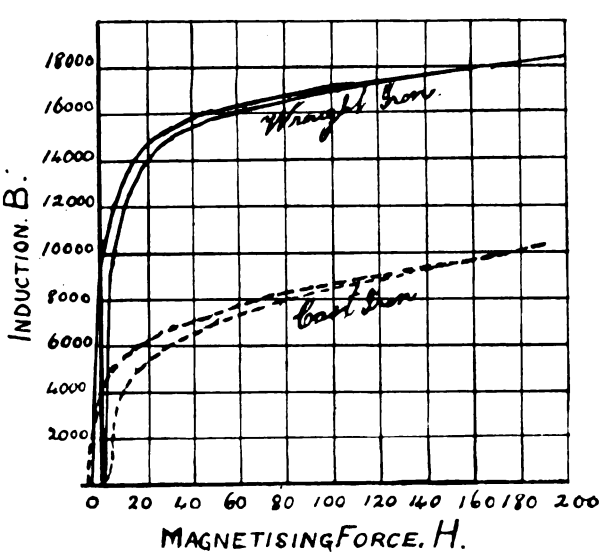

FIG. 1.

to further induction. The curves in Fig. 1, which are taken from Prof. S. P. Thompson's "Dynamo-Electric Machinery," show the relations between B and H for wrought iron and cast iron at different stages. The top portions of the two curves show the residual magnetism due to hysteresis.

Now, in designing field magnets for dynamos, etc., it is obviously necessary to know the quality of iron or steel to be used. If its permeability be low, the magnets must be of greater cross-section, or else have more ampere-hours of magnetising current—and therefore more copper—than if the iron be very permeable. For this reason several methods have been devised for determining the permeability of iron or steel. The two most generally used laboratory methods are the "magnetometer" and the "ballistic" methods. In the former, the sample to be tested—the length of which must be at least 200 times its diameter—is placed in a solenoid situated with its axis at right angles to the magnetic meridian. The magnetometer is placed with its needle also normal to the magnetic meridian, and in such a position that the line joining the centres of the needle and the solenoid is either parallel or at right angles to the magnetic meridian.

To allow for the effect of the solenoid itself on the magnetometer, a few readings are first taken without the core. The core is then placed in and readings taken with varying magnetising forces, first positive and then negative, and so on, the opposite signs being obtained by a reversing switch in circuit. From these readings the inductions, B,

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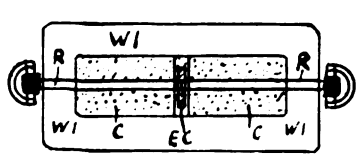
can be obtained, and knowing the magnetising forces, H, the permeability, μ, of the iron may be calculated for the various inductions. The simplest form of magnetometer consists of a magnetic needle or needles with mirror attached, hung by a silk fibre in a slot in a vertical wooden bar, the front and back of the slot being covered by strips of glass to prevent air currents, except in front of the mirror, where a lens is fixed and takes the place of the ordinary glass. The deflections of the needle are read by throwing a beam of light on to a scale, as in the mirror galvanometer.

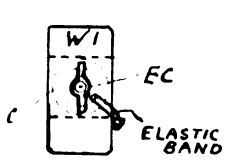
In the ballistic method the sample is usually in the form of a ring, although sometimes a bar as before. The ring formation does away with the effect of the free poles at the ends, which have a demagnetising effect on the central part of the sample when the latter is in the form of a bar. Obviously, when in the ring form, the induction in the iron would have no effect on a magnetometer needle, as it has no external field, and therefore a small coil known as an "exploring coil" is wound over the magnetising coil, so as to enclose all the lines of force in the iron. This small coil is connected up with a ballistic galvanometer. The ring is first laid on the table and then turned over sharply in order to obtain a deflection due to the earth's field, so as to allow for it in the subsequent tests and calculations. Readings are then taken by starting and suddenly stopping, or by reversing, the current and noticing the throw of the galvanometer needle, from which the permeability is subsequently calculated as below.

Now, in ordinary practice, neither of these forms of the sample to be tested is practicable; for in the case of the bar form, the core, and consequently the solenoid, must either be of great length or else, as is usually the case, of very small diameter and moderate length, in order to obtain the necessary ratio of length and diameter. To get a sample—say of cast steel, which is largely used for field magnets—of small diameter, it would have to be drawn and its magnetic properties would thereby be altered, and the sample would be useless. In the case of the ring form, it would be a good deal of trouble to have a true ring made for each sample, besides the trouble and expense of having to wind a fresh magnetising coil on each sample. Dr. Hopkinson, recognising the commercial impracticability of these methods, devised the ingenious arrangement shown in Figs. 2 and 3, the test, however, still being by the ballistic method.



SIDE VIEW

FIG. 2.



END VIEW

FIG. 3.

The sample to be tested consists of two bars about 9in. long, turned from the rough sample to such a size (usually ½in.) as to fit accurately two holes in the wrought-iron frame, W I. The magnetising coils, C C, are placed as shown, whilst the exploring coil, E C, is placed between them, and so arranged that when the bars, which meet in the centre between the coils, are drawn apart, it is suddenly pulled from its position by an elastic band or other spring. The effect of this is to reduce the induction through the exploring coil to zero, the throw of a ballistic galvanometer in the exploring circuit indicating what the induction was. The effect of the massive wrought-iron frame, W I, is to do away with the external poles of the core, the frame forming a closed magnetic circuit. As the permeability of the frame is great—*i.e.*, its magnetic reluctance small—it can be neglected in the calculations, as it does not affect the induction in the circuit, this being governed solely by the permeability of the sample bars, R R, in the figures. If C = magnetising current in amperes, n = number of turns of coil, l = length of bars inside frame, then

$$H = \frac{4\pi C n}{l}.$$

Now the deflection of the galvanometer gives the total induction, and from this the induction, B, per square inch is obtained by dividing by the area in square inches of the area of the cross-section of the rods. Knowing now the values of B and H, the permeability, μ, is found by the formula $\mu = \frac{B}{H}$ as before.

Before leaving the subject, mention should be made of the "permeability bridge" and the "magnetic balance," both invented by Prof. Ewing and described by him recently in a paper before the Institution of Civil Engineers. In the former instrument the sample is turned as before into a rod and then tested against a standard rod of the same size, whose permeability is already known for various intensities of induction. The instrument is manipulated in a manner similar to that in which a Wheatstone bridge is used. In the other instrument the attraction between the bar being tested and a fixed magnet is used so as to allow the induction produced by any magnetising force to be read off direct on a graduated scale. This latter is a very convenient and speedy method of determining the permeability of a sample.—C. H. R. T.

Answer to No. 169 (*awarded* 5*s.*).—The word "permeability," when used in a magnetic sense, is a term which is not readily amenable to direct definition, and therefore before attempting a definition it would be well to consider what is meant by the word. If a coil of wire is taken and a current passed round it, then the space in the immediate vicinity of that coil of wire will be found to have acquired marked magnetic properties, and we express this fact by saying that a magnetic "field" has been created. The strength of this magnetic field is found to be proportional to the current strength in the coil, and is expressed by the convention of supposing that there are a certain number of magnetic "lines" of force per unit of cross-sectional area of the coil. If we by suitable methods determine the number of lines per unit area passing through a coil carrying a current, and then insert, say, an iron core, keeping the current constant, we find that the number of lines per unit area in the iron core is enormously in excess of the number found in the coil previous to the insertion of the core; in fact, we find that the iron core has, owing to its great conductivity of the magnetic lines, gathered them up, as it were. It is this property, then, of influencing the number of magnetic lines per unit of cross-sectional area, and in the case of iron, etc., apparently multiplying them, which is called the permeability of a substance. Other substances as well as iron possess this quality, but none to such a great extent. Permeability, therefore, is that property of a substance by virtue of which it influences the number of magnetic lines per unit of cross-sectional area in a given magnetic field, or its capability to become permeated by them, and its amount or magnitude is measured by the ratio of the number of lines per square centimetre, found in the core, to the number which would have been found in the field had the core not been introduced therein. Or, in symbols, if μ represents the permeability, H the number of lines per square centimetre without the core, and B the number with the core, then

$$\mu = \frac{B}{H}.$$

H is usually known as the magnetising force, while B is often called the induction. The ratio of B to H is not constant for any particular specimen, but varies with the magnetising forces employed, and there is a wide variation of the value for different specimens of iron. It is usual when determining μ for any specimen to take a number of measurements of B with different values of H and then plot a curve having values of μ for ordinates and values of B for abscissa, thus showing at a glance the value of the permeability for any stage of the magnetisation. Fig. 1, which is taken from Prof. S. P. Thompson's "Dynamo-Electric Machinery," shows several such curves for different materials. From what has been said, it follows that to determine the value of μ we must know simultaneous values of B and H. The value of H for any coil (assuming its length to be great in comparison with its diameter) is given by the expression

$$H = \frac{4\pi S i}{10 l} = 1{\cdot}257 \frac{S i}{l},$$

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where S = number of complete turns in the magnetising coil;
i = currents in amperes flowing in coil;
l = length of coil in centimetres.

B may be measured in a variety of ways, but perhaps one of the most "practical" methods is to use an instru-

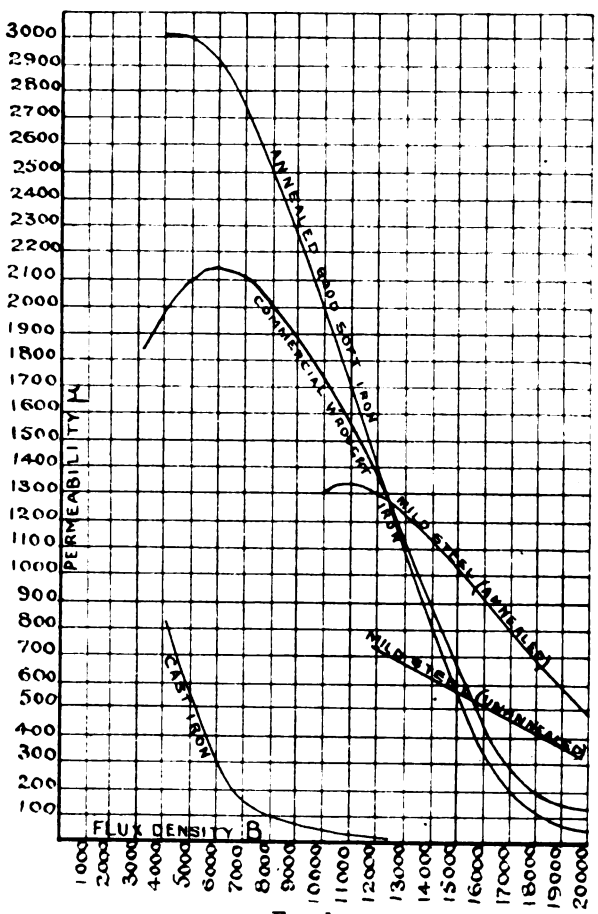

Fig. 1.

ment designed by Prof. S. P. Thompson, and called by him a permeater. For the following description the writer is

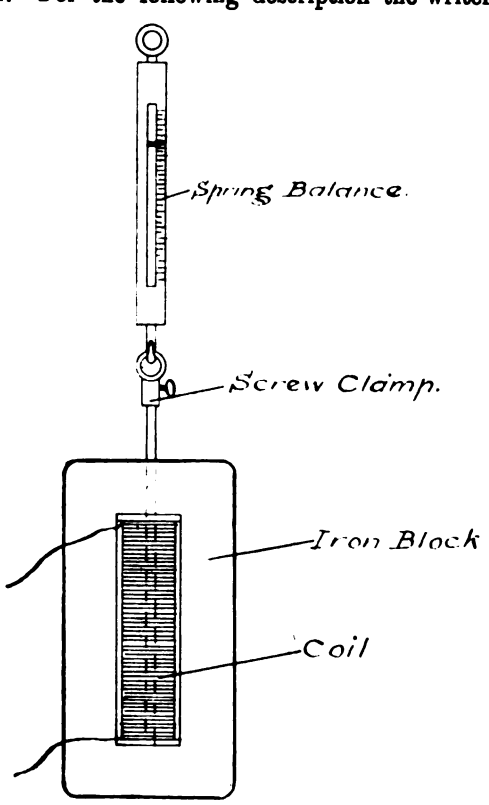

Fig. 2.

indebted to Prof. Thompson's book, "The Electromagnet," wherein will be found most complete descriptions of various other methods of measuring permeability:

"The instrument consists (Fig. 2) of a rectangular piece of soft wrought iron, slotted out to receive a magnetising coil, down the axis of which passes a brass tube. The block is 12in. long, 6½in. wide, and 3in. in thickness. At one end the block is bored to receive the sample of iron that is to be tested. This consists simply of a thin rod about 1ft. long, one end of which must be carefully surfaced up. When it is placed inside the magnetising coil and the exciting current is turned on the rod sticks tightly at its lower end to the surface of the iron block, and the force required to detach it (or rather, the square root of that force) is a measure of the permeation of the magnetic lines through its end force. In the first permeater which was constructed the magnetising coil is 13·64 cm. in length, and has 371 turns of wire. One ampere of exciting current consequently produces a magnetising force of H = 34. The wire is thick enough to carry 30 amperes, so that it is easy to reach a magnetising force of 1,000. In a simple experiment the current used was 25 amperes. Two rods were taken of 'charcoal iron' and 'best iron' respectively; they are of ¼in. square stuff. A spring balance was used, graduated carefully, and provided with an automatic catch so that its index stops at the highest reading. The tractive force of the 'charcoal iron' was about 12½lb., while that of the 'best iron' was only about 7½lb., so that B was about 19,000 in the 'charcoal iron,' and H being 850, μ was about 22·3. The formula for calculating B when the core is thus detached by a pull of P pounds (the coil being left behind), the area of contact being A square inches, is as follows:

$$B = 1{,}317 \times \sqrt{P \div A} + H.$$

"The reason for adding H in the formula is that in this instrument the coil remains fixed, the core only being moved. Hence the pull is that due to B – H lines."

Prof. Ewing, to whose labours on the subject of magnetism we owe so much, has recently brought out two instruments for the measurement of permeability. Both these instruments are described in recent issues of this paper in a report of the "James Forrest" lecture, lately delivered before the Institution of Civil Engineers. Indeed, the description of the latter instrument appears in the same issue as this question, so that it would be out of place to repeat it here.—A. A.

Question No. 170.—For lighting the streets of a city with about 400 arc lamps, given choice of plant at a central station (alternating), would you prefer to use direct-current arc lighters for series running, supply the lamps from the mains, or use rectifiers. Consider (1) lighting effect, (2) cost.

Best Answer to No. 170 (*awarded* 10*s.*).—In considering this question with respect to the lighting effect, there is very little doubt as to which is the best of the three kinds of current to adopt—*i.e.*, continuous, alternating, or pulsating (rectified)—for the continuous current maintains the arc steadily throughout. In the alternating-current arc the arc really goes out for a greater or less time every alternation and is then relighted. During this extinction there is a sensible cooling of the incandescent portion of the carbons, for at these very high temperatures considerable radiation takes place. In addition to this loss of light there is another loss, in consequence of each of the carbons being a positive, and thus raised to its maximum luminosity only for one alternation out of two, and for the other alternation it is negative and its luminosity is much less. The pulsating-current arc suffers in a similar way to the alternating one, except that the direction of the current is not reversed and the carbons do not change polarity; so the lamp can be fixed, as with the continuous current, so as to reflect the rays of light downwards from the positive carbon. The exact ratio of efficiency is a rather debatable figure, as various authorities give it differently. Prof. Fleming gives it as 2 : 3; the Frankfort Commission gave it as 4 : 5. If the latter figure be taken as an average, the amount of light sent downwards as is required in public lighting would be for equal power only one-third of that of the continuous-current arc if there was no reflector used, and $\frac{1 \cdot 7 0}{3}$, or approximately one-half, if a reflector be employed. It is, however, evident that the alternating-current arc has a lower efficiency than the continuous-current one, while the

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pulsating-current has one higher than the alternating, but not so high as the continuous.

In considering the question with respect to the cost, there are, of course, two costs to consider—viz., capital or initial cost and the running costs or upkeep. In regard to the former, there is no doubt that the initial cost is in favour of alternating current if it is intended to run two or four lamps in series off the low-tension supply mains, as in this case there is very little capital outlay except the increased size of transformers in the sub-stations, but the running cost in this system outweighs the saving in capital, so that it resolves the question to rectifiers *versus* series arc lighters. Of these two systems the rectifier has the advantage in respect to capital cost, for its first cost is not heavy and there is no special engine to provide for this purpose, as in the case of a series arc lighter (continuous current). Then, again, the floor space ought to be taken into consideration, for there is such a marked difference in the space required for the two classes of plant, and where the price of land is high a considerable saving in this respect may be affected by the adoption of rectifiers.

Exact data in connection with the saving of one system over the other are rather difficult to get, but the writer had the opportunity some time ago of testing both kinds of plant under the same circumstances. The rectifiers were of the well-known Ferranti make, and the arc lighters were Brush 60-lighters driven by ropes from compound engines running at a speed of 150 revolutions per minute. The efficiency, *i.e.*, $\frac{\text{E.H.P.} \times 100}{\text{I.H.P.}}$, of the continuous-current sets was 53 per cent., whereas that of the rectifiers and alternators was 80 per cent. The efficiency of the rectifiers themselves was more than this figure, being about 90 to 92 per cent. In addition to the above, the rectifier has the advantage of having a much higher efficiency than its rivals at other loads than full. In addition to having a higher efficiency, the rectifiers have the advantage of being able to be run from the 'bus bars, and thus larger alternators can be used and run at most efficient loads. Judging from the general practice of to-day, it looks as though most engineers of alternating-current stations were of the opinion that rectifiers are the best, for there are already some 20 stations equipped with them.—W. WYLD.

Answer to No. 170 *(awarded* 5*s.).*—To do justice to this problem it will be necessary to briefly review the nature of the arc. It has been shown that the amount of light given by an arc depends on the area and temperature of the crater, the area depends on the current, and the temperature, which for a carbon arc is the temperature of volatilisation, and which is always constant, depends on the potential difference, which is 39 volts. The crater is formed on the positive carbon in the direct-current lamp, and the positive carbon at the arc has a very much greater temperature than the negative carbon at the arc. In the alternating-current lamp the polarity of the carbons changes every period, and thus it is evident that the temperatures of the carbons at the arc must be constantly changing, or the mean temperature must be lower than in the case of the direct-current lamp. Apart from this, a true crater on either carbon cannot be formed. But perhaps a point of more importance is that with the alternating current the voltage is always varying, and as it requires 39 volts to form the arc, for the greater part of the time the arc is extinguished and the carbons are cooling. It would appear at first sight that, as an alternating-current lamp can be worked with 39 volts (virtual), it takes 50 for a continuous-current lamp. Therefore, with a 10-ampere lamp we have a consumption in the first case of $39 \times 10 = 390$ watts, and in the second $50 \times 10 = 500$ watts; but it has been shown that the candle-power per watt is much less for the alternating lamp than the continuous-current lamp. The disadvantages of alternating-current lamps are: (1) low efficiency as compared with continuous-current lamps; (2) that the light is thrown alternately up or down, and for street-lighting a great amount of the up light is lost; (3) the lamps are more difficult to make owing to the necessity of complete lamination; (4) the screws of alternating-current lamps are found to work loose—this may become a source of much trouble and annoyance; (5) the humming sound, though perhaps not an objection in street-lighting, is undesirable in buildings. To overcome some of these objections, a rectified lamp may be used. This class of lamp has the advantages of being able to form a crater and of throwing the light in the direction required only, but the disadvantage of the continual alteration of voltage and thus loss of efficiency. It would therefore be seen that for lighting effect we have (1) continuous-current lamps; (2) rectified-current lamps; (3) alternating-current lamps.

The cost of the different systems would be of the following order, commencing with the lowest: (1) alternating current; (2) rectified current; (3) continuous current. The reason of this is that whereas separate mains would have to be run for the two last, the first could be connected direct on to the low-tension mains with only the cost of switches, fuses, choking coil, and leads for each lamp. In the second case there would be the cost of a rectifier, its maintenance, and the cost of mains. In the third case there would be the cost of a combination set to transform the alternating current into continuous current; its maintenance, the loss of efficiency, and the extra mains, which would cost the same as in the second case. Of course, in the first case there would have to be larger mains to carry the current required for the lamps, but the cost would be very much less than separate mains.

We have therefore that the best effects in lighting are those which cost the most, and everything depends on the particular circumstances under consideration which system to adopt. The alternating would under ordinary circumstances not be advisable, and the choice between rectified and continuous would depend on local conditions, such as available space, cost of current, allowance for lighting, etc. In conclusion, it must be remembered that, taking the lamps alone, the continuous-current lamp is the most efficient and most satisfactory.—E. T. WILLIAMS.

CITY OF LONDON ELECTRIC LIGHTING.

At a meeting of the Court of Common Council, held on Thursday, June 8, a report from the Streets Committee on the subject of the future of civic electricity was discussed. From the *City Press* we gather that the report of the committee was as follows:

"Agreeably to your instructions of the 29th ult., a letter was addressed to the City of London Electric Lighting Company intimating that, although your Court is advised that the existing contracts are null and void, you do not desire to take advantage of the circumstance provided they are prepared to come to satisfactory arrangements in regard to the supply of electricity to private consumers; and the company were requested to forward any further proposals they might desire to make, it being pointed out that upon their reply would depend the nature of your answer to the Board of Trade. It will be in your recollection that the company had already offered to reduce the maximum price to 6d. per unit as from Jan. 1 next provided the Corporation would withdraw its request to the Board of Trade to defer the granting of the formal approval by that department of the company's system of continuous current. We now submit the following reply received from the company: 'Sir,—In reply to your letter of the 29th ult., I am instructed by my directors to state that they are unable to make any further proposals than are contained in my letters of the 17th and 24th ult. It is impossible that, in justice to its shareholders, this company can immediately reduce its charge to private consumers to 6d. I am to point out that the price fixed by the Corporation is 8d. per unit, subject to a sliding scale which, in the terms of the contract, is not yet applicable. Notwithstanding, the company have voluntarily reduced the price, and, as I have already stated, it is the avowed policy of the Board to make further reductions as the financial position of the company permits. The question of price is not, however, the only one involved in the matter of giving an efficient supply to private consumers. There is the question of providing for the additional 50,000 to 60,000 lamps which will have to be supplied next winter. On Dec. 20, 1898, this company received from the Board of Trade a distinct intimation that they intended to approve the additional system of supply proposed by this company, and on the faith of such intimation my directors have ordered machinery, and have made arrangements for the expenditure upon continuous-current plant of the sum of upwards of £70,000 to enable them to cope with next winter's increased demand. The Board of Trade, however, at the instance of the Corporation, are deferring the giving of their formal approval of that which they had

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already intimated their intention to approve. My directors invite the serious attention of the Corporation to this matter, as its action is calculated to seriously jeopardise the efficient supply of current to the citizens during the coming winter. I am to add that the introduction of the continuous-current supply will not, as has been stated, involve a general reopening of the streets, but all that will be necessary will be to open the streets at a very few places in order to join up existing conduits.—I am, Sir, your obedient servant, J. CECIL BULL.'

"We have very carefully considered the said letter, and further discussed the question of the future supply of electricity in the City; and, having regard to the fact that the beforementioned offer of the company to conditionally reduce the price of the electric light to private consumers to 6d. per Board of Trade unit as from January 1 next did not find favour with your honourable Court, we could come to no other conclusion than that the company's answer is unsatisfactory, and that under the circumstances competition would be desirable with a view to obtain a cheaper and more efficient supply of electricity in the City. We now ask you to confirm our opinion that, having regard to the unsatisfactory nature of the reply of the City of London Electric Lighting Company, competition, subject to such terms and conditions as may be approved by your honourable Court, would be desirable in order to secure efficiency of electric light and reasonableness of charges, and recommend that Sir Courtenay Boyle be informed accordingly."

The committee further submitted a letter from the Board of Trade forwarding a copy of Sir Courtenay Boyle's report on the recent enquiry held by him at the Guildhall respecting the three applications for provisional orders for the supply of electricity in the City. The letter stated that a provisional order would be granted to the Charing Cross and Strand Electricity Supply Corporation, Limited, but the applications of the other two companies would not be granted.

"The conclusions arrived at by Sir Courtenay Boyle were as follows: 'With regard to the agreements between the City Corporation and the City of London Company, I am of opinion that they cannot be held to give that company any exclusive right of supplying electricity for private purposes within the City. The Electric Lighting Act, 1888 (Section I.), provides that the grant of authority to any undertaker to supply electricity within any area, whether granted by license or by means of a provisional order, shall not in any way hinder or restrict the granting of a license or provisional order to the local authority or to any other company or person within the same area. In 1889, after an exhaustive enquiry into the question of the electric lighting of the Metropolis, Sir Francis Mirindin reported that "in the abstract competition is desirable as tending to keep down the price, and to cause the manufacture and supply of electricity to be carried on with all the attention and energy which it is possible to devote to it." The Board of Trade thereupon adopted the policy, as regards the Metropolis, of granting powers to two bodies in respect of the same area, and this policy has been confirmed by Parliament. The two petitions to which I have referred, and the evidence tendered by various witnesses, tend to show that there is a considerable feeling among consumers, ratepayers, and others, in favour of a competitive supply in the City. After a careful consideration of the evidence and arguments put before me, I am of opinion that a competitive supply is desirable, both in the interests of private consumers and of the public, and I recommend that it be authorised. I do not think that powers should be given to more than one of the applicant companies, and it remains to be considered, therefore, to which of the companies powers should be given. The operations of the Smithfield Company have been very limited. They have no statutory powers, and the strength of their financial position is not such as to justify exceptional consideration. I regret I am therefore unable to recommend the grant of an order to this company. The Metropolitan Company are already supplying energy over a large area adjoining the City, and are constructing a large generating station at Willesden, from which they propose to supply energy throughout the whole of their areas of supply. This proposal presents considerable difficulties, especially having regard to the powers of purchase given to local authorities by the Electric Lighting Acts. The company do not propose to establish a generating station in the City, and, in the event of the Corporation exercising their powers of purchase, they would, under this scheme, acquire mains and distributing plant without any generating station. Their proposals do not appear to me to meet the requirements of the Corporation, and I regret that I cannot recommend the granting of an order to them. The Charing Cross Company are also supplying energy over a large area adjoining the City. It was stated in evidence that they would be prepared to keep the generating and distributing system for the City separate from those for any other district; but that, pending the erection of the new generating station, they would propose to give a supply from their existing station. It was also stated in evidence that the company would accept a clause giving the Corporation power to purchase the undertaking within a shorter period than that prescribed by the Electric Lighting Acts. I am of opinion that the proposals of this company most nearly meet the wishes of the Corporation, and recommend, therefore, that the consent of the local authority be dispensed with in the case of the application of the Charing Cross and Strand Electricity Supply Corporation, Limited, and that an order be granted to the company, subject to the following conditions: (1) that a clause be inserted requiring the company, within two years from the commencement of the order, to establish a separate generating station for the purposes of the City undertaking; (2) that power be given to the Corporation to purchase the City undertaking at any time after the expiration of a reasonable time, to be hereafter settled, from the commencement of the order, on terms to be agreed upon between the Corporation and the undertakers, or, in default of agreement, to be determined by arbitration.' We now beg to recommend that we be authorised to attend the proposed meeting of the Board of Trade on Friday, the 9th inst., and to prepare and submit to the Board all necessary clauses for the protection of the Corporation, with power to obtain, if necessary, the assistance of an electrical expert."

A letter was read from the City of London Electric Lighting Company suggesting that before the Corporation took the extreme step of repudiating their contract, upon the faith of which £1,500,000 had been subscribed by the public and expended upon the electric lighting of the City, the Corporation should remember that they had reduced their agreed price of 8d. per unit to 6d., and were prepared to make further reductions when their financial condition admitted of it; were willing to surrender (in certain circumstances) their right to light the minor streets; and were prepared to negotiate the sale of their undertaking to the Corporation on terms which would leave a very handsome profit to the Corporation.

After a very long debate the reports of the Streets Committee were adopted, though the opinion was expressed in many quarters that in, for the moment, ridding themselves of the monopoly of a single company the Corporation and the citizens might find themselves opposed to a combination of influential syndicates and interests from whom the consumers would have no mercy.

On June 9 at the Board of Trade, Whitehall, a conference was held between representatives of the Corporation and the Charing Cross and Strand Electricity Supply Corporation, Limited, for the purpose of considering the clauses in the draft provisional order granted by the Board of Trade under the Electric Lighting Acts of 1882 and 1888 to the Charing Cross and Strand Company relating to the City of London. Sir Courtenay Boyle, the permanent secretary of the department, attended to hear the objections raised by the City to certain of the clauses, and the suggestions that were forthcoming for their amendment in the draft provisional order of the Board.

Sir COURTENAY BOYLE said he would like them that afternoon to consider and discuss the clauses to be settled on Monday.

The CITY SOLICITOR pointed out that Sir Courtenay Boyle had reported in favour of the company, and that what they had to do at the present moment was to consider what clauses could be inserted safeguarding alike the interests of the company, and, through the Corporation, those of the ratepayers and consumers. The most important question was the one of purchase. Here the point as to the date of the purchase arose, and the City Corporation thought that should be Dec. 31, 1907. Another consideration was respecting the cost of acquiring the undertaking from the company. On that matter it was felt by the Corporation that there should be liberty to purchase at its cost plus 10 per cent., a guarantee being given to the shareholders to make up their dividends in the interim to an average of 4 per cent. per annum. The third point was that the City Corporation should have the right to purchase either the whole or the part of the undertaking.

Sir COURTENAY BOYLE observed that, as far as the Board of Trade was concerned, that could not be.

The CITY SOLICITOR, continuing, next called attention to the question of the expenses of the electrical inspector. Owing to a want of clearness in the wording of the sub-section dealing with that matter, the whole expense of the electrical inspector's salary, office, etc., had been practically thrown upon the Corporation. What the Streets Committee now proposed was that there should be a clause stipulating that any reasonable expense incurred by the Corporation should be defrayed by the competing company.

After some further discussion it was arranged that the parliamentary draughtsman should put into legal shape in the provisional order the clauses to be agreed to at the conference to be continued in private that afternoon between the parties.

The meeting then adjourned till Monday, June 12.

On Monday afternoon the conference was resumed. The first discussion arose upon the right of the company to disturb the surface of the streets for the purpose of laying mains, etc. The CITY SOLICITOR urged that the clause should be amended so that such work should not be undertaken until the written consent of the Corporation had been given.

Sir COURTENAY BOYLE, however, thought that the word

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consent alone was sufficient, and declined to insert a qualifying phrase.

It was agreed that the expenses of the electrical inspector should be borne by the company, no objection being raised.

Mr. FLADGATE, for the company, complained that the terms offered by the Corporation were not sufficiently liberal. To offer a price of only 10 per cent. above the cost in 1907, and to guarantee a dividend of but 4 per cent., was, he contended, putting a premium, not upon the success of the company in the meantime, but upon its failure. As to the date of the proposed purchase, in his opinion 1907 was far too short. The least period he had anticipated was 21 years. The Act of 1882 gave 42 years. The terms would have a very prejudicial effect on the stock of the company.

The PRESIDENT (Sir Courtenay Boyle) said he was not prepared to grant the full 42 years, but thought that the eight years proposed by the Corporation were too short. They must give the company time to make some profit. He thought that the terms offered by the Corporation were not a sufficient inducement to the company.

Mr. MORTON said that if more were demanded it would be absolutely prohibitory. On the same terms they could buy up the present company, and so settle the whole difficulty.

Sir COURTENAY BOYLE said he should urge the parties to agree, and save him the onus of exercising his authority.

Mr. FLADGATE said there was no chance of an agreement being come to. The 4 per cent. dividend and the 10 per cent. premium on the cost were not sufficient for such a short term of years. The company would have to raise half a million of money to carry out the installation, and he doubted if they would be able to obtain it from the public on such terms. He was afraid that the whole scheme would drop through if better terms could not be obtained.

Mr. MORTON said the question of extending the time for purchase would be the variation that was least liable to cause a diversity of opinion in the Corporation.

Sir COURTENAY thereupon postponed the year of purchase until 1915; but at the suggestion of the CITY SOLICITOR, this was reduced to 1914, in which year, Mr. Crawford said, the option of purchasing the City Electric Company would belong to the Corporation.

The question of what portion of the company's property should be purchasable was then entered upon.

The PRESIDENT said he had caused a clause to be inserted compelling the company to erect their generating station in the City itself. Otherwise he did not see why the City should be compelled to purchase the station.

The CITY SOLICITOR strongly objected to the City being asked to ultimately purchase something situated in the jurisdiction of another authority.

Mr. FLADGATE said that if the clause were insisted on it would be fatal to the order, as the price of a site in the City was prohibitory. The station would cost at least £250,000, and if eventually the City would not purchase it so much money would have been absolutely thrown away. If the station were not absolutely in the City it would be used exclusively for supplying the City, and that, he contended, was much the same thing.

The PRESIDENT said he saw the point, and ultimately the clause was worded to the effect that, if the site were selected by the company with the approval of the Corporation, the latter should be compelled to purchase the station.

The question of the price of the supply was then considered, and it was decided that the cost of the general supply should be 5d. per unit for any amount up to a number of units equal to the number obtained by dividing the number of watts in the maximum power demanded by 10; and 4d. per unit above that amount. For the motive power the price was to be 3d. per unit and 2d. per unit respectively, the number of watts demanded in this case being divisible by 4.

Some points of detail were referred to the solicitors, and the proceedings terminated.

DUNDEE TRAMWAYS.

The following is the report of Mr. E. Manville to the convener and members of the Tramway Committee of the Corporation of Dundee on the proposed extension, etc., of the Corporation tramways:

Gentlemen,—In accordance with your resolution appointing me to advise you as to the suitability, or otherwise, of a proposed tramway line between South Union-street and Gelly Burn, or an alternative route to be worked electrically, I visited Dundee, and, after a conference with your Council, inspected generally the existing tramway system in Dundee, the extensions that are proposed to be made to it in the immediate future, and particularly the above-referred-to routes. At the interview with your Council I was further instructed to advise you as to the suitability of substituting electrical conduit in place of overhead wires in the centre of the city, and to confer with Mr. Mackison, your burgh engineer, and Mr. Tittensor, your electrical engineer, in relation to the way in which they are proposing to carry out the work of the electrical equipment of the existing tramways and the construction and electrical equipment of the extension tramways; and I therefore propose to divide this report into two sections—the first dealing with the proposed cable or electrical tramway from South Union-street to Gelly Burn, and the second dealing with the substitution of conduit for overhead wires in part of the city, and the suitability of the arrangement proposed by Messrs. Mackison and Tittensor.

SECTION 1.

Proposed Cable or Electrical Tramway from South Union-street to Gelly Burn.

I have had before me the original propositions of the promoters of a company who proposed to construct a cable tramway from South Union-street to a point without the municipal boundary, and the reports upon this proposal by Mr. Fisher, your tramway manager, and Mr. Mackison, your burgh surveyor; and I understand it is the desire of your Council, should such a tramway be constructed at all, to both construct and work it themselves, either taking the route proposed by the promoters of the company if a cable system be deemed the more advisable, or select some other alternative route capable of dealing with the traffic from the same district if electric traction be considered the more desirable; an alternative route being necessary to that proposed by the company should electrical traction be adopted, owing to the severity of the gradients along what may be termed the cable route.

As to the desirability of a tramway existing in that neighbourhood, I think there can be little doubt that this is of course a question which can be more readily settled locally by those having an intimate knowledge of the wants of the city. But it appears to me that the district proposed to be served, and which is at present hampered in its development by the excessive gradients encountered on the direct route, and the consequent difficulties of communication, would provide a very paying traffic for a tramway system removing these difficulties, and which tramway system would at the same time very beneficially affect the development of the district. There can be little doubt, looking at the general arrangement of the tramway systems at present existing near the centre of Dundee, that had it not been for the difficulties in the past of dealing with this district, it is most likely a tramway route would already have existed in this part of the city.

If it were ultimately decided to construct a cable line there is little doubt that the route proposed by the company, from South Union-street along Barrack-street, Constitution-road, Carmichael-street, Bruce-street to its junction with Strathmartine road, would be a very suitable route for such a system. But if it be decided to construct an electrical tramway to serve the same district, it would be impossible to follow the cable route exactly owing to the excessive gradients encountered in Constitution-road, the gradients in part of which are beyond those which can safely be dealt with by adhesion; and in that case, whilst the first part of the route might be the same as that proposed for the cable route, the line should be carried along Barrack-road, Dudhope-terrace, and Somerville-place until Constitution-road is reached again. From that point the line might either follow the route of the cable tramway, along Carmichael-street, Bruce-street, etc., to the junction with Strathmartine-road; or it might alternatively, be carried along Constitution-street and Hilltown to the junction of this latter with Main-street. As to which of these two alternative routes from the junction of Somerville-place with Constitution-road should be adopted, again matters of local interest arise of which those well acquainted with the requirements will be the best judges; but on general grounds, I am of opinion, unless there is some very good reason to the contrary unknown to me, that it would be better to carry the line from the junction of Constitution-road and Somerville-place, along Constitution-street and Hilltown to Main-street, where it would effect a junction with the existing tramways. Adopting this route, in place of that along Carmichael-street to Strathmartine-road, would save in course of construction, owing to the shorter length of the alternative route to Main-street; and I hardly think the extra cost of construction *vid* Carmichael-street to Strathmartine-road would be justified, as the existing line along Strathmartine-road to Main-street parallels Bruce street at a very short distance away. If the electrical system were adopted in preference to the cable system, the necessity of diverting the line around Barrack-road and Dudhope-terrace in place of its proceeding straight up Constitution-road would, I consider, be no disadvantage to it; it would bring it into close communication with the considerable residential district in the neighbourhood of Dudhope-terrace. I therefore think that, so far as either the cable system carried by the proposed route, or the electric system carried by the alternative route, concerns the tramway requirements of the neighbourhood, either system would be about equally serviceable. But having effected a connection with Strathmartine-road, all the considerations are in favour of electric traction.

It is your intention, I understand, to equip all the tramways in Dundee electrically, including therefore amongst them that at present running through Main-street and Strathmartine-road; and if the new tramway connecting with these were run electrically, it would form a natural branch of the existing tramway in Strathmartine-road. Further, when the extension proposed from the terminus of the line in Strathmartine-road at Fairmuir is made to the burgh boundary, and ultimately possibly into Downfield, the electric system would undoubtedly be the better of the two; and this superiority of the electrical system would be still more emphasised if your Council at any future date had to provide a tramway system in Downfield itself. For, were the cable system to take the traffic as far as Downfield, it would, as Mr. Fisher

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suggests, be almost necessary that any possible tramway system in Downfield should likewise be a cable system, though it could not there compare with an electrical system. At the other end of the proposed new line—*i.e.*, that portion from the end of Constitution-road through Barrack-street to the bottom of South Union-street—I am of opinion that if the electrical system be adopted, this line might well be carried as far as the junction with Nethergate and High-street, with which it might connect, or, if thought desirable, to extend it into it into Union-street to make a terminus of it; or both courses might be adopted—*i.e.*, forming a junction with the lines in Nethergate and High-street and having also a terminus in Union-street, so that occasionally cars might be run straight through from the Perth-road system to Strathmartine-road, and other cars be run from Union-street straight through to Strathmartine-road onwards.

Now as regards the other respective advantages and disadvantages of the two systems on this route, it is hardly necessary for me to point out to you that it would be, for many reasons, very preferable for your Corporation to have but one system of propelling their tramcars. The adoption of a second system for propelling a small portion of the tramways within the burgh would necessitate considerable additional expense in the way of maintenance, and would require the duplication of machinery a second time, which would be quite unnecessary if this route were worked off the machinery installed for the rest of the tramways in the city. I am aware that it may be urged that the current generated in the electric power station at Dudhope-crescent-road might be utilised to drive the cables on this tramway if that system were adopted; but even if that were done, I still consider that the advantage would lie with the direct use of the electric current for the propelling of the tramcars on this route; and, in fact, should you, after due consideration of the matter, decide to instal a cable system, I think it would on the whole be better not to utilise the electric current for propelling the cable, but that it would be better to carry the cables into the present electric station, along Dudhope-crescent-road, and instal in the electric station the steam hauling machinery for driving the cable.

Now as regards the capital expenditure that would have to be incurred in the equipment of this route—on the one hand electrically with overhead conductors, and on the other hand with a cable. I have very carefully considered this question; and in considering it, I have dealt as leniently as possible with the cable system, and as stringently as possible with the electrical system, in the following ways: (1) The length of the cable route is 12,255ft. from the end of South Union-street to Gelly Burn. The electrical system, if taken to the same terminus, but diverted *vid* Barrack-road, Dudhope-terrace, Constitution-street, Hilltown, and Strathmartine-road, would measure about 14,355ft. I have compared the cost of construction of the two systems on these bases, whereas it is obvious that, if the electrical system be adopted, a portion of the electrical line along Strathmartine-road from Main-street to Paterson-street would, in any case, be equipped electrically for the tramway system running thereon at present, and in making an impartial comparison, the cost of the reconstruction and electrical equipment of this portion of the line might be deducted from the cost of the electrical equipment and construction of the new route.

2. I have taken the average speed of both electrical and cable cars on this route as being the same, which, owing to the somewhat greater length of the electrical route, results in an additional car requiring to be provided for the electrical scheme; whereas it might be urged that electrical cars were able to make a better speed average than the cable cars, and that, therefore, notwithstanding the somewhat greater length of the electrical route, the same number of cars would suffice as that provided for under the cable scheme.

3. Whilst it is practically essential that the cable line should be double track throughout, the electrical line might certainly, for a considerable portion of its length, be single track with passing places. I have, however, in the following estimates provided for a complete double track for the electrical system as for the cable system.

The following, then, are the two estimates of capital expenditure:

Estimate I.—Capital Cost of constructing and equipping Cable Tramway, from South Union-street to Gelly Burn.

The construction of 2·32 miles route length of cable tramway, equalling 4·64 miles of single track cable tramway, consisting of track, conduit, paving, cable pulleys (all complete)	£46,400
Twelve cable cars, complete with grippers and auxiliary slipper brakes, 10 being required for the service, and two being spare	3,600
	£50,000

Estimate II.—Capital Cost of constructing and equipping Electrical Tramway with Overhead Conductors from South Union street to Gelly Burn *vid* Barrack-road, Dudhope-terrace, Constitution-street, and Hilltown.

The construction of 2·72 miles, route length, equalling 5·44 miles of single track—say, 5½ miles—including bonding, at £5,000 per mile	£27,500
Overhead construction—2·72 miles of cross suspension construction, complete with trolley wires and fittings, at £1,300 per mile	3,536
The requisite feeders calculated on the basis of a loss not much above 5 per cent. to any portion of the line, including earthenware ducts, switch-pillars, drawing-in boxes, etc.	1,437
Thirteen motorcars, two being spare, equipped with specially powerful motors, electromagnetic brakes and slipper brakes, at £600 per car	7,800
	£40,273

The above estimates speak for themselves as to the difference in cost between the two systems, so far as road construction, rolling-stock, and the delivery of power is concerned, the cable system (on the above bases favourable to it as compared with the electric system) being nearly 25 per cent. greater cost. As regards motive power, the following is my opinion of the relative merits of the two schemes:

Cable System (on the basis of a five minutes' service).—The number of cars in actual operation would be 10; the average speed, with stops, six miles per hour; the total brake-horse power required to propel these cars—half going uphill and half going down—together with the five miles of cable, would be, I estimate, 118 b.h.p., of which no less than 93 b.h.p. would be required to propel the cable, and only 25 b.h.p. to move the cars once the cable were running at full speed.

Electric System (on the basis of five minutes' service).—Number of cars in use at one time would be 11; average speed, with stops, six miles per hour; total energy required, 1·2 kilowatt-hours per car mile, which equals 122 b.h.p.

From the above two estimates it will be seen that the actual brake horse-power required to propel the electric cars is about four more than that required with the cable cars with the above service, or a little over 3 per cent. additional. But I would draw your attention to the fact that no less than 93 h.p. out of 118 h.p. is in the case of the cable system required to keep the cable in motion, and therefore if fewer cars than those required for a five minutes' service were in use, the power taken per car mile would rapidly increase, until it would approximate to 95 h.p. should only one car be in use; whereas with the electric system, not only would the energy taken on the system decrease in exact proportion to the diminished number of cars running at the time, but the efficiency would actually slightly increase, owing to the diminished loss in the feeders with a smaller service of cars. On the other hand, should the service be increased beyond a five minutes' service, the power per car running would show in favour of the cable system as the service was increased.

As regards the capital cost of the motive power plant, even assuming that the buildings of the electric light station were utilised for the reception of the cable machinery, if that system were adopted, the capital cost of the two steam-engines which would then be required (one being spare) for the propulsion of the cable, together with the cable hauling gear, would, I estimate, be a little greater than the cost of additional electrical apparatus to that already installed and about to be installed in your electric generating station for the lighting, and other tramway systems in the city. For, of course, in the case of the electrical system being adopted, no spare electrical plant would be required, but only the exact addition necessary to run this route, since the spare plant will already have been provided in connection with the existing tramway system. The one possible disadvantage in connection with the adoption of an electrical system for this route is the rather severe gradients that will be encountered, even after the route has been diverted, as suggested in this report. At the present moment a gradient in the connecting street between Dudhope-terrace and Barrack-road has a ruling gradient of 1 in 8¾, and in Barrack-road itself a gradient of 1 in 13½. Your burgh surveyor, however, tells me that it is proposed that these two gradients should be equalised so as to give in both these streets a steady gradient of 1 in 11, and there does not, in fact, appear to be any reason why this improvement should not be effected. That being so, the curve into Barrack-road will be the only remaining point requiring consideration. There is no doubt that a curve on a severe gradient is a danger with a track laid quite horizontally, since, should a driver allow his car to get away from his control, it might under that condition leave the track at the curve. I, however, noticed that the road at this particular corner is particularly wide; and there should be no difficulty in carrying the tramway track right to the outside of it, where it would not interfere with the ordinary traffic, and then sufficiently elevate the outer rail, as in railway practice, to ensure the car remaining on the track at any speed it might be likely to attain; and if the road is constructed in this manner I consider that no danger need be apprehended from this source. Further, in a town situated so far north as Dundee, where severe weather may be met with during some portion of the year, severe gradients might again be considered objectionable, owing to the formation of ice on the rails, preventing reliable braking. This, however, I do not consider should prove at all a real difficulty, as no doubt with the careful management which your tramway system will have, the track along the severest gradients would be well looked after at such times, and properly salted and cleared of ice and snow. From the statements made above, I think you will agree with me that, for the many reasons set forth, the electrical system in your particular case should prove the more efficient and satisfactory for you to adopt in constructing this tramway route.

Section 2.

The Question of substituting Conduit for Overhead Wires in the Centre Part of the City, and the suitability of the arrangements proposed by Messrs. Mackison and Tittensor for the Reconstruction and Electrical Equipment of the Tramways.

Mr. Mackison has informed me that the first section of the new tramways to be constructed and electrically equipped is tramway No. 8 in the parliamentary Bill, in Perth-road, and a part of

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tramway No. 3 in the High-street, also in the parliamentary Bill, and the reconstruction and electrical equipment of the existing tramways in Perth-road, Nethergate, and High-street, lying between these two new tramways. Of the existing portion of these tramways, the single line between West Park-road and Dalhousie-terrace is to be laid with new rails on the existing concrete bed, and properly repaved with setts. The second section, between Dalhousie-terrace and Airlie-place, which is a double line, and has recently been relaid with new rails of heavy weight, on concrete foundations, with Marshall's joints, is not to be reconstructed, since he considers this road-bed good enough for the present. It will, however, require to be properly bonded, and the paving put in good order. The third section, being a double line between Airlie-place and Tay-street, which is at present laid with longitudinal sleepers and saddle rails, will be replaced by new girder rails, which he proposes should have bed-plates. The fourth section, from Tay-street to the point of junction in High-street with tramway No. 3, consisting of one line of girder rails and one line of saddle rails and sleepers, will also be taken up and reconstructed with new rails and proper foundations.

As I understand it, as much as possible of the new tramways and of these to be reconstructed will, where double line exists, have the two tracks laid sufficiently far apart to enable centre poles to be erected to take the trolley wire over each track, and that this actually will be the method of construction on the portion of the above lines extending between Sea-wynd in the Nethergate and the junction with the tramway No. 3. It is intended to have all the rails forming the new and reconstructed tracks tied together by substantial tie-rods at distances of 6ft., and all points and crossings are to be made of the best crucible cast steel, with automatic points and steel guides and fixings. Mr. Mackison further sends a tracing of the section of the new type of rail to be employed in the reconstruction of the tramways, and is going later on to furnish me with plans of the sections to be reconstructed, and with his specification. He also informs me that it has been suggested that the new rails might in part be laid upon wooden planks laid in the concrete foundations in order to soften the sound, and give greater smoothness in running. He further suggests that fishplates might be used of a type known as the "Dicker" fishplate, in which the top of one of the fishplates passes up through a notch in the side of the rail, thus distributing the weight of the car over both rails at the joints.

Taking now the various points thus brought forward by Mr. Mackison in their order. It is, of course, necessary where the track is worn out that it should be completely renewed, and that no money should be wasted upon endeavouring to patch up an old and unsuitable track, so as to enable it to serve the purposes of the electrical line for a short period before being renewed; but with regard to the existing tramway between Dalhousie-terrace and Airlie-place, which has recently been laid with new rails of heavy weight resting on concrete foundation, I quite agree that it would be desirable to utilise this track as it at present stands, after being bonded for the proper conduction of the electrical currents that will traverse it. The shape and depth, however, of the flanges of the motorcar wheels to be ordered must be considered in connection with the running section of this old piece of track, as well as in connection with the running section of new rails ordered in the future. The method of laying and fixing rails as suggested by Mr. Mackison will be satisfactory, though I do not consider the use of soleplates really necessary if the external section of the rail, where the fishplates come, is such as to secure a perfectly good joint without the aid of soleplates, and it is our experience that this can be most satisfactorily achieved. To explain my meaning, I attach herewith section of rail recently designed by my firm for the Corporation of Southampton, in which these conditions as to effective fishing are perfectly complied with, and in which it will be noticed, in order that the fishplates might fit either side of the rail, the fishing section has been made symmetrical on both sides of the rail. I notice that Mr. Mackison thinks that, owing to the shortness of time that can elapse before commencing the first contract, it may be necessary to get a market section of rail to start the work with, and afterwards stipulate possibly for a more improved section for the remainder of the work. If, however, you and he were to approve of the adoption of some such section as this, there can be no difficulty in getting it forthwith, as this section is now being rolled in Leeds for the Southampton Corporation. There may be a difficulty in adopting exactly this section, since the rail is not quite so deep as that shown by Mr. Mackison in his tracing, the difference in depth being no doubt due to the depth of the granite setts used in Dundee; and, in that case, if it were necessary to alter the dimension of the Southampton rail by deepening the web, at the same time increasing its section and widening the flange to compensate for the increased height of the rail, delay would be occasioned in making new rolls, and it might then be necessary to start with a market section for the first contract, following on with rails of the description I have suggested.

In reference to Mr. Mackison's question as to whether the rails can be obtained sufficiently quickly in the United Kingdom, it has been the experience of my firm, in ordering rails of a good many sections lately for a large number of tramways, that both quicker delivery and cheaper prices were obtainable in the States. However, we are glad to report that in the last contract let by us for rails—*i.e.*, that of the Southampton Corporation—the Leeds Steelworks, of Leeds, were both the cheaper in price and the quickest in delivery, and, moreover, undertook to comply with a very stringent specification as to the quality of the material out of which the rails should be rolled; and whilst I do not think it would perhaps be desirable for your Council to prohibit tenders from abroad, I think there is little doubt but that they would now obtain sufficiently favourable tenders both as to price and time from British manufacturers. In regard to the quality of the material from which the rails are to be made, I need hardly point out to you that special attention should be given to the specification for this, as the wear and tear caused by a rapid service of electrical motorcars on the rails is most considerable, and it very largely depends upon the quality of the material of which the rails are composed as to the length of wear to be got out of the rails, and the consequent cost of maintenance. The same remarks as to wear and tear apply to the foundations of the rails. I am quite aware that wood under the rails, particularly if laid as cross-sleepers, tends both to soften the sound and to give greater smoothness in running; but from the experience which my firm have had with this form of construction abroad, I feel convinced that the same satisfactory results in the maintenance of the track would not be experienced if wood is introduced as part of the foundations in place of the whole foundation being of concrete. Not only does the wood itself often rot, but the water, which, even with the best-laid paving, will find its way beneath the sleepers, both loosens them and disturbs the setts, especially those immediately next the rails. I have only referred here very generally to the points raised by Mr. Mackison in connection with his proposals, and I should like to have the opportunity, with your permission, of going into these at more considerable length with that gentleman.

Mr. Tittensor has furnished me with a draft giving the headings of what he proposes to provide in the way of plant, feeders, and equipments for the electrical working of the existing tramways, and has further furnished me with details of the general scheme he proposes for the satisfactory distribution of electrical energy to the various parts of the tramways. Primarily, he proposes that the plant for this purpose, which will be installed in the electric lighting station, should be equally suitable for both lighting and tramway purposes, so that so far as generation of current is concerned there would be no difference for which of the two purposes it is applied. The first proposition includes plant for the supply of current to 39 cars, which if distributed over the existing system, with the extensions on the Perth-road line only from High-street to the western boundary, would be exactly sufficient for a five minutes' service over these tramways, leaving out of consideration the line at present existing along Strathmartine-road between Fairmuir terminus and the corner of Main-street, which I suppose he has done purposely pending the consideration of the cable or electric system along this route, under which scheme the equipment of that portion of the existing tramways might legitimately come if carried out. The generating plant he proposes to instal to supply current to these 39 cars consists of four 30ft. by 80ft. Lancashire boilers and two steam generators, each of 319 kw. output. I consider that one of these machines would be rather small for the maximum demand likely to be thrown on to it for short intervals of time with 39 cars actually running, whilst if it be his intention to use both these machines together for this purpose, it would be too much to be operated economically. The mean power generated by one of these sets would be amply sufficient for running the 39 cars were it not for the occasional overloads which occur from time to time. I notice that Mr. Tittensor has not provided for any battery of accumulators to be used in conjunction with this generating plant. It has lately become the custom on the Continent to largely use accumulators in this connection, and is also even becoming a custom in the United States of America; and I am inclined to think that, with the steam generators to be installed, if a suitable battery of accumulators were added, a most economical and satisfactory arrangement could be made of the combination. A battery used in this way is not intended to do much in the way of supplying current to the tramway system by itself, but is primarily intended to act simply as an equalising battery—that is to say, at the time when the cars are taking a smaller output than the economical output of the engine, the battery is receiving the surplus, and during the time that the demand of the cars is in excess of the economical output of the engine the battery supplies the excess current so required; and in this way, notwithstanding the violent fluctuations taking place on the line side of the battery, the load on the engine side of the battery is almost perfectly constant, with the result that the cut-off of the engine and the load of the generator can be set for about the mean load of the tramways and kept at that all day long. I should like to have the opportunity of discussing this point with Mr. Tittensor. The current from the tramway generators will be taken through throw-over switches arranged to either connect them to the traction switchboard or to the lighting switchboard, one or other at a time. The traction switchboard would contain certain switches and instruments set forth by Mr. Tittensor in his description, which I am of opinion are sufficient and suitable for the work contemplated. From this switchboard will also proceed the feeder mains, which are to consist of lead-covered cables drawn into ducts to the various feeding points, where they are to be connected up to the distributing mains at the feeder pillars. This I consider also to be a satisfactory arrangement, for since the feeders have no intermediate connections between the generating station and the feeding point, they can, if drawn into ducts, be pulled in and out of the ducts as the occasion requires without any further disturbance of the street's surface. The distribution mains he proposes should consist of insulated conductors laid parallel to the track, and connected at each half-mile of section through the feeder pillars to the line. Pilot wires would also be provided in the conduits from the station to the extremity of the rails, together with two telephone cables running alongside the distribution mains, and connected to the telephone transmitter and receiver in each feeder pillar. Mr. Tittensor proposes that the feeder pillars should be fitted up with certain switches, cut-outs, and lightning arresters, which appear to be quite suitable. He proposes that the return rail circuit should be

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bonded with bonds of a suitable type of an ample contact area. He does not, however, specifically state that more than one bond is to be used per rail joint, and as it would be a somewhat serious matter if a rail were to be completely disconnected at one end, I consider that in all cases two separate bonds should be used, irrespective of the quantity of current to be carried at that point. He also proposes that the rail should be cross-bonded and the two tracks interconnected in a suitable manner. Mr. Tittensor further proposes that two negative feeders should be used to carry current back from the rails to the generating station, and that the potential between the rails and the negative feeders should be reduced to zero by the use of negative boosters in the generating station, of which arrangement I quite approve. He has further suggested that positive boosters may be used on the outgoing feeders to produce a compounding effect, according to the load at any moment, which I think it would be very wise to instal, especially if an equalising accumulator battery were used, which would prevent the dynamos being so constructed as to increase their pressure with the load, and thus provide for the drop of pressure in the feeders. He proposes that the trolley wire should be double throughout its length, even if the track be single, so as to avoid the use, as far as possible, of points and crossings on the trolley wire, and with this I also agree. In connection with the trolley wire, he proposes that the trolley arms on the cars should be of the side swing type with swivelled heads (of the "Dickinson" type), which will enable short brackets to be used, and the trolley wire kept close to the side of the streets, where side poles are provided, and will further have the very good effect of preventing the use, to an excessive extent, of pull-off wires round curves. The trolley wire is to be guarded by suitable guard wires, in accordance with the Board of Trade regulations, where telegraph or telephone wires cross these. He also states that the feeders are worked out so as to be ample for 2½ minutes' service for the whole of the existing tramway system at eight miles an hour, and the feeders will be carried through streets in which the electric light mains are to be laid, so as to save the expense of opening up streets specially for the laying of the tramway feeders.

Generally, I consider that the scheme, as so far worked out by Mr. Tittensor, is quite satisfactory, with the exception, perhaps, of the arrangement both of the positive feeders, their distribution points, and the number and position of the negative feeders. Regarded only from the point of view of the electrical equipment of the existing system, the arrangement of these feeders and distributors and their distributing points might be reconsidered, especially having regard to the conditions that will pertain when the various extensions to the existing tramway system are made, and I will on my next visit to Dundee produce for Mr. Tittensor's consideration my suggestions on these points. I notice that no reference is made to the electrical equipment of the rolling-stock, and of the arrangement of depôts, repair shops, etc., by either Mr. Mackison or Mr. Tittensor, and I presume that these matters have not yet been considered ripe for discussion. I think, however, that the details of the electrical car equipments should be considered carefully, especially in relation to the application of electric brakes, either magnetic or otherwise, and points of that description, which I shall be happy to go into.

I have given consideration to the question put by a member of the committee as to the substitution of conduit for overhead wires in the centre part of the city, which I presume refers more particularly to the Perth-road line where it passes through Nethergate and High-street, and also to the extensions from the Perth-road line to the east where still in the centre of the city, and likewise the lines in Reform-street and the proposed new lines in Commercial-street, both of which run into Meadowside-road. I would state that there is no practical difficulty in running conduits in combination with the overhead conductors so long as the streets in which the conduits are laid are efficiently drained, so as to enable the conduits to be connected to the drains and thus kept free of water. The extra cost of constructing such a conduit per mile of track where the tramway lines are, in any case, to be reconstructed with new concrete beds would not exceed £3,000 per mile of single track, and at the point in the road where the overhead conductors terminate and the conduit commences, iron cover plates would be arranged on the surface of the conduit and connected to a system of levers enabling these plates to be moved slightly upwards and outwards, thus opening up the conduit for easy insertion of the collector, the car, in the meantime, of course, standing over the aperture in the conduit. Such a system is in use in several European cities—notably in Paris and Brussels—and the length of time taken to change from the overhead conductor to the conduit does not in practice, as I have myself observed, exceed 20 to 30 seconds, and, no doubt, should you ultimately decide to adopt such a combined system, this junction between the conduit and overhead wires would be arranged in all cases at points where the cars would in any case stop to take up and set down passengers so as to involve little or no extra delay to the service. At the same time, I think the overhead system, if well arranged, has proved so satisfactory that you may consider that there is but little need to make a departure in the direction indicated in Dundee. It is true that in the centre of the city at the points indicated there would be a good many junctions of tramways, which would necessitate some pull-off wires. but I notice that in High-street particularly there are already refuges in the centre of the roadway which could be very well used for the reception of pull-off poles, whilst with the use of the "Dickinson" or side carrying trolley arm, which accommodates itself so readily to sharp curves, there would be no need to use any large number of pull-off wires to disfigure the appearance of the streets. Further, the cost of the erection of the overhead system is not great, and if the lines are equipped completely at present with overhead conductors, and are found after trial not to give satisfaction to the ratepayers, the standards and fittings could be taken down and used on future extensions of the tramways in the outskirts of the city, and the only additional expense that would then be incurred by the ultimate change from overhead wires to conduits in the centre of the city would be the breaking-up of the bed of concrete on which the track without conduit at that time was laid. I am, however, under the impression that from the papers Mr. Mackison has furnished me with that at the present time a good deal of the Perth-road tramway in Perth-road and Nethergate is already laid on concrete foundations, which will not require renewing, and that certainly is the case on that section between Dalhousie-terrace and Airlie-place, and, therefore, in that case it would cause no extra expense to the Council whether that bed of concrete were broken up now for the building of a conduit, or whether this was done at some future date. I think it has invariably been the experience in those towns where electrical traction with overhead conductors has been tried that popular opinion finds no objection to make to the use of overhead conductors properly installed; and under all the circumstances you may deem it wiser to defer consideration of the installation of a conduit, at least until the overhead conductors have had a fair trial. Further, I cannot see that the use of overhead conductors would in any way interfere with the traffic on the street surface.

I trust I have above given you all the information you immediately require, but if there is anything further you require to be informed about I shall be very happy to go into it for you; and if you desire it, I can go into the work to be carried out by Mr. Mackison and Mr. Tittensor in detail from time to time as it arrives. (Signed) E. MANVILLE.

PHYSICAL SOCIETY.

At the ordinary meeting held on June 9, 1899, Prof. Lodge, president, in the chair,

The **Secretary** read a paper by **Mr. C. G. Lamb "On the Distribution of Magnetic Induction in a Long Iron Bar."** A Lowmoor iron rod, whose length was *250* times its diameter, was taken, and a B – H curve plotted by ballistic measurements made with a search coil at the centre of the bar. The search coil was then moved along the bar, and the distribution of induction was determined for magnetising forces varying from H = ·74 to H = 35·0. Up to fields of 3·35 the induction leaks out more and more quickly as H increases, but above this value the induction tends to keep in more and more. From the curves obtained the mean induction was deduced, as well as the distance of the resultant pole from the middle of the bar. It is shown that this distance first decreases and then increases with the rise in field strength. According to the ellipsoidal theory it should be constant. The bar was then made into a ring, and the B – H curves again determined. From these curves, together with known relations between B, H, and μ, curves showing the variation of μ along the bar were constructed.

The **Chairman** gave a general explanation of the way the leakage depended upon the permeability in the case of a long iron bar.

A paper **"On the Absolute Value of the Freezing Point"** was read by **Mr. Rose-Innes.** The corrected values of the absolute value of the freezing point determined by Lord Kelvin from experiments on hydrogen air and carbonic acid contain discrepancies amounting to ½ per cent. between the carbonic acid and the hydrogen, while the separate measurements for carbonic acid agree among themselves to about ⅛ per cent. Starting with Lord Kelvin's equation for the forcing of a gas through a plug, the author has obtained a formula for the absolute value of the freezing point which can be worked out from the experimental researches of Regnault. The formula is based on the experimental proof by Joule and Kelvin that the ratio between the cooling effect per atmosphere of differential pressure and the pressure is constant for all pressures. Applying data from Regnault's experiments to the formula deduced by the author, the values of the freezing point are practically the same as those given by Lord Kelvin. Hence it is thought probable that the discrepancies are due to inaccuracies in the experiments of Regnault, which were conducted at constant pressure. The value of the zero calculated from experiments on hydrogen at constant volume made by M. Chappius is, if we treat hydrogen as a perfect gas, 273·034. Applying a thermo-dynamic correction for the deviation of hydrogen from the laws of a perfect gas, the value of the freezing point becomes 273·19. This figure agrees very closely with the value 273·14 obtained by Lord Kelvin from the constant-pressure experiments on air. The correction has only been applied to hydrogen, because in this case it is so small that a large percentage error in its determination has a very small effect upon the absolute value of the freezing point. In constant-pressure work the experiments are difficult to carry out and the correction is easily applied, while in constant-volume work the experiments are easily performed and the thermo-dynamic correction is difficult to apply.

Prof. Gray expressed his interest in the manner in which Mr. Rose-Innes had obtained his results without using the experimental data of Joule and Kelvin, and pointed out that Lord Kelvin attached most importance to the results he had obtained for air. It would be useful to have the gas constants redetermined with greater accuracy. The compensating arrangement devised by Prof. Callendar would enable experiments at constant pressure to be carried out satisfactorily.

Dr. Lehfeldt drew attention to the sign of the correction applied by the author, and asked if it should not be negative instead of

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positive? He pointed out that variation in the specific heat of a gas might affect the formula, and said that Boltzmann had shown that it was impossible to determine an absolute temperature without introducing calorimetric measurements. As Joule and Kelvin had sometimes found positive and sometimes negative valves for the cooling effect in the case of hydrogen, large percentage errors might occur in the value of the correction.

Mr. Blakesley asked what the probable error was in the numbers given by Lord Kelvin?

Mr. Watson said that the author had calculated the value of the freezing point from experiments on hydrogen, and had shown that the result agreed closely with the value of the zero deduced by Lord Kelvin from experiments on air. He would like to know what agreement would be got by applying Mr. Rose-Innes's correction to the case of air.

Mr. Rose-Innes, in replying, said he agreed with Prof. Gray that it would be useful to have the constants redetermined. It was only in their early work that Joule and Kelvin observed a cooling effect for hydrogen, the bulk of the experiments giving a heating effect. The sign of the correction depended on the increase or decrease of the effect with temperature, and was positive in the case of hydrogen. Regnault has proved experimentally that the value of the specific heat is constant.

COMPANIES' MEETINGS AND REPORTS.

ELECTRIC AND GENERAL INVESTMENT COMPANY, LIMITED.

Directors: George Herring (chairman); J. B. Braithwaite, jun., Emile Garcke; B. H. Van Tromp.

Report of the directors, to be submitted to the tenth ordinary general meeting of the shareholders, to be held at Winchester House, Old Broad-street, E.C., on Tuesday, June 27, 1899, at 3 p.m.:

The profit and loss account shows a gross profit on the transactions of the year of £31,744. 7s. 1d., and after deducting all general charges and the interim dividend already paid on the ordinary shares, there remains a net balance of £25,450. Of this sum the directors propose to carry £11,450 to the contingencies fund. This will leave a balance of £14,000 available for distribution as follows: Ordinary shares—To the payment of a dividend of 5s. per share for the year ended May 31, 1899, of which 2s. per share was paid *ad interim* on Dec. 15, 1898, leaving 3s. per share to be paid, £3,000. To the payment of a bonus of 4s. per share for the year ended May 31, 1899, £4,000. Founders' shares—To the payment of a dividend of £30 per share for the year ended the 31st May, 1899, £3,000. To the payment of a bonus of £40 per share for the year ended May 31, 1899, £4,000. Total, £14 000. The trustees for the ordinary shares reserve fund propose to distribute to the holders of such shares a sum of 2s. per share out of the proceeds of investments sold and dividends received in respect of such fund, making with the above-mentioned dividend and bonus a total present distribution of 9s. per share, or 11s. for the year, on each ordinary share. The trustees for the founders' shares reserve fund propose to distribute to the holders of such shares a sum of £20 per share out of the proceeds of investments sold and dividends received in respect of the fund, making with the above-mentioned dividend and bonus a total distribution for the year of £90 on each founder's share. The directors retiring this year are Mr. J. B. Braithwaite, jun., and Mr. Emile Garcke, who, being eligible, offer themselves for re-election. The auditor, Mr. G. T. Rait, also retires, but offers himself for re-election. It is proposed to make the dividends payable on June 27, 1899.

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
General charges, including directors' fees, and additional remuneration as per articles of association, legal charges, advertising, printing, auditor's fee, etc.	4,294	7	1
Interim dividend of 2s. per share paid for the six months ended Nov. 30 1898	2,000	0	0
Net profit	25,450	0	0
	£31,744	7	1

Cr.	£	s.	d.
Interest, dividends, commissions, and sundry profits	31,744	7	1
	£31,744	7	1

Dr. BALANCE SHEET.	£	s.	d.
Capital subscribed, 20,000 ordinary shares	100,000	0	0
100 founders' shares	500	0	0
Capital called up, £1 per share on 20,000 ordinary	20,000	0	0
£5 per share on 100 founders'	500	0	0
	20,500	0	0
Provision for contingencies as at May 31, 1898	13 723	19	3
Sundry creditors	6,974	14	5
Unclaimed dividends	5	1	8
Balance of profit and loss account	25,450	0	0
	£66,653	15	4

Cr.	£	s.	d.
Investments at cost	63,159	7	9
Sundry debtors	700	14	0
Cash in hand and at bankers	2.793	13	7
	£66 653	15	4

TELEGRAPH MANUFACTURING COMPANY.

An ordinary general meeting of the shareholders in this Company was held last Friday at Liverpool, Mr. James Taylor, chairman, presiding.

The directors' first annual report showed a profit on the year's working of £28,271. 9s. 10d., being an increase of £7,485 over the profits stated last year in the prospectus. A dividend of 6 per cent. and a bonus of 2 per cent., free of income tax, for the period during which the capital of the Company has been paid up was declared, being in all at the rate of 8 per cent. per annum, leaving a balance of £5,161. 15s. 3d. to be carried forward.

The report was adopted.

Mr. J. S. Harmood Banner was elected a director in the room of the late Dr. J. Hopkinson. The re-election of auditors and a vote of thanks to the chairman closed the proceedings.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Hammersmith.—The Vestry invite tenders for the supply of transformers, etc., by July 5.

Barrow-in-Furness.—The Corporation invite tenders for an engine and generator by 28th inst.

Blackpool.—The Corporation invite tenders for the supply of coal, oil, and carbons. Tenders by 10 a.m. on June 20.

Woolley Collieries (near Barnsley).—Tenders are invited for an electric lighting plant, and fixing the same. For particulars and to view apply at the Colliery Offices.

Barrow-in-Furness.—The Corporation invite tenders for erection of extension to the existing electricity works in Buccleuch-street. Tenders by 12 noon on 28th inst.

Rathmines and Rathgar.—The Electric Lighting Committee invite tenders for the supply and erection of various plant for the municipal electricity works. Tenders by July 14.

Pembroke (co. Dublin).—The Electric Lighting Committee invite tenders for the supply and erection of various plant for the municipal electricity works. Tenders by July 14.

Cardiff.—The Corporation invite tenders for the purchase of a 40-kw. Paxman-Siemens steam alternator, 2,500 volts, 16 amperes, 40 periods, at 200 revolutions. Tenders by July 6.

Alcala la Real (Province of Jaen, Spain).—The Municipality require tenders for an electric lighting installation and the working of the same for three years. Tenders close June 25.

Kingston-upon-Hull.—The School Board invite tenders for the electric light wiring and fittings at the Central Higher-Grade School in Brunswick-avenue, Beverley-road, Hull. Tenders by 27th inst.

Grimsby.—The Corporation invite tenders for the supply, delivery, and erection, and the carrying out of various work in connection with the electric lighting of the borough. Tenders by noon on July 10.

Inverness.—The Highland Railway Company invite tenders for stores, including brass and copper plates, carriage fittings, telegraph instruments and fittings, and telegraph construction material. Tenders by 24th inst.

Dudley.—The Electric Lighting Committee invite tenders for: (Section A) water-tube boilers, economiser, etc.; (B) steam dynamos, balancers, and switchboard; (C) cables and other street work; (D) arc lamps, etc.; (E) travelling cranes. Specifications, etc., can be obtained from Messrs. Wilson and Story, 66, Victoria-street, Westminster, upon payment of £2. 2s. for each section, to be returned on receipt by the Council of a bona fide tender. Tenders by June 17.

RESULTS OF TENDERS.

Yarmouth.—The Council have accepted the tender of Mr. W. Cork, of Yarmouth, to erect the proposed rubbish destructor buildings, and a chimney shaft, 200ft. high, for £4,134.

London.—The London County Council have accepted the revised tender of the Private Wire and Telephone Installation Company, at £86. 9s. 5d., to do certain telephone work at the chief station.

Derby.—The tender of the London Crane Company, Slack-lane, Derby, of £195, for a crane, and the tender of Mr. Henry Vernon, £5,369, for building the superstructure of the engine-house and boiler-house at the electric lighting station, have been accepted.

Wolverhampton.—The Electric Committee have accepted the tender of Mr. J. O. Brettell, of Worcester, at £2,218, for the construction of a new battery-room at the works, and to recommend that the Council approve of Messrs. Dorman, Long, and Co., of Middlesbrough, as sub-contractors, under clause 12 of the general conditions.

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Grimsby.—The Corporation Public Lighting Committee have decided to recommend the acceptance of the tender of Messrs. Hewins and Goodhind, of Grimsby, for the erection of buildings and chimney shaft at a cost of £11,525. 2s. There were five tenders altogether—one from Stalybridge, another from Leicester, and three local ones—Messrs. Hewins and Goodhind being the lowest.

Blackpool.—The Tramways Committee have received the following tenders for the construction of 10 bogie tramway cars: Midland Railway Carriage and Wagon Company, Limited, Abbey Works, Shrewsbury (accepted); Lancaster Railway Carriage and Wagon Company, Limited; Ashbury's Railway Carriage and Iron Company, Limited; Hurst, Nelson, and Co., Limited, Motherwell.

Hereford.—The following contracts have been entered into: Messrs. W. P. Lewis and Co., buildings, £2,752, works to be ready for engines, etc., by Aug. 10, and to be completed by Sept. 18; Messrs. Alexander and Duncan, iron roofing, £394. 17s., to be completed by July 21; Silvertown Company, £11,230. 12s. 5d., for dynamos, engines, boilers, and installation generally, to be completed by Oct. 1, or two months after buildings are ready for engines.

BUSINESS NOTES.

Morley.—Mr. Herbert Drewett has been appointed borough electrical engineer.

Lages.—The Government is to be asked to provided electric light at the post office.

Brierley Hill.—It is stated that the electric trams will be running on or about July 4.

Londonderry.—The Corporation are about to apply for a loan of £20,000 for electric lighting.

Fareham.—The Electric Light Committee propose to increase the salary of the electrician (Mr. Arthur Blake).

Burton-on-Trent.—The Local Government Board have sanctioned the borrowing of £10,600 for electric lighting.

Maidstone.—The estimate for the proposed electric scheme is £22,319 for lighting and £4,275 for refuse destructor.

Hyde.—The Town Council have decided to make application to the Board of Trade for a provisional electric lighting order.

Ilfracombe.—Mr. Trentham has been asked to prepare plans for the provision of an electric light installation for the town.

Scarborough.—After much discussion the refuse destructor question has been settled by the adoption of the old gaol site.

Buckinghamshire.—A local company proposes to obtain powers for the construction of an electric tramway through the Wycombe Valley.

Kingston.—The Guardians have decided not to accept the offer of the Kingston Corporation to supply the electric light to the workhouse.

German Atlantic Cable.—The steamer "Britannia" has arrived at New York after completing soundings for the new direct German Atlantic cable.

Morecambe Electric Launch Company.—The first of the new electric launches has reached Morecambe, and made a series of trial trips over the bay.

Lincoln.—The Electricity Works Committee's report is in favour of the construction of tramways to be worked by electricity on three separate routes.

Perth.—The Electric Lighting Committee have decided to arrange for acquiring the site selected by Mr. Hawtayne for the proposed supply station.

Keighley.—The Town Council have now approved the Gas Committee's proposition that they be empowered to appoint an electrical engineer at a salary not exceeding £300 a year.

Whitehaven.—The Electric Lighting Committee of the Town Council have decided to recommend the appointment of Mr. Scott, of Bradford, as electrical engineer for the borough.

New Issue.—The National Telephone Company, Limited, are making an issue of £263,000 3½ per cent. debenture stock, being balance of an amount which is limited to £2,000,000.

Leatherhead.—Upon enquiry it has been found that the number of intending customers for the proposed electric light is not sufficient to warrant the Council proceeding at present.

Electric and General Investment Company.—The transfer books and register of members of the company will be closed until June 27 for the purpose of preparing the dividend warrants.

Barnet.—The North Metropolitan Electric Power Distribution Company have allotted 3,000 shares of £10 each, one-half of which is intended to be applied to the carrying out of the Barnet order.

Eccles.—The Electric Lighting Committee propose very shortly to recommend the Council to carry out a further extension of the plant in order that the whole district might be supplied with electricity.

St. Marylebone.—At last night's meeting of the Vestry it was proposed to concur with the memorial to the Treasury in favour of the telephone service being undertaken by the Post Office authorities.

Royal Electric Company of Montreal.—The directors announce a dividend of 2 per cent. for the quarter ended 31st ult., being at the rate of 8 per cent. per annum, payable on and after 3rd prox. to shareholders on the register on 31st ult.

Hendon.—Mr. Robert Hammond's scheme on the proposed electric lighting will come before the Council by the middle of next month. Delegates have been appointed to attend a conference in connection with the proposed light railways.

Ilford.—A deputation of the members of the Ilford (Essex) Urban District Council have made an inspection of the Kidderminster tramways, and expressed their approval of the system as being the most suitable to their proposed line.

Plymouth.—We learn that the electric lighting works are so far completed that at the end of the present week the fires will be lighted, and when the results of the trials are known steps will be taken to open the works at an early date.

Barrow.—The borough electrical engineer's report states that the extra applications for supply of electricity received since his last report would practically exhaust the capacity of the existing works when all the applicants had been connected.

Appointments Vacant.—Two physical laboratory assistants are required at the Northampton Institute, Clerkenwell. Particulars of this and other vacancies, including motor inspector, switchboard attendant, engine-driver, etc. will be found in another column.

House-to-House Electric Light Supply Company, Limited.—The transfer register of the 4½ per cent. mortgage debenture stock of this Company will be closed from the 21st to the 30th inst., both days inclusive, for the preparation of warrants payable on July 1.

Nernst Electric Light, Limited.—The statutory meeting of this Company will be held at their offices on Wednesday, June 21. The chairman and directors of the company entertained Prof. Nernst and Madame Nernst at a dinner given at the Hotel Cecil last week.

Bradford Telephones.—The council of the Chamber of Commerce on Wednesday passed a resolution advocating municipal control of telephones, and approving of the Government proposals (including the Telegraphs Telephonic Communication Bill, 1899).

Rochdale.—The Electric Lighting Committee have instructed Mr. Duncan, of the firm of Butterworth and Duncan, architects, Rochdale, to prepare a plan for the boiler, engine-house, and chimney required for the installation of electric light at the workhouse.

City of London Electric Lighting Company, Limited.—The transfer books and register of holders of debenture stock of this Company will be closed from 15th to 30th inst., both days inclusive, for the purpose of preparing the warrants for the interest due July 1, 1899.

Tyneside Electric Power Company, Limited.—This Company has been registered with a capital of £100,000 in £10 shares, and the object is to carry on in the Tyneside district and elsewhere in Northumberland the business of electricians for the purposes of light, heat, or power, etc.

Sheffield.—A final distribution of assets of the electric power company has resulted in a dividend of 9s. When the Corporation completed the purchase a distribution of £17. 10s. per share was made to the shareholders. They have thus received £17. 19s. in respect of every £7 share.

Castleton.—The Council will support the British Electric Traction Company, Limited, in their application to the House of Commons *re* the Oldham Corporation Bill, the object of the application being to secure that the company shall have running powers into the borough of Oldham.

Cheltenham.—The electric lighting of Queen's and Lansdowne roads is now complete. The Whish fountain and the Gordon Memorial lamp remain to be treated. Mrs. Disney Thorpe has expressed her willingness to bear the entire expense of the installation at the Gordon lamp.

St. Pancras.—The ballot taken at the Vestry's meeting on Wednesday night for the election of an inspector of works in the electricity public lighting department, resulted in favour of Mr. Harold McNight Sillar, at present engaged in the electrical department, Great Central Railway.

The "Electric Horse."—A first meeting of creditors was held on Tuesday in the matter of Jules Kelsey, otherwise Inge, who was the plaintiff in a recent libel action in which he recovered ½d. damages without costs. The unsecured liabilities were returned at £17,259, with assets of small amount.

Yarmouth.—The Town Council have resolved to reduce the charge for electric current to 6d. per unit for the first hour and 4d. per unit per hour after; to adopt the maximum demand indicator; to borrow £27,000 for extension of electric lighting plant, and to spend at once £4,000 on part of such development.

Edinburgh.—At a meeting of the Electric Lighting Committee of the Town Council on Wednesday it was resolved to recommend the acceptance of estimates in connection with the Dewar-place power station as follows: for the extension of the boiler-house, about £5,000; and for the supply of fans, etc., about £4,000.

London Electrical Fittings Company, Limited.—This Company has been registered with a capital of £3 000 in £1 shares, and the object is to enter into an agreement with A. G. Hopkins W. B. Hopkins, M. H. Galsworthy, and S. S Galsworthy, and to carry on the business of electrical fittings manufacturers, etc.

Southampton.—The Tramways Committee of the Corporation have received several tenders for the supply of motors for the electric tramways at Southampton, and a report will shortly be made to the Council on the subject. It is stated as probable that electric traction will be in operation at Southampton in October.

Halifax.—A Tramways Sub-Committee visited Hebden Bridge, Stainland, and Elland last week to view proposed extended routes for the Corporation tramways. They also inspected Parkinson-

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lane and Hopwood-lane, within the borough, to consider the desirability of constructing branch tramways in those directions.

London Gazette.—The first meeting in the estate of Alec Gavan Inrig (trading as the Globe Electrical Company), 46, Whitepost-lane, Victoria Park, has been fixed for the 21st inst., 12 noon, at the Bankruptcy-buildings, Carey-street, W.C. The public examination will take place July 20, at 11.30, at the same place.

Southport.—The report of the fourth year's working of the electricity estate just issued shows a net profit of £2,027, as against £643 the previous year, and it is being disposed of as follows: £620 in aid of rates, £203 to wipe off a disallowance by the Local Government Board, and £1,024 in the reduction of capital.

Cromer.—The Council have adopted a report recommending them to establish electric lighting works for the district, and to proceed with the scheme forthwith. The custom of about 1,000 lamps for 32 houses has been promised. Mr. Cozens-Hardy, of Messrs. O'Gorman and Cozens-Hardy, has been consulted in the matter.

Darlington.—Mr. W. O. E. Meade-King, C.E., has held an enquiry into the application of the Corporation for power to borrow £30,000 for the purpose of electric lighting. The Town Clerk stated that it was not intended at the outset to spend the whole of the £30,000; £4,215 would be left for future extension.

Worcester.—The Council intend to apply to the Local Government Board for sanction of a loan of £3,000 for payment of the cost of the extensions of electricity mains already ordered, including the proposed extension along the Henwick and Hallow roads, and the outlay on transformers and house and service connections.

Derby.—Mr. J. T. Boothman has been engaged as clerk of the works for the new buildings at the electric lighting station. The Tramways Committee have under consideration a joint report of the borough surveyor and electrical engineer upon electric traction, and are visiting and inspecting the tramway systems adopted in other towns.

Canterbury.—Tenders for the foundation works and boiler settings and flues are to be advertised locally, also for trenching and relaying for the cable extension work. At present 3,415 8-c.p. lamps are connected, representing 125 private consumers. The additional cable for the extension scheme is expected to arrive within the next few days.

Klein Engineering Company, Limited.—With regard to water cooling for condensing purposes, we are informed that the above Company have now in hand cooling plants for the City and South London Electric Railway (3,000 i.h.p.), and for the Bournemouth, Chatham, and St. Helens electricity works, besides a number of others for electrical plants.

Brighton.—As a consequence of the Continental trip of the Corporation's Tramway Committee, the Corporation was to be asked last night to promote a Bill in Parliament for electric tramways practically covering the whole of the borough with trams on the overhead trolley system. A double track is to be provided wherever practicable.

Leeds.—The Tramways Committee are progressing fast with the completion of the installation of the electric system over the Headingley-Chapeltown route. Of the surplus profit on the working of the trams for the year ended March 25, which has been £12,030. 14s. 10d., a sum of £4,000 has been reserved for renewals of electrical equipment.

Farnham.—At the last meeting of the Urban District Council a question arose out of the minutes in respect to electric lighting and the fixing of a special meeting to consider it. The Chairman said that, as the gas company's Bill was soon coming on, he thought it would be better to postpone the matter until the next meeting. This course was agreed to.

Leamington.—At the monthly meeting of the Town Council on Monday the Town Improvement Association forwarded a protest against the adoption of the overhead system of electric traction for the local tramways. It was stated that the Council had already condemned overhead wires, and the communication was referred to the Tramways Committee.

Caversham.—The Urban District Council have agreed to consent to the Reading Corporation constructing the tramway from Caversham Bridge to the Star Inn, Lower Caversham, and from the bottom of Prospect-street to the Black Horse Inn, Emmergreen, with an additional recommendation that Hemdean-road to Priest-hill should be included in the route.

Harrow and Uxbridge Railway.—The Select Committee of the House of Commons presided over by Mr. A. de Tatton Egerton have concluded the consideration of this Bill, and have passed the preamble subject to an arrangement being come to between the Metropolitan Railway Company and the District Railway Company, the guarantors under the original Bill for the line.

Walker.—With regard to the Walker and Wallsend Gas Company's Electric Lighting Bill, the Select Committee of the House of Commons have decided that the preamble of the company's Bill was proved with respect to all places proposed to be supplied, except Walker. They also confirmed the order of the Board of Trade with respect to the Walker Council's scheme.

Blackpool.—The maximum charge for electricity will be reduced from 8d. to 7d. per unit from July 1 next. It is stated that Mr. Quin, the electrical engineer, expects to still further reduce the working expenses, and consequently to reduce the charges to consumers. The Tramway Committee have ordered 10 new cars. The tramway manager's salary has been increased by £20 per annum.

Ilkeston.—The minutes of the Tramways and Electricity Committee adopted last week showed that the Ilkeston Electric Supply Provisional Order Confirming Bill passed the Unopposed Committee of the House of Commons without amendment on May 18; also that a similar Bill with respect to the tramways was on May 3 introduced into the House of Lords and read the first time.

Helios Company.—With regard to a note in our issue of 2nd inst. referring to this Company, we are informed that they have been engaged in the construction and installation of electric traction lines for some years past, and have already several important lines on the Continent running, and others are being completed. The present acquisition is therefore only an extension of their traction department.

Stock Exchange.—Applications have been made to the Stock Exchange Committee (1) to appoint a special settling day in and to grant a quotation to British Mutoscope and Biograph Company, Limited, 250,000 ordinary shares of £1 each fully paid; and to appoint a special settling day in Charing Cross and Strand Electricity Supply Corporation, Limited—further issue of 20,000 ordinary shares of £5 each.

Yeadon.—The joint committee of representatives of the Horsforth, Rawdon, and Yeadon Councils are considering a letter from Messrs. Greenwood and Batley, Limited, of Leeds, stating that it is their intention to apply for a provisional order for the construction and working of an electric tramway to connect the townships of Guiseley, Yeadon, Rawdon, and Horsforth with the Leeds system of tramways.

Middleton.—The Town Council will shortly consider a resolution that application be made to the Board of Trade for a provisional order authorising the Council to construct tramways that will connect with the Manchester line. The borough surveyor is preparing plans, sections, and estimates of the proposed tramlines from the fountain to the Manchester city boundary, along the New-road, and from the railway station to the New-road.

Crewe.—The Crewe Co-operative Friendly Society, Limited, intend to carry out the electric lighting of their principal premises independently of the Corporation, but the latter are averse to granting any easements over the public streets, and have again suggested to the Co-operative Society that they should arrange to take their current from the borough scheme, for which the Local Government Board have sanctioned loans of £24,200 and £1,800.

Oswestry.—The Town Council on Tuesday resolved to acquire the Oswestry Electric Light Company's undertaking at a sum not exceeding £11,750, the price asked by the company. Mr. Hawtayne, who had been called in by the Council, valued the property at £8,250. A poll of the ratepayers was demanded, the price being declared too high by some of the members. (A note referring to this matter was inadvertently inserted under "Shrewsbury" in our last issue.)

Twickenham.—The Light Railway Commissioners held their enquiry on the 12th inst. into the order deposited by the London United Tramways Company, Limited, for the construction of a series of light railways in the Thames Valley. They have decided that as the lines were laid out to compete with the London and South-Western Railway, it was a scheme which ought to be considered by Parliament. So far as the Commissioners are concerned, the order will not, therefore, be sanctioned.

Iron and Steel Institute.—The meetings on Aug. 15 and 16 will be held in the Town Hall, Manchester, and the programme includes visits to the Lancashire and Yorkshire Railway Company's works and foundry at Horwich, to Simon-Carves coke ovens at Barrow and Wharncliffe Collieries, the Manchester Ship Canal, receptions by the Lord Mayor of Manchester and the Mayor of Salford. The latter takes place on the 17th. For the 18th excursions are planned to Chatsworth and Crewe.

Hereford.—The Electric Light Committee of the Town Council have received 54 applications for the post of electrical clerk of the works, and the same are now under consideration. The committee are now taking steps to ascertain what persons are prepared to take the electric current, and they are willing at the time they are laying the mains to put in the necessary wires to consumers' own premises free of cost, but any subsequent connections will have to be made at the expense of the consumer.

Wolverhampton and South Staffordshire Illustrated.—We have received a profusely and beautifully illustrated pamphlet containing biographical and commercial sketches of the industries and manufactories of the district, published by Messrs. Robinson, Son, and Co., Chancery-lane. The Bushbury engineering works of the Electric Construction Company, Limited, come in for a fair share of the contents, a ground plan of the works and a number of views of their various shops being included among the illustrations.

Batley.—A Corporation committee have under consideration a plan which includes the purchase of a portion of the rights of the company who now run steam cars between Dewsbury and Gomersal; also arrangements with the neighbouring authorities for the working of all or part of the existing lines. The adoption of the overhead electric system of traction is favoured, and it is proposed to provide the requisite current from an electrical generating station large enough to supply electricity also for private and public lighting.

Bath.—The Electric Tramways Committee have decided to oppose the application made by a company to inaugurate a tram service in the town, and will recommend the Council to themselves

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apply for an order in November next. The promoters will be granted an interview, provided that they first answer certain questions as to what is proposed to be done. A committee has been appointed to formulate these questions. The Monkton Coombe Parish Council have passed a resolution in favour of the promoters' proposal.

Bury St. Edmunds.—It appears that the Local Government Board, at the instigation of some ratepayer with a grievance, has asked the Town Council why they have taken part of a former playfield for the electric station site. The town clerk has been directed to remind the Local Government Board that the site of the proposed works was viewed by their inspector at the time of the public enquiry upon the application of the Council for the loan for electric purposes, and was approved by him. This will probably settle the matter.

Torquay.—Application is to be made to the Local Government Board for sanction to borrow £10,000 for electric light extensions. Private lighting has increased from 3,310 8-c.p. lamps in March of last year to 5,644 last month. There are now 140 consumers, not including applications from 15 consumers for 529 more lamps. During the 12 months ending March 31 80,490 units were used for public lighting, 67,909 for private lighting, and 12,282 expended on excitation. The revenue amounted to £2,839, and the costs of working to £1,781, leaving a gross profit of £1,057.

British Columbia Electric Railway Company.—The report for the year ending March 31 shows a gross profit amounting to £30,188. From this the directors have paid the debenture interest and the 6 per cent. dividend due on the income bonds up to the date of redemption. Including £208 brought forward, the accounts show a net balance of revenue of £16,575. The directors have decided to pay a dividend of 4 per cent. per annum (free of tax) on the ordinary shares. A further 20 per cent. has been written off the preliminary expenses, and the reserve fund increased to £12,000.

Hull.—In consequence of the near completion of the electric tram system the chairman and vice-chairman of the Finance Committee of the Corporation and the chairman of the Tramway Sub-Committee have been appointed to consider the question of the staff, and the treasurer and accountant will visit other cities and towns where a similar electric system is in operation to ascertain the most perfect system of keeping the accounts. The Corporation have made £3,660 net profit on the electricity works during the year, after payment of interest on loans and repayment of capital.

Elmore's Trust, Limited. — This Company has now been registered with a capital of £400,000 in £1 shares, and the object is to acquire as going concerns the businesses of Elmore's Wire Manufacturing Company, Limited, Elmore's American and Canadian Patent Copper Depositing Company, Limited, Elmore's Patent Copper Depositing Company, Limited, Elmore's Foreign and Colonial Patent Copper Depositing Company, Limited, or any of them, to adopt and carry into effect certain agreements with the above-mentioned companies for the sale to the English Metallurgical Company, Limited, etc.

Manchester Steam Users' Association.—The annual memorandum of Mr. E. Stromeyer, M.I.C.E., the chief engineer of the association, deals with matters of general and technical interest, such as the moral responsibility resting on owners of steam-boilers even after they have insured them; the best type of boiler for any particular service; some experiences as regards causes of boiler explosion, more particularly the influence in this respect of last year's dry weather; an exhaustive analysis of over 200 furnace collapses and experiments, including experiments made by the German Admiralty, which we believe have not been previously published in this country.

Sheffield.—Mr. T. J. Ballard, of the Wandsworth Electric Lighting Company, has been appointed superintendent of mains in the place of Mr. A. Lucas, resigned. The committee have asked Mr. Robert Hammond to report fully as to whether there is at present in existence any system for the supply and distribution of electricity applicable to the city of Sheffield which would, having regard to the capital expenditure already incurred, and to all the other circumstances of the case, be more advantageous than the system now in operation, or whether any modification of the existing system of supply is advisable and practicable, and, further, on what lines the future development of the undertaking should proceed.

Lancashire.—A conference of representatives of Radcliffe, Whitefield, and Little Lever District Councils has been held to consider the provision of electricity for lighting the three townships and for traction purposes. The conference was attended by representatives of a London syndicate, who propose to lay an electrical tramway connecting Whitefield, Radcliffe, Little Lever, Farnworth, and Worsley with the Manchester Ship Canal at Barton Bridge. It was decided that the Radcliffe Council should prepare a rough scheme for the supply of electricity for lighting and traction purposes for their own locality, Whitefield, and Little Lever, and that the London syndicate should provide further details of their proposal.—*Manchester Guardian.*

Beckenham.—The surveyor has been authorised to proceed with the construction of a culvert, roadway, etc., in preparation for the electric lighting station, and terms are being arranged with the South-Eastern Railway Company for a siding from the Mid-Kent Railway on to the electric lighting premises. The Local Government Board's sanction to a loan for the electric lighting is expected shortly. The British Insulated Wire Company have made arrangements with the Bromley Electric Light Company for a temporary supply of electricity for South Hill Park, and have been asked to make arrangements for a temporary supply to certain other parts of Shortlands and Beckenham, as many residents have wired their houses and would like the light as soon as possible.

Bordeaux Tramways and Omnibus Company, Limited.—At the nineteenth ordinary general meeting held on Monday, Mr. Egerton W. Ruck, who presided, stated that the decree approving the substitution of the new French company for this Company in the concession was signed on the 15th ult. by the President of the French Republic. This Company was, therefore, now enabled to go into liquidation, and distribute the funds representing the purchase price of the various assets. Since the sale of the undertaking the Municipality of Bordeaux had granted permission to the new company to work the line by electric traction, and the extension of certain new lines had also been authorised. In addition, the concession had been prolonged till the end of 1929.

Wolverhampton.—A House of Lords Committee, the Duke of Northumberland presiding, have passed the preamble of the Wolverhampton Corporation Tramways Bill, the object of which is to authorise the making, improving, and altering of tramways inside the borough boundaries of Wolverhampton, to acquire, alter, and improve tramways outside the boundaries, and to work the whole by electrical power. The Local Government Board have sanctioned powers for the Corporation to borrow another £28,870 for extending the electric lighting works and cables for both public and private lighting. The committee's report for the year ending last March shows a profit of £1,004, and that 19,900 lamps are in use for public and private lighting. The large business establishments in the town are being gradually connected with the system, and customers are rapidly increasing in number.

South Staffordshire Tramways.—A House of Lords Committee, over which the Duke of Northumberland presided on Thursday last week, considered the South Staffordshire Tramways Bill. Mr. Balfour Browne, Q.C., who appeared with Mr. Worsley Taylor, Q.C., and Mr. Moon for the promoters, stated that the Bill did not give power to construct any further tramways. It was promoted by the British Electric Traction Company, although in the name of the South Staffordshire Company. After hearing evidence, the Chairman announced that the committee were of opinion that so much of the Bill as deprived the local authorities of any power they now enjoyed in their districts was not proved, and the committee had decided not to give costs. He supposed Mr. Balfour Browne would now take his Bill back and alter it. Mr. Balfour Browne assented to this course, and the amended Bill is to come up for consideration shortly.

Ealing.—The report of the Electric Lighting Committee, adopted by the District Council last week, recommended that the following clause be added to the conditions for the supply of current: "The energy shall be supplied continuously day and night throughout the year, but the Council will not be responsible for accidental interruptions or defects, or other inevitable cause, but shall use all reasonable diligence in restoring the supply as soon as possible. The Council also retain the right to discontinue the supply for such short periods as may from time to time be necessary for the purpose of connecting other consumers to their system or of carrying out repairs or alterations to their plant or mains." It also stated that since the last meeting of the committee applications had been received for 107 8-c.p. lamps to be connected, making a total of 23,954 applied for, of which number 23,356 have already been connected.

Cardiff.—On Monday several resolutions of the Council, passed in 1897 and 1899, sanctioning the doubling of various tramlines, were rescinded. It was stated that the company had not proceeded with the work, that the Corporation would get the lines in their own hands in 1901, and that the latter would save great expense over their feeder main by laying that down before the lines were dealt with. The recommendation of the Health Committee that the new sanatorium buildings should be lighted with gas was referred back to the committee. The borough engineer's report on the comparative cost stated that electricity would cost £400 a year more than gas. That, however, is based on the sanatorium providing its own installation. Another recommendation which was referred back was to the effect that the most experienced fitter in the employ of the Corporation at the electrical works be engaged on trial for one month to carry out the duties of electrician under the charge of the electrical engineer.

London County Council.—At Tuesday's meeting it was agreed to hold a special meeting on July 18 for the purpose of considering the advisability of applying for a provisional order to construct 16 new tramways, and double others in other parts of London. A recommendation of the Highways Committee was adopted to the effect that, in consequence of the refusal of the representatives of the Middlesex County Council to agree to a joint committee on the light railways question, the negotiations should be terminated, and the following resolution was carried: "That it be referred to the Highways Committee to investigate and report to the Council as to the practicability of constructing a shallow underground electric tramway from Westminster (*viâ* Parliament-street, Strand, Fleet-street, and Cheapside) to the Bank, thence under Moorgate-street to the terminus of the North Metropolitan Tramways Company at Finsbury-pavement, on a similar principle to those laid under Andrassy-strasse, Budapest, and in Boston, U.S.A., provision being made beside the tramlines for suitable subways to contain gas and water mains, electric light mains, telephone wires, etc."

Tottenham.—Mr. W. Dawson, surveyor to the Leyton Urban District Council, in his report on the three dust destructor schemes, directs attention to the fact that, notwithstanding Clause 3 of the instructions, that a motto or *nom de plume* shall be made on the

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drawings, specifications, and estimates, the specification of design No. 2, "Intensifier," is headed in such a manner as to designate the author, and is consequently not in compliance with the Council's instructions, and if disqualified "Algebric" would take second place. After reporting fully on the merits of each scheme, Mr. Dawson states: "I should hesitate before adopting any of the designs submitted." The committee had given very full consideration to the whole subject, but are unable to advise the Council to adopt either of the schemes submitted, and therefore recommended: "That the scheme 'Intensifier' be disqualified for non-compliance with the instructions laid down. That the premiums be apportioned as follows—viz., No. 1, 'Smokeless,' £25; No. 2, 'Algebric,' £15. That all well-known firms designing or constructing refuse destructors be invited to send in schemes, together with probable estimates of the cost, in accordance with the requirements, conditions, and instructions laid down by the Council's engineer." The report has been adopted.

Huddersfield.—The *Leeds Mercury* says apparently the townships of Kirkburton, Holmfirth, Linthwaite, Slaithwaite, and Marsden, all well within a dozen miles' radius of Huddersfield, feel flattered at the proposals of the Huddersfield Corporation to work tramways in connection with these places. Holmfirth and Kirkburton have, by a vote in their respective Urban District Councils, placed on record resolutions in favour of the extensions; Linthwaite has already applied to the Board of Trade for powers to lay down the lines; and the Slaithwaite Urban District Council have now appointed a deputation to wait upon the Marsden Council to confer as to the latter's intention to construct a line to be worked by the Huddersfield Corporation. From Huddersfield to Kirkburton is about six miles, to Holmfirth seven, and to Marsden eight miles, with Linthwaite and Slaithwaite at intervals in that distance. In the event of the scheme being sanctioned, there is little doubt that the more modern system of electricity will be adopted.—Major Cardew, R.E., held an enquiry on Tuesday into an application of the Corporation for power to borrow £47,782 to enable them to erect a power station and to electrically equip three sections of tramway, one of which has been already constructed, and the other two of which are to be made. Mr. F. C. Lloyd, town clerk, gave the following particulars: power station, £8,000, with 30 years in which to repay; equipment, plant, etc., £17,120, 25 years; equipment of routes, £11,162. 2s. 4d., 25 years; 23 cars, £11,500, 15 years—total, £47,782. 2s. 4d. The details of the scheme were given by the town clerk and the borough engineer (Mr. K. F. Campbell).

Newington.—At the last meeting of the Vestry the Electric Lighting Committee reported that the electric lighting station was inspected on June 3 by the members of the Vestry. Notwithstanding the delay which has arisen in the completion of the works, a general feeling of satisfaction prevailed that the station, as arranged, was capable of providing machinery and plant to meet all reasonable requirements of the parish. The testing of the street-lighting would take place within the next fortnight, and there was no reason why the current should not be ready to be switched on to the arc lamps and to private consumers by the end of the month or within a period of two years of the Vestry receiving parliamentary sanction to their order. The question of a public opening had been the subject of a conference between the clerk and the consulting engineers, the result being that the engineers had submitted to the committee an invitation to the Vestry to dine with them. The engineers were willing out of their commission, and the contractors out of their profit, to subscribe, and, in fact, pay for the expenses of a dinner to celebrate the opening, provided the committee and the Vestry would sanction such a celebration, the Vestry bearing the expense of sending out the invitations and providing the floral decorations should the dinner be held within the parish. The committee recommended: "That the Vestry accept the invitation of the respective contractors and consulting engineers to a dinner to celebrate the opening of the electric lighting station." The Vestry, however, decided to decline the invitation. At the invitation of the Electric Lighting Committee a large number of the inhabitants of the parish inspected the new electric lighting station on Saturday afternoon last. The station, which adjoins the Vestry's depôt, contains plant capable of supplying 10,600 8-c.p. lights and 90 arc lamps. The light is to be ready for switching on by the 22nd inst. The work has been carried out at a cost of £50,000. The consulting engineers are Messrs. Kincaid, Waller, and Manville, and the engineer-in-charge is Mr. J. Rutherford Blaikie.

Parliament.—In the House of Lords during the past week the Great Grimsby Street Tramways, North-Eastern and Hull and Barnsley Railways (Joint Dock), and North-Eastern Railway Bills were read a third time and passed. The following Bills were read a second time: London, Chatham, and Dover Railway, Great Western and Great Central Railway Companies, London, Brighton, and South-Coast Railway (Various Powers), Manchester Corporation (General Powers), North Pembrokeshire and Fishguard Railway, and Uxbridge and Rickmansworth Railway. The Royal assent was given to commission to a number of private Bills and provisional order Bills. In the House of Commons the following Bills were read a second time: Moss Side Urban District Council Tramways, Stretford Urban District Council Tramways, Weston-super-Mare, Clevedon, and Portishead Tramways, Whitehaven Corporation, Whittington Urban District Council Tramways, Port Talbot Railway and Docks, Salford Corporation, Wakefield Corporation, Great Northern Railway, Sunderland Corporation, Brighton Marine Palace and Pier, Furness Railway, and the Paisley and Barrhead District Railway. The following Bills were read a third time: Dublin Corporation, London and North-Western Railway (New Railways), and the Stockport Corporation. The City and Brixton and the Blackpool Improvement Bills were considered and ordered for third reading. The Grimsby Street Tramways, North-Eastern and Hull and Barnsley Railways (Joint Dock), Mansfield Electric Lighting Order, and Wath-upon-Dearne Electric Lighting Order were ordered to be reported to the Upper House for second reading. The Court of Referees of the House of Commons presided over by Mr. Green, M.P., have refused to allow the Bury Rochdale, and Oldham Tramways Company to appear by counsel against the Bury Corporation Bill. The Great Northern Railway Company have deposited in the Private Bill Office of the House of Commons a requisition for leave to withdraw their opposition to the Derby Corporation (Tramways, etc.) Bill. The Ilkeston Corporation Tramways Bill was certified for second reading by the Examiners of the House of Lords. The Glossop Electric Lighting, the Hartlepool Electric Lighting, and the Tudworth and Mellor Joint Sewerage District Provisional Orders were ordered to be reported for second reading in the House of Lords.

Tunbridge Wells.—A debate ensued at the Council meeting last week upon the question whether the consumers were being charged too much, and whether the committee were making far too much profit. It was said the consumers had increased to 419, but they might have increased still more if the charges had been more reasonable. The committee were now introducing a third meter. The gross profit had gone up to £3,044 last year, while there was £887 net profit from 236 customers in 1897, and £1,632 profit from 316 customers the succeeding year. The big profit was made out of the private consumers, who were also buying the plant in a period of 25 years as a gift to the town. The minimum charge, it was said, was a great injustice, and to abolish it would be a very slight loss to the committee. An amendment that the committee be instructed to consider a reduction in the charge of current was accepted by the committee. The following comparative statement was submitted:

	1896 (6 months).	1897.	1898.
Consumers	102 ...	236 ...	316
Income	£1,032 0 0 ...	£3,393 0 0 ..	£4,703 0 0
Gross profit	738 0 0 ...	2,160 0 0 ...	3,044 0 0
Net profit.	738 0 0 ...	887 0 0 ...	1,632 0 0
Average charge per consumer	10 2 4 ...	14 7 6 ...	14 17 8
Average net profit per consumer ...	7 4 8 ...	3 15 2 ...	5 3 4
Average percentage on above.....	71 ...	26 ...	34

A complaint having been made as to the smoke nuisance from the electric lighting station, Mr. Boot said they were using nothing but the best Welsh smokeless coal. The demand on the works varied to such a great extent that it was impossible to avoid smoke. They were now using coke with the coal, although the coke did very great harm to the boilers. The smoke was really very thin, and was only due to the horse-power having to be suddenly increased between six and eight o'clock. At other times of the day there was no trouble, and all the time the load was constant there was no trouble. Engineers were only too anxious to have a smokeless furnace, because it meant more economy. The new shaft would be carried higher.

Islington.—At the last meeting of the Vestry, the Electric Lighting Committee reported upon the advisability of adding condensers to the steam generating plant at the electric lighting station, stating that the engineer has advised the committee that considerable economy would result if condensing plant was utilised, and has estimated that the cost of the necessary appliances complete, including surface condensers capable of condensing 20,000lb. of steam per hour, including air and circulating pumps, accessories and erection, cooling tower, with all accessories complete, steam and exhaust pipes, valves, fittings, connections, bot-well, etc., as well as the alteration to the existing pipes with contingencies, would be £4,000; that the engineer has also estimated that the saving which would be effected would not be less than £800 per annum, or 20 per cent. clear upon the capital expended. The committee therefore recommended that the scheme be adopted, the cost to be defrayed by a loan." This was agreed to. A further report from the committee recommended that two tubular wells be sunk to a depth of 500ft. each, and two pumps procured for the same with engine, fixing foundations, steam and other pipes and contingencies, at a total cost of £2,750. The engineer pointed out that last year the consumption of water at the electric lighting station was 8,500,000 gallons, and this year it would probably reach 16,000,000 gallons, for which they would have to pay 8d. per 1,000 gallons. An amendment to defer consideration of this report for six months was carried. At the meeting to-day the Electric Lighting Committee will present a report stating that Mr. Robert Gordon has been reappointed as chairman and Mr. Thomas Walter Vine as vice-chairman of the committee for the year ensuing; and that the salary of Mr. Yeaman, the assistant electrical engineer, be increased to £250 per annum as from March 25, 1899, and by two further increments of £25 each at Lady-Day, 1900, and Lady-Day, 1901. With regard to the proposal of the Vestry of St. Pancras giving notice that on and after June 24 next they propose to lay mains in the Brecknock and York roads in the parish of Islington for the purpose of supplying electric current to consumers in the parish of St. Pancras, the committee have deemed it necessary to refer the matter to the vestry clerk and the solicitor with instructions to obtain an injunction probiting the work being commenced or to take such steps as may be necessary for preventing the Vestry of St. Pancras from interfering with the roads in this parish.

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Glasgow.—The Sub-Committee of the Tramways Committee of the Corporation have conferred with a deputation from engineers and boilermakers in the district, who pointed out the difficulty of passing large boilers underneath the trolley wires used in connection with the electric tramways. The sub-committee stated that if the various firms who are interested would sketch out the route from their works to the quay, arrangements would be made for disconnecting the wires when necessary, so that the boilers might pass. The Streets Electric Lighting Sub-Committee have received an offer from the Electricity Committee offering to supply current for street lamps at the rate of £14 per lamp for all-night lighting, or £12 per lamp up to 11.30 p.m., provided that the minimum number of electrically-lighted street lamps in the city be raised to 400. Mr. Hamilton, the inspector of lighting, is preparing a report on the requirements of the leading thoroughfares, with a view of the extension of the system. We learn from the *Glasgow Herald* that the Corporation on Tuesday approved of the minutes stating "that a sub-committee of the Electricity Committee recommended that, in the event of the Watching and Lighting Committee resolving to light certain thoroughfares referred to with arc lamps, a supply of current should be given for double-carbon lamps similar to those recently erected along the Springburn tramway route (which burn for 40 hours without retrimming, and require trimming only once every two days), at the following prices per lamp per annum: (1) if the lamps are kept lighted the whole night, £14; (2) if each alternate lamp is extinguished at 11.30 p.m. and left out for the remainder of the night, £12; (3) if each alternate lamp is extinguished at midnight and left out for the remainder of the night, £12 5s.; (4) if each alternate lamp is extinguished at 11.30 p.m. and relighted at 5.30 a.m., £13. 10s.; (5) if each alternate lamp is extinguished at midnight and relighted at 5.30 a.m., £13 15s. These reduced prices could not, however, be applied to the existing single-carbon arc lamps, which were now charged at £18 per lamp per annum, on account of the large additional cost of trimming single-carbon as compared with double-carbon lamps. In the event, however, of double arc lamps being hereafter substituted for the existing single-carbon arc lamps, the above-mentioned rates would then apply throughout. If the Watching and Lighting Committee resolved upon an extensive scheme of street arc lighting, it might be possible, by grouping several circuits of arc lamps at distributing centres for various districts, to lessen the cost of labour, and consequently to still further reduce the price to be charged for each lamp. It was, however, impossible at present to indicate what this further reduction might be. The inspector of lighting submitted a report on the cost of lighting Saltmarket, Albert Bridge, Crown-street, and Cathcart-road at the proposed scale of charges, and it was remitted to Mr. Hamilton to further report on the cost of lighting by electricity of a large number of streets." It was explained that the committee were considering a very extensive scheme of electric lighting alike on the north and on the south side of the river. It had been continued for a fortnight to give the members of the Watching and Lighting Committee an opportunity of considering the whole proposals, and these would be brought before the Council at the next meeting. A statement of the cost of lighting by gas compared with the cost of lighting by electricity would also be placed before the Council.

Bradford.—At the meeting of the City Council on the 13th inst. the chairman of the Tramways Committee, in moving the adoption of the minutes of that body, gave the following account, for which we are indebted to the *Bradford Observer*. He said the Bolton-road Corporation tramway was opened on July 30, 1898, and up to March 31 last—to which date the figures which he should give were brought—this line had been opened 245 days. The Horton-road Corporation tramway was opened on August 27, 1898, and had been opened 217 days. During that time the mileage run on the Bolton-road section had been 62,549 miles, and on the Horton-road section 122,900. Salary and wages in connection with the Bolton-road line amounted to £886. 4s. 4d., representing 3·15d. per car mile. The same items for the Great Horton route amounted to £1,707. 11s. 5d., or 3·33d. per car mile, so that there was a difference of about a farthing per mile in the wages of the two sections, caused by the greater difficulty of the Great Horton route and the Board of Trade restrictions. The Bolton-road line had been depreciated by £768 and the Great Horton line by £1,393. The total income from Bolton-road tramway during the 245 days had been £3,002. 12s. 7d., or 10·668d. per car mile run. The total expenditure, including interest and sinking fund, was £2,744. 1s. 3d., or a cost of 9·749d. per car mile, leaving a net profit of £258 11s. 4d. for the 245 days, or ·919d. per car mile. The total income of the Great Horton section for the 217 days was £5,867. 9s. 11d., or 11·458d. per car mile, or four-fifths of a penny more than the Bolton-road section. The total expenditure, including interest and sinking fund, but exclusive of the charges in respect of the accident, was £5,706. 19s. 6d., or a cost of 11·144d. per car mile, leaving a net profit—assuming no accident had occurred—of £160. 10s. 5d. for the 217 days, and representing ·313d. per car mile. The net loss on the Horton section, including the accident, was estimated at £4,927. The income for the Bolton-road section was £3,002. 12s. 7d., and the expenditure £2,347. 14s. 1d., yielding a trade profit of £654. 18s. 6d. The income for the Great Horton line was £5,867. 9s. 11d., and the expenditure £4,850. 11s., yielding a trade profit of £1,016. 18s. 11d. A full year's working in the same proportion would show a trade profit for Bolton of £976 and for Horton of £1,710 Against these trade profits had to be charged the interest and inking fund on the capital invested, which in the case of Bolton-road section represented, with accounts still unpaid, an estimated capital outlay, of, say, £22,000. The annual interest and sinking fund on this amount for 30 years on a 3 per cent. basis represented £1,122, which would make as between this sum and £976 a net loss of £146. With regard to the Great Horton section, with its capital expenditure of, say, £46,000, the annual interest and sinking fund on this amount for 30 years on a 3 per cent. basis represented £2,347, which would make, as between this sum and £1,710, a net loss of £637. Of course, there would doubtless be, as time went on, a tendency towards more economical working by reason of falling into the best methods, which were only suggested by familiarity with every branch of working, and therefore the foregoing figures might be less favourable than would prove to be the case. As it was, the trade profits shown were £976 for Bolton and £1,710 for Horton, and he might say that the summer traffic, which had not yet been fully experienced since the lines were opened, was very encouraging. On Monday the receipts on the Great Horton route, including the Park-avenue branch, were £102.

PROVISIONAL PATENTS, 1899.

JUNE 5.

11590. Improved microphonic contact sensitive to both sound and Hertzian waves. Sidney George Brown, 22, Holland-road, Kensington, London.

11596. Improvements in the means of insulation of electrical mains and other conductors. Philip Cardew, 13, Queen Anne's-gate, Westminster, London.

11646. Improvements in devices for securing incandescent electric lamps in their sockets. Wilhelm Ravené, 111, Hatton-garden, London. (Complete specification.)

11657. Apparatus for forming plates of secondary batteries. Henry Leitner, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

11658. Appliance for preventing the fraudulent or erroneous changing of glow lamps in electric light installations. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske, Aktien-Gesellschaft, Germany.) (Complete specification.)

11678. Improvements in electrolytic apparatuses for extracting metals lighter than the electrolyte. William Phillips Thompson, 6, Lord-street, Liverpool. (Hermann Becker, France.)

11679. Improvements in magnetic apparatus for curative purposes. William Phillips Thompson, 6, Lord-street, Liverpool. (Thomas August Steffens, Germany.)

11682. Improvements in electric switches. Thomas Herbert Marsh and Albert Vandam, 322, High Holborn, London.

11685. Improvements in motorcars driven by electrical or other motive power. Wilhelm Müller, 6, Bank-street, Manchester. (Complete specification.)

11693. Improvements in apparatus for connecting branch circuits to electric mains. Callender's Cable and Construction Company, Limited, and Thomas Octavius Callender, 24, Southampton-buildings, Chancery-lane, London.

JUNE 6.

11717. Improvements in electric batteries. Albert Edward Hodgson, Penny Bank-chambers, Halifax.

11747. Improvements in telephones, phonographs, and such like apparatus. Arthur Sydney Bowley, 168, Fleet-street, London.

11775. Improvements in dynamo-electrical machines and motors. Roslyn Holiday, 24, Southampton-buildings, Chancery-lane, London.

11776. Improvements in apparatus for electric traction. Henri Dolter, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

11780. A new or improved mould for casting plates or grids for secondary batteries. William Alfred Gent and Samuel Jevons, 99, Cannon-street, London.

JUNE 7.

11843. Improvements in devices for starting electric induction motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The Union Elektricitäts-Gesellschaft and Arnoldo P. Zani, Germany.) (Complete specification.)

11879. Production of chromium oxide by electrolysis. Ernest Auguste George Street, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

11880. Improved portable electrical drilling machine. Alphonse Louis Croneau, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

11881. Electrical apparatus for effecting rotation at a distance. Alphonse Louis Croneau, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

11885. Improvements in controlling apparatus suitable for use with electric motors. Henry John Walker, 46, Lincoln's-inn-fields, London. (Complete specification.)

JUNE 8.

11939. An improved electrolytic apparatus. Tranquille Michel Ivan Wilhelm and Hildebert Richard, 100, Wellington-street, Glasgow. (Complete specification.)

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11901. Improvements in electrical brush-holders. William John Poole, 19, Waverley-park, Shawlands, Glasgow.

11931. Electric light saver. Walter Cox, Rowsley House, Holland Park-road, London.

11938. Improvements in electrically-driven sheep-shearing or hair-clipping machines. Gershon Bowmar, 355, Earlsfield-road, London.

11943. Electric circuit-closing devices. Ferdinand Wilke, 52, Chancery lane, London. (Complete specification.)

11983. Improvements in attachments for collectors in electric tramways with slotted conduits. Michael Holroyd Smith, 36, Chancery-lane, London.

11984. Improvements in poles for supporting overhead wires in electric tramways. Michael Holroyd Smith, 36, Chancery-lane, London.

11985. Improvements in overhead conductors for electric tramways. Michael Holroyd Smith, 36, Chancery-lane, London.

JUNE 9.

12056. Improvements in or connected with conduits for underground electric conductors. James Yates Johnson, 47, Lincoln's-inn-fields, London. (Louis Dreyfus, Germany.)

12085. Improvements in or relating to apparatus for the reception, transmission, and reproduction of telephonic communications. Alfred Julius Boult, 111, Hatton-garden, London. (Heinrich Hugo Burckhardt, Germany.)

JUNE 10.

12105. Methods of employing resistance materials for electrical purposes where such materials are in the form of a powder. William Benjamin Spikins and Alfred Hubert Mayes, 34, Western-road, Hove, Sussex.

12113. Machine for covering electric wires or cables with strips of fibre. Francis Lewis Sperry and William James, 82, St. Vincent-street, Glasgow. (Complete specification.)

12114. Improvements in electrically-driven fans. William Harding Scott, 47, Lincoln's-inn-fields, London.

12131. An exciting fluid for generating a constant current in primary batteries. Richard Frederick Drury, 2, St. Stephen's-road, Canterbury.

12164. Dynamo-electric generators. James Norman Smith and William Asahel Johnson, 4, South-street, Finsbury, London. (Complete specification.)

12165. Improvements in electric motors. William Joseph Still, 4, South-street, Finsbury, London.

12171. Improvements in galvanic cells. Willard Erastus Case, 1, Queen Victoria-street, London. (Complete specification.)

12172. Improvements in galvanic cells. William Erastus Case, 1, Queen Victoria-street, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1898.

11076. Telephone installations. Baivy.

11416. Method of and apparatus for signalling or advertising by electricity. Ginisty and Metz.

11525. Electrical switches. Wade, and Electric Motive Power Company, Limited.

11570. Electrolytic cells. Bell and Bell.

12765. Electrolysis of liquids and apparatus therefor. Thompson. (Hazard-Flamand.)

14132. Electrical furnaces, more particularly applicable for the production of calcium carbide. Durban and Gore.

14318. Dynamo electric machines and motors. Brown.

15443. Electrical switches. Veritys, Limited, and Steel.

15509. Electric clocks. Whidbourne and Ball.

15785. Switches for electric circuits. Belfield. (Scott, Davies, and Wright.)

15879. Contact-boxes for electrical railways or tramways with underground conductors. Wise. (Diatto.)

16120. Prepayment apparatus suitable for use in connection with electricity and other meters. Harrison.

17522. Means for transmitting motion from electric motors to other machinery. Geipel.

1899.

2726. Electrical measuring instruments. Flower and Gambrell.

3233. Conduits for cables for carrying electric currents. Belknap and Sundh.

6213. Insulating lining for electrical apparatus and process of making same. British Thomson-Houston Company, Limited. (Painter.)

6883. Apparatus for the production of silent electric discharges. Otto.

7656. Current collectors for electrically-driven vehicles. Carroll.

8140. Electricity meters or measuring apparatus. Siemens Bros. and Co., Limited. (Siemens und Halske, Actien-Gesellschaft.)

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1899.	Corresponding week 1898.	Increase or decrease.	Total receipts for half-year. 1899.	1898.
		£	£	£	£	£
Birmingham Tramway Co.	June 10	4,364	3,828	+ 535	90,859	83,436
Blackpool and Fleetwood Tramroad	,, 10	640	—	—	8,011	—
Bradford City Trame	Feb. 5	145	—	—	6,733‡	—
Bristol Tramways and Carriage Co.	June 9	3,159	2,899	+ 260	—	—
City and South London Railway	,, 11	888	931	− 43	25,118	24,558
Dover Tramways	,, 10	182	157	+ 25	3,629	2,834
Dublin U.T., elec. cars	,, 9	1,411	971†	+ 440	22,863	18,155†
Dublin S.D. Electric Tramways	,, 9	1,095	636	+ 459	16,771	10,868
Halifax Corporation Tramways	Mar. 29	312	—	—	10,712*	—
Liverpool Overhead Railway	June 11	1,469	1,482	+ 13	33,086	34,067
South Staffordshire Tramways	,, 9	644	556	+ 88	14,528	13,572

* Since June 30, 1898. † Including horse cars. ‡ Since July, 1898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	9½-9¾
Bournemouth and Poole Electric Supply, Limited, Ord.	10	10½-10¾
—— 4½ per cent. Cum. Pref	10	10¼-11¼
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	13¾-14¼
—— 6 per cent. Cm. Pf., 30,001-40,000 (all paid)	10	14-14½
—— 6 per cent. Cm. Pf., 40,001-60,000	10	13¾-14¼
—— 5 per cent. Perpetual Debenture Stock	100	127-130
Brush Electrical Engineering, Limited, Ordinary	2	1¾-2¼
—— Non. Cum., 6 per cent. Pref.	2	2¼-2½
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	103-106
Callender's Cable Company, Debentures	100	114-117
—— Ordinary	5	13¾-14¼
Central London Railway, Ordinary	10	10¾-11¼
——	8	8¼-9¼
—— Pref. Half-Shares	8	8-8¾
—— ,, ,,	5	5¼-6
Charing Cross and Strand	5	11-12
—— 4½ per cent. Cum. Pref.	5	5¾-6¼
Chelsea Electricity Company	5	8-9
—— 4½ per cent. Debentures	100	114-116
City of London, Ordinary	10	16-17
—— 6 per cent. Cumulative Pref.	10	15-16
—— 5 per cent. Debenture Stock	100	125-130
City and South London Railway, Consolidated Ordinary	100	67-69
—— Ordinary	3	4¼-5¼
—— 4 per cent. Debenture Stock	100	133-136
—— 5 per cent. Pref. Shares	10	14¾-15¼
—— ,, ,, ,, '96	10	13¾-14¼
County of London and Brush Prov. Elec. Light Co., Ord.	10	11-12
—— 6 per cent. Cum. Pref.	10	14-15
—— 4½ per cent. Prov. Certs.	—	54-56
Crompton and Co.	3	3¾-4¼
—— 5 per cent. Debentures	—	99-102
Crystal Palace District, Ordinary 5 per cent. Stock	100	133-136
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	3-3¼
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	96-98
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5¼-5¾
Electric Construction, Limited	3	3¼-3¾
—— 7 per cent. Cumulative Pref.	3	3-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	103-106
W. T. Henley's Telegraph Works, Ordinary	10	25-26
—— 7 per cent. Preference	10	18-20
—— 4½ per cent. Debentures	100	113-115
House-to-House Company, Ordinary	5	7¼-8¼
—— 7 per cent. Preference	5	9-10
Imperial Tramways, Limited	6	24¼-25¼
India Rubber, Gutta Percha, and Telegraph Works	10	21-23
—— 4 per cent. Debentures	100	101-105
Kensington and Knightsbridge Ordinary	5	12¼-13¼
London Electric Supply, Ordinary	3	3¼-4
—— 6 per cent. Pref.	5	6¼-6¾
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	100-103
Metropolitan Electric Supply, Limited, Ord., No. 1-62,500	10	16¾-17¼
—— ,, ,, No. 62,501-85,000	10	15¾-16¼
—— 4½ per cent. First Mortgage Debenture Stock	100	118-121
National Telephone, Ordinary	5	4¾-5
—— 6 per cent. Cum. First Pref.	10	11-13
—— 6 per cent. Cum. Second Pref.	10	11-12
—— 5 per cent. Non. Cum. Third Pref.	5	4¾-5¼
—— 5½ per cent. Deb. Stock, Red.	100	100-103
Notting Hill Electric Lighting Company, Limited	10	16-17
Oriental, Limited, 1879	1	1¼-1½
—— £5 Shares	5	7¼-8
—— £4½ Shares, New	4½	6¾-7
Oriental Telephone and Electric Company	1	¾-1
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6¾-7¼
Royal Electrical Company of Montreal	1½	165-185
—— 4½ per cent. First Shares Mortgage Debentures	100	105-107
South London Electric Supply, Ordinary	3	4¼-4¾
St. James's and Pall Mall, Limited, Ordinary	5	17-18
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	37-41
—— 5 per cent. Bonds	100	106-108
Waterloo and City Railway, Ordinary	100	105-108
Westminster Electric Supply, Ordinary	5	14¾-15¼

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NOTES.

A Rumford Medal.—At its recent annual meeting in Boston, the American Academy of Arts and Sciences unanimously voted the award of a Rumford medal to Mr. Charles F. Brush for the practical development he is responsible for in electric arc lighting.

The Leeds Accident.—We regret to have to note a double fatality in the Corporation electric generating station at Leeds. In this case electricity was in no way connected with the accident, which was caused by a scaffold plank breaking. The two men were engaged in painting the roof of the station, and were killed by falling on to the concrete floor.

American Institute of Electrical Engineers.—At the sixteenth annual meeting of this institution, held recently in New York, it was stated that the total membership on May 1 was 1,133, a net gain of 35 during the year. Mr. A. E. Kennelly was elected president, and a paper on "The Multiple-Unit System of Electric Railways" was introduced by Mr. F. J. Sprague.

Isle of Man Tramway Extension.—The Laxey and Ramsey section of the electric tramway was opened last Saturday morning. It extends from Douglas to Ramsey, a distance of 16 miles. The route of line opens up a beautiful country hitherto practically unknown to tourists and pleasure-seekers, and commanding picturesque glen and mountain scenery, with fine marine views. The line is double throughout and is on the overhead system.

Rustchuk Exhibition, 1899.—The Bulgarian Government have arranged for an industrial exhibition, which will be opened at Rustchuk on Aug. 14. The position of the town, near the Roumanian and Servian frontiers, will ensure visitors from these countries, especially as exhibitions are rare events in these parts. The exhibition should especially attract the notice of manufacturers of motors. Mr. Arthur Gobiet, of Prag-Karonlinerthal, is the manager.

George Heriot Trust.—At a general meeting of the Governors of the George Heriot Trust at Edinburgh last week, the Heriot-Watt College Committee recommended the awarding of the diploma of the college to the following students: in the department of mechanical and electrical engineering—William Graham Griffith, John M. F. Wilson; in the department of electrical engineering—William D. M'Gregor; in the department of mechanical engineering—William Baxter, James C. Smail.

American Electro-Therapeutic Association.—This association will hold its next annual convention in Washington, D.C., on Sept. 19, 20, and 21. The headquarters will be at Willard's Hotel. Willard's Hall, adjoining the hotel, has been secured for the display of exhibits. Arrangements will be made for the convenience of exhibitors, including the use of both direct and alternating current. Dr. Clifton Mayfield, 1,335, Thirtieth-street, N.W., Washington, is chairman of the committee on exhibits.

An Earthing Device.—Messrs. Houston and Kennelly have recently protected a novel earthing device for the safeguarding of low-pressure circuits from high voltages. The author's idea consists in using a circuit to earth, in which a small button or layer of chemical substance is interposed. This substance is so chosen that it has a high resistance to low-voltage currents, while a high voltage quickly renders it a comparatively good conductor. Among the substances instanced are manganese dioxide, stannous chloride, lead acetate, copper bichloride, copper and ammonium, and silver sulphide. A sulphide silver button $\frac{1}{16}$in. thick and $\frac{3}{8}$in. in diameter will permanently insulate under a pressure of approximately 50 volts.

I.E.E. "Journal."—The June number of the *Journal* of the Institution of Electrical Engineers has been issued, and among its contents may be found reproduced a paper entitled "A Rotary Converter," by Prof. E. Wilson; a communication on "The Effect of Governors on the Parallel Running of Alternators," by Leonard Wilson; "The Hissing of the Electric Arc," by Mrs. Ayrton, which was followed by a lengthy discussion; and the discussion on Messrs. W. Duddell and E. W. Marchant's paper, "Experiments on Alternate-Current Arcs by Aid of Oscillographs."

Books Received.—We have received vol. viii. of the *Transactions* of the Institution of Junior Engineers for the session 1897-98: also a well-bound and useful volume by John Perry, D.Sc., F.R.S. (published by Messrs. Macmillan and Co., Limited, London), on "The Steam-Engines and Gas and Oil Engines," and intended for the use of students who have time to make experiments and calculate the results. We have also received a copy of the sixth edition of a practical handbook on "Electricity in its Application to Telegraphy." It is by T. E. Herbert, engineer of Postal Telegraphs, and covers the syllabus of the new technical examination adopted by the Post Office Telegraph Department. The publishers are Whittaker and Co., White Hart-street, Paternoster-square.

Frankfort-on-the-Maine.—It will be remembered that we some time ago described the central electric supply station at Frankfort. We understand that this station has now been extended to its full capacity—*i.e.*, 9,000 h.p.—and a sub-station constructed underground in the centre of the town. The latter is exclusively for traction purposes, and its equipment consists of motor-transformers for converting the high-tension alternating current from the main station—which, by-the-bye, is situate some few kilometres distant—into low-pressure direct current for working the town tramcars. The power installed in this sub-station is equivalent to 4,000 h.p. Electric traction is new to Frankfort, which has now equipped its lines on the overhead trolley system throughout.

Electric Lighting in the City.—The question of competition in the electric lighting of the City of London has given rise to much trouble during the past few months, and there are evidences that the matter will ultimately be referred to the law courts. The City of London Electric Lighting Company has refused to accept the conclusions of the Corporation that the contracts under which the company is working are null and void, and have issued a writ declaring that they are valid. What precise form the action will take is not quite clear at present, but we presume it would tend towards a claim for damages on a breach of agreement by the Corporation because they have not opposed the introduction of a new company into the City, As regards the provisional order which the Board of Trade propose should be issued to the Charing Cross and Strand Company, the decision of Parliament in the matter has yet to be given.

Wireless Telegraphy.—Some further experiments were carried on in connection with Mr. Marconi's system of wireless telegraphy on Saturday last in which the French naval authorities were interested. Their store-ship, the "Vienne," was used as the receiving station, and the signals were sent both from the Boulogne and the South Foreland apparatus. One object of the test was to determine how far signals could be transmitted by using a certain height of wire. This maximum distance at Saturday's test was 42 miles. Other informa-

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tion is given as to the signals from the ship to either of the land stations, and we are told that distinctive signalling was obtained. It is said that messages were sent at will either to the South Foreland or to France without the other station being able to read them. Some further information as to how this was done would be of scientific value.

Conversazione.—The Society of Arts conversazione duly took place at the Natural History Museum, Cromwell-road, S.W., on Tuesday evening last, when a reception was held from 9 p.m. to 10 p.m., in the central hall, by Sir John Wolfe Barry, K.C.B., F.R.S., chairman, and the other members of the council. As is usual at these gatherings, the attendance was very large, and the band of the Royal Artillery, which performed in the central hall, assisted by the Red Band in the bird gallery, provided an excellent entertainment, the programme of music being very happily selected. We were glad to see that a temporary installation of electric light had been put up for the occasion, the central hall being illuminated by arcs and the side galleries by incandescent lamps. The pleasant effect so obtained may perhaps assist in hastening the introduction of a permanent installation, for the building is well worthy of such in place of the present miserable gas jets.

U.S. National Electric Light Convention.—The American technical Press give copious accounts of the proceedings of the recent convention of the National Electric Light Association at New York. In his address, President Young presented some interesting data referring to the electrical developments which have taken place in that city—a city which, he claims, has no equal in electrical progress. He pointed out that within its limits are placed 35 electric lighting stations, furnishing more than 1,000,000 incandescent lights, 30,000 arc lights, and at least 30,000 h.p. in electric motors, the capital invested for carrying on all this being about £20,000,000. In 1897 there were in the city of Brooklyn alone 678 miles of track, and a capitalisation of £11,000,000. To-day every transit company is either using or is about to use electricity as its motive power, while the capitalisation is £30,000,000. Over this track last year no less than 236,680,010 persons were carried.

Canadian Electrical Association.—This year's convention of the above association is to be held at the New Royal Hotel, Hamilton, Ontario, on June 28, 29, and 30. At this meeting papers on the following subjects are to be read: "Meters," by A. A. Dion, Ottawa; "Cost of Power," by C. B. Hunt, London, Ont.; "Inspection," by W. J. Plewes, Montreal; "The Enclosed Arc Lamp and Its Use," by W. A. Turbayne, Hamilton; "The Incandescent Lamp for Central Stations," by E. E. Cary, St. Catherines, Ont.; "Central Station Accounting from a Business Standpoint," by P. H. Hart, Montreal; "Transformer Economy," by F. E. Leonard, jun., Montreal. In addition to the above papers there will be a few matters for general discussion, including an oral description of the Cataract high-power tension distribution by Mr. H. R. Leyden, also a "question box." From the programme we have seen there is little doubt but that the social functions of the convention will be well patronised.

Electricity on Railways.—Mr. H. B. Thwaite contributes to the June number of the *Engineering Magazine* an article upon the influence of electricity upon railway locomotion. He quotes instances to show that, as regards the working expenses on lines already built, it has been conclusively proved that the adoption of electricity is more economical than the use of steam locomotives. Referring to the great weight which steam locomotives have to be made in order to deal successfully with heavy loads, he contends that a large saving of coal is bound to result from using electric traction on long lines. In some cases the reduction in the quantity of fuel required would be about two-thirds of that when steam is employed. Mr. Thwaite's ideal equipment of a line for the transportation of large masses of raw material or manufactured products is to employ large trucks capable of carrying 20 to 50 tons each. He would then provide motors on every truck, so that a large number of axles on the train would be driven.

Commutator Wear.—We learn from an American contemporary that a patent has been issued to Mr. Edwin W. Rice, jun., for a device for equalising the wear on a commutator. The way in which Mr. Rice proposes to do this reminds one of the old debate as to whether it is the dog which wags the tail or the tail which wags the dog. He suggests mechanism for keeping the armature of a dynamo moving to and fro longitudinally in its bearings in order that there may be relative motion between the brushes and the commutators. This distributes the wear on the commutator, but it seems to us to move the brushes, which weigh only a very small fraction of the total weight of the armature, is a much more feasible method. We remember seeing in the early nineties a device which was invented, and, we believe, protected, by Mr. Druitt Halpin. In this case, by means of a worm and wheel, the brush-holders were kept moving slowly to and fro on their spindles. The device was originally to be seen in the private installation at the Grand Hotel.

The Possibilities of Wireless Telegraphy.—At a recent meeting of the New York Electrical Society, Mr. W. J. Clark lectured to a crowded audience on the future possibilities of wireless telegraphy. The lecturer claimed that Marconi's system was not new, and that the transmission of electricity without wires was known as far back as 1746. In that year Dr. Watson transmitted signals across the Thames. In 1748 Benjamin Franklin stood on one side of the Schuylkill River, and by means of electricity ignited a fire for a picnic party on the other side, using the water for a conductor. In 1838 Prof. Henry made discoveries in this line, and transmitted a message across the Potomac. In 1881 Prof. Dolbear sent messages without wires for the distance of half a mile. Later on Prof. Hertz, while experimenting on an entirely different line, discovered the fundamental principle of Marconi's work. Although Marconi has discovered nothing new, the author considers he (Mr. Marconi) deserves credit for the results he has achieved.

"Electromobile."—The *Electrical Review* of New York has recently offered prizes for the best name to be applied to a self-propelled electrical vehicle for use on the roads. As a result, some 400 names were forwarded, and the judges have decided in favour of the word which appears as the heading of this note. The arbiters selected were Messrs. C. Blizard, Louis Duncan, and J. J. Carty. According to the competition rules, the word had to convey the idea of a self-propelled vehicle. With these rules we consider the successful candidate has complied, but we think that the word, although selected as the best out of such a large number, will not find its way into common usage. The length is, perhaps, its greatest objection. With a tendency nowadays to cut down all terms connected with sport to the irreducible minimum, "electromobile" will have to undergo extensive pruning. From the expression on the faces of the committee of judges in the illustrations reproduced by our contemporary, we do not think that they themselves were particularly pleased with the selection.

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Shoreditch Cricket Club.—We have received from the cricket club connected with the Shoreditch electric lighting station their match programme for the present season. We are pleased to note that the club has such a strong membership, and feel honoured that they have included us amongst their list of honorary members. The president of the club is the electrical engineer to Shoreditch, Mr. C. Newton Russell; while the vice-president, Mr. E. Willshear, is the engineer-in-charge of the refuse destructor. The team is captained by Mr. W. Weekes, and Mr. Cecil F. Love is the hon. secretary and treasurer. Amongst the matches arranged with clubs connected with other electric lighting works, we notice it will meet the St. Pancras Electrical Department Cricket Club, the St. James's and Pall Mall Electric, and the Wandsworth Electric. The initial match was with the first-mentioned (St. Pancras) club. It resulted in an overwhelming victory for the Shoreditch team, and we trust that it is only the forerunner of many another triumph.

New York Electrical Exhibition.—This exhibition, which has been held for the past few weeks in Madison-square Gardens, is now being closed. Amongst the excitement organised by the executive to visitors, was a voting contest for deciding by the largest number of votes who was the most popular American actress. The prize for the solution of this knotty question was to consist of an automobile driven by electricity. The vehicle was built specially by the Riker Electric Motor Company, and is of the dog-cart type. It is trimmed in English hunting scarlet, with running gear picked out in vermilion, and with handles, etc., in silver and nickel. Its rear axle is equipped with two motors of ¾ kw. each, and the battery consists of 24 cells of 60 ampere-hour capacity. The steering is effected by the front wheels. The carriage is capable of running 20 miles, and it weighs only 1,100lb. complete. One of our contemporaries states that Miss Maude Adams take the automobile with 14,764 votes. We certainly think this method of attraction is preferable to that adopted last year of holding electric weddings in a chapel which was lighted by vacuum tubes.

Telephones in Jersey.—Now that the Telephone Bill is under active discussion in the House of Commons, it may be of interest to again refer to the system of charges adopted by the State telephone service in Jersey. There are in this island three tariffs which are now in use. Under the first the subscriber pays £1. 10s. per annum, and 1d. per call, payable by the caller only; when 1,000 calls have been had, the subscriber gets five calls a penny for the remainder of the year. Under the second tariff the sum paid is £5. 13s. 4d. per annum, which covers 4,000 free calls; any excess is charged at five calls a penny. The subscriber under the third pays £2. 10s. per annum, which covers 1,520 calls at ½d. each, any excess being charged at five calls a penny. The first is used mostly by subscribers who have not an extended use for the telephone, but who wish their customers to call them up to give orders. The next tariff is more suitable for those who have to make calls more frequently; while the third has found on the whole the largest number of supporters. It will be remembered that Mr. A. R. Bennett is responsible for the engineering of the telephone system in Jersey.

Dynamo Giving Several Voltages.—In the *Elektrotechniker* Mr. O. Milius eulogises the advantages of constructing dynamos for generating several voltages simultaneously. The idea, says Mr. Milius, of taking several currents at different voltages from the commutator of a multipolar machine is no longer new, but offers many advantages in practice despite the little adoption which it has hitherto found. One may obtain currents of different voltages and directions from a multipolar machine by exciting the pole pairs to various degrees and not cross-connecting the brushes. On this principle it is possible, for instance, to transform direct current without auxiliary apparatus. To accomplish this it is only necessary to conduct the current to the one pair of brushes and to tap it again at the remaining pair at its altered voltage, when the ratio of transformation, just as ordinarily, will be dependent on the ratio of the corresponding field intensities. A diagram accompanies the article showing the application of the principle for charging accumulators without the aid of boosters. In this case the one pair of brushes is connected with the battery and the other with the feeders. By giving the magnets on the accumulator side a stronger excitation, the latter may be charged during running on load. The principle is also suggested for the purpose of keeping the pressure at the different feeding points in a network of mains constant.

Congo Telegraphs.—In a recent number of the *Belgique Coloniale* there appears an interesting article on the inception and carrying out of the telegraph across the Congo State. We have at various times referred to the progress made by this long African line, but our contemporary gives a good history of the undertaking, which should be filed by telegraph engineers. The standard equipment used consists of iron posts about 23ft. high and weighing about 150lb. each. These are placed 5ft. in the ground, and support phosphor-bronze wires. After Stanley Pool had been reached, the question arose whether an aerial line or a cable in the river would be preferable. On careful deliberation the engineers on the spot decided in favour of the overland route. From the troubles experienced by the Amazon Cable Company with cables laid in the river, we are sure that the best course has been adopted. As regards the progress of the work, it is confidently expected that before the end of the year the telegraph office will be open at Equateurville. This place is 800 miles east of Boma. At the same time another fully-equipped telegraph party, under Mr. Mohun, an American engineer, is at work from the side of Tanganyika. This section will commence at M'Toa, on the lake, and proceed by the Lukuga and the Lualaba to Stanleyville, the new town at Stanley Falls. A branch line to Ridjaf, on the Nile, has also been sanctioned, but will not be commenced until the main line is completed.

Municipal Telephones.—Mr. Harcourt Clare, the town clerk of Liverpool, has prepared a well-worded statement of his views on the Telephone Communication Bill, which he has presented to a member of Parliament for that city. Mr. Clare argues that, when considered from a municipal point of view, the period in which a telephone undertaking would have to return its capital is so short as to seriously affect the lowest price at which connections can be given. Estimating the actual cost for connection to come out at £30 per subscriber, Mr. Clare states that with such at 2¾ per cent. and a 12 years' sinking fund, the capital charge alone will amount to £3 per subscriber With the working expense of perhaps £4 per subscriber, together with the royalty to the Government, a total charge of £7. 14s. is arrived at. This being a cost figure, it does not look as if municipal telephones have a bright future. The argument against Mr. Clare's reasoning is that there is no need to pay back the whole of the capital in the 12 years, as long as the capital account is reduced to represent the actual value which the Government would take over at the end of the license. Mr. Clare also considers that the Government scheme is unduly favourable to London as compared with the provinces, as there the Government propose to spend £2,000,000, and even if the 10 per cent.

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royalty which has to be paid by other exchanges is not earned, the Government will bear the loss and not the municipalities of London.

Conversazione.—The President of the Institution of Electrical Engineers and Mrs. Silvanus Thompson held a conversazione at the Natural History Museum, South Kensington, on Friday last. The reception took place in the central hall, which was brilliantly lighted and adorned with palms and flowers. The guests who responded to the invitation of Prof. Thompson numbered not far from 1,500. These included many distinguished men of science. The great hall was filled for several hours with ladies and gentlemen, many of whom found abundant entertainment in inspecting the rich collections in natural history so generously afforded by the museum. A delightful programme of music was given by the string band of the Royal Engineers, conducted by Lieutenant Sommer, and this contributed greatly to the pleasures of the evening. The company present included Prof. S. P. Thompson, F.R.S. (president), Prof. W. E. Ayrton, F.R.S., Sir J. Wolfe Barry, K.C.B., Prof. Ciamician, Dr. Crehore (U.S.A.), Mr. R E. Crompton (past-president), Sir William Crookes, F.R.S. (past-president), Herr M. von Dolivo-Dobrowolsky, General Sir J. F. Donnelly, Prof. D. E. Hughes, F.R.S. (past-president), Lord Kelvin, G.C.V.O., F.R.S., Sir Henry Mance, C.I.E. (past-president), Mr. Hiram S. Maxim, Prof. Michelson, Dr. Ludwig Mond, Mr. W. M. Mordey (member of council), Dr. W. Pasteur, Sir E. J. Reed, K.C.B., Sir W. C. Roberts Austen, K.C.B., Prof. Short, Madame Antionette Stirling, Mr. Geo. Westinghouse, and Sir W. H. White, K.C.B.

Atmospheric Electricity.—Prof. Pellat recently communicated to the French Physical Society the results of some interesting experiments conducted by him to prove the correctness of a well-known theory relating to the origin of atmospheric electricity. Ages ago it had been observed that a considerable amount of electricity was conveyed to the atmosphere through the evaporation of water from the earth's surface. Actual proof, however, was not forthcoming until Prof. Pellat undertook his experiment. He employed two brass vessels insulated from earth, and equally charged with electricity. The one was filled with water and the other left empty, then set aside for 1½ hours in a room at normal temperature. At the end of this period it was ascertained with the aid of an electrometer that the vessel containing water had parted with the greater portion of its charge, while the other had not lost any appreciable amount. It is impossible to explain this fact otherwise than that the water of the filled vessel in the process of evaporation had transferred the electricity to the atmosphere. This would certainly seem to prove that water in process of evaporation from the earth's surface carries with it a portion of the earth's static charge, which theory is strengthened by the fact that the earth's electrical state during the warmest hours of the day is weakest, because evaporation of the earth's moisture then reaches its maximum. Prof. Pellat also pointed out that the smoke from chimneys is likewise a medium through which a considerable quantity of electricity is transferred to the atmosphere, smoke, moreover, being generally charged with negative electricity.

Electrical Notes from Japan.—A series of articles are now appearing in the New York *Electrical World* on this subject. They are from the pen of Prof. F. B. Crocker. In the article before us electrical railways in Japan occupy most of the author's consideration. Their use up to the present is not very general, and their extension is hampered by the extreme narrowness of the roads. Prof. Crocker has several suggestions to make as to how this difficulty should be overcome. He thinks that the houses, which are made mostly of paper, should be cut down on one side of the street, or that after one of the frequent fires which occur in Japanese towns the tramway company should seize an extra strip of land for the benefit of the public and itself. He thinks that if this were done, the street railway might be equipped before the landowners could obtain injunction. It seems to us that the Japanese might object to this further step in their education. As regards the manufacture of electrical machinery in Japan, this, we gather, is much hampered by the fact that high-class raw materials, such as magnetic and transformer iron, are not manufactured in the country. The professor has nothing but commendation for the educational facilities afforded in Japan for electrical engineering purposes. The universities at Kyoto and Tokyo have each a well-equipped electrical department under Profs. Nanba and Nakano respectively. Both these gentlemen have had extensive experience in electric technology, and we remember that the latter attended for some time the Central Institution. We also gather that they make frequent visits to America and to Europe in order to keep themselves well informed as to the progress of electrical engineering.

Electric Railways in 1880.—Mr. Edwin W. Hammer contributes to the *Electrical World* an interesting article on the electric railways equipped by Mr. T. A. Edison in 1882. As Mr. Hammer was intimately connected with the equipment of these lines, his reminiscences are most interesting reading. The illustrations which accompany the article are made from photographs obtained of these first electric locomotives, and constitute an important feature in connection with the history of electric railways. We fancy, however, that Mr. Hammer somewhat exaggerates the work done by Edison in the development of dynamo design. He practically acknowledges this in his description of the dynamos used to drive this line, which were made with inordinately long magnetised bars in order to obtain a great magnetic moment. Mr. Hammer explains that the dynamos for this road were originally two in number, of the standard size then being made at the laboratory, and were known as the "Z" type—in the laboratory vernacular, "long-waisted Mary Anns." These dynamos were first placed in the machine shop, and were connected to the two rails of the road by underground conductors. It will be seen that this road was one in which one rail acted as positive conductor, and the other rail as negative conductor. These first dynamos were 110-volt machines, and had a capacity of about 75 amperes each. No especial precautions were taken to insulate the rails from the earth or from each other, and it may seem surprising that under these circumstances there was so little loss of current due to leakage. The locomotive consisted of a four-wheel iron truck, upon which a similar dynamo was laid on its side. The gearing originally employed consisted of a friction pulley upon the armature shaft, another friction pulley upon the driven axle, and a third friction pulley which could be brought in contact with the other two by a suitable lever. On May 13, 1880, the first successful run with this locomotive was made, but Mr. Hammer states that the friction gearing was wrecked on the return journey, owing to its being thrown into action too quickly. After that experiments were made in which leather belts were used to drive, and an idle pulley employed to alter the tension in this belt. When starting, the motor was first run up to speed and the belt was then tightened in order that the locomotive might gain speed slowly. Other interesting details in connection with this early attempt are given by Mr. Hammer, who also describes somewhat fully the more perfect machines made in 1882.

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Electric Units.—The editors of the *Electrical World* of New York have forwarded to us an advance proof of their leading article on the desirability of names for the fundamental electric and magnetic units. The services of the eminent electricians of the British Association in establishing a universal system of electromagnetic units is spoken of highly in the article, but the editor, while accepting with gratitude the C.G.S. system, objects at the same time to the so-called practical system introduced by the British Association. This objection is based on the fact that ohm, the volt, and the ampere do not by their names indicate their connection with the C.G.S. system. Our contemporary claims that this is bad, because it tends to separate the practical electrician from the scientist. The solution of the difficulty suggested by our contemporary is to give names to the fundamental units, and to apply prefixes to indicate what multiple of the absolute unit the practical unit is. This is already followed in certain cases, as, for instance, in the units of capacity, where the microfarad, the practical unit, is one-millionth of the absolute unit. As an example of the change which would be introduced in this way, our contemporary suggests that if the fundamental C.G.S. unit of current had been named the "flu," the ampere would be called a "demi-flu." In the same way a joule would under the new system be called a "septerg." Our contemporary concludes by saying that "we do not want any more units. The C.G.S. system gives us all the units we require, but we want names for these to make them more than mathematical abstractions and to give them the dignity of concrete quantities. No harm can be done by the creation of these names. The worst that can happen would be that they should not come into use, but the teachers and students in the electro-technical courses would be only too glad to avail themselves of such aid." Personally, we think that the suggestions referred to are 35 years too late. The number of men who have to work with practical units, who never by any chance wish to refer back the quantities to absolute units, are, we should say, a hundred times greater than those who wish to do so. Again, those gentlemen who work mostly in the absolute units have no difficulty in converting their calculations into both amperes and ohms, as they have now become used to the multiplying factors which have to be employed.

The Pacific Cable.—The disappointment expressed by the Colonies as to the first decision of the Government on the Pacific cable scheme has borne fruit, insomuch as the matter is to be further discussed. The *Times* now announces that "the representatives of the Colonies have been informed that her Majesty's Government is prepared to accept the principle of utilising Imperial credit for the purpose of providing the capital required for the undertaking, and, as this decision creates certain new questions with regard to the manner of raising the capital, the form of management, and the construction and working of the cable, the Colonies were invited to empower delegates to meet the Chancellor of the Exchequer and the Colonial Secretary for the purpose of a further discussion of details. The High Commissioner for Canada and the Agents-General of New South Wales, Victoria, Queensland, and New Zealand have been given power by their respective colonies to represent them in the matter, and have placed themselves at the disposal of the Imperial authorities. It now rests with Sir Michael Hicks-Beach and Mr. Chamberlain to name a day for the conference to take place. Time being of importance, in order that all preliminary arrangements may be concluded before Parliament rises, it is probable that an early day may be selected." Our contemporary points out that the statement made, that the Colonies are more interested in this proposal than Great Britain, is not correct. It seems that on the present telegraphic messages to Australia some £230,000 would be saved per annum by the British public by the use of the new route and paying three shillings per word. That this Pacific cable opens a new western route of communication with a portion of the world to which communications have hitherto passed over eastern lines is at once the great merit and the great obstacle to successful initiation of the Pacific cable scheme. There is no ignoring the fact that the already existing great Eastern companies must in their own interests be opposed to the creation of a western rival. That they should do all they legitimately can to prevent the success of the Pacific cable scheme is to be expected. But the choice from the public point of view must be held to lie between general and individual interest, and in such a case there can be no room for hesitation on the part of the Governments concerned. In fact, the day has come when the jealously-guarded western route must be thrown open.

Safety in Electrical Distribution.—Mr. W. L. R. Emmett read a paper before the recently-held National Electric Light Convention in America on "Means of affording Safety in Electrical Distribution." The first part of this paper is devoted to the consideration of how one can assure that the low-pressure side of a transformer shall not become either connected or charged to a dangerous potential. In this respect the author is inclined to advocate a permanent earthing of transformer secondaries, and concludes that there are several desirable exceptions to the prohibitions now made by fire offices in America. These rules Mr. Emmett considers should be given up, because they lead to danger rather than to safety. He quotes a forcible illustration of the danger of ungrounded secondaries as afforded by a recent occurrence in New Orleans. In a residential district, where the houses were connected to a system of three-wire alternating mains, a cross caused by wind occurred between one of the main wires and a 2,000-volt primary wire in the same street. The result was that the insulation between the wiring and the ground was broken down in a large number of the houses, the trouble being principally in combination fixtures where conductors were near gas-pipes. Fires occurred in 20 houses, several were totally destroyed, and the loss was over £40,000. If the neutral of this system of mains had been grounded, the trouble could not have occurred. The author refers to the practice in Europe, and it seems to us that the earthing device as invented by Major Cardew is much more advantageous in this respect than the permanent earthing of one wire. If a high pressure on the secondary ensures the earthing, all the same freedom from danger is obtained without the objections which arise from earthing when an extended system of distribution is employed. Of the other safety device considered by the author is that of the circuit-breaker to be used on high-potential circuits with large outputs. Of this device he describes several examples which have found more or less favour in the United States. The one used at Niagara Falls consists of a shunt device used in connection with the circuit-breaker, so that the fuse in the shunt opens the circuit after the main contacts have been broken. This system has been found to work well. The small fuse placed in the shunt is so arranged inside a tube that the arc cannot be maintained, as the hot air blows it out. With respect to the size of wire to be used in this shunt circuit, it has been found that a No. 20 conductor is quite sufficient for a 1,000-ampere circuit.

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MUNICIPAL ELECTRICAL ASSOCIATION.

BRISTOL CONVENTION.

On June 15, owing to the absence of Mr. H. Faraday Proctor in London, where he was engaged with his chairman, Councillor G. Pearson, in opposing the Bristol Gas Company's Bill, the chair was occupied by Mr. J. H. Rider, vice-president of the association. Having explained the reason of his presiding, Mr. Rider proceeded to give an abstract of his paper on "Combined Lighting and Traction Works," which we give in full below:

Combined Lighting and Traction Works.

BY JOHN H. RIDER, A.M.I.C.E., M.I.E.E., BOROUGH ELECTRICAL ENGINEER, PLYMOUTH.

MR. J. H. RIDER.

The writer feels that no apology is needed for again bringing the subject of combined lighting and traction works before this association. Since his 1896 paper much attention has been given to it in various quarters. This city has taken its share in the discussion, and recent events in Glasgow and Manchester will be familiar to most of you. It may be interesting in the first place to notice what has already been done, or, at least, decided upon in this country in those towns where the local authority owns either both the electric lighting and the tramway undertakings or one of them.

1. Local authority owning both undertakings. Separate works (5): Glasgow, Huddersfield, Hull, Leeds, Sheffield. Combined works (10): Bolton, Blackburn, Blackpool, Bradford, Halifax, Liverpool, Manchester, Plymouth, Southampton, Wolverhampton.

2. Local authority owning lighting works; tramways owned by company. Combined works (2): Brighton and Devonport. Separate works (3): Bristol, Coventry and Dublin.

3. Local authority owning tramways; lighting works owned by company. Combined works (1): Dover.

4. Company owning both undertakings. Combined works (1): Cork.

The above lists are complete as far as the writer's information goes. It will be seen from them that out of 22 towns 14 have decided upon combined lighting and traction works. Where the local authority owns both undertakings, combined works have a majority of two to one, and in the single instance where a company is supplying electricity for lighting and tramways it is doing so from the same works. In two cases the tramway company is buying current from the lighting works of the corporation, and in one case the corporation is buying current for its tramways from the lighting company. At Leeds and Sheffield the lighting works were purchased by the Corporation from a company, and the Corporation had decided upon its tramway works before the transfer had taken place.

The arguments which have been brought against combined works have been many. They may be summed up in the following—viz.: (*a*) that the natures of the tramway and lighting demands are so different, and the output for tramway purposes so large compared to that for lighting, that the two undertakings should be separate; (*b*) that a combined lighting and traction works cannot produce current for tramway purposes as cheaply as can the separate tramway works; (*c*) that the importance of an uninterrupted tramway service is so great, that the tramway should not be dependent upon any outside source for its power.

Free discussion on these points can only be productive of good results. If combined statlons be right in principle, then we should do all in our power to increase their number. If they be wrong, then it will be to the advantage of all for separate works to be established.

An electricity works, whether for lighting, or tramways, or both, consists essentially of two distinct departments—viz., one for steam producing, and the other for steam using or electricity producing. In considering the effect of a combined lighting and traction load upon any works, both of these departments must be taken into account. In the average English town the lighting load is very small, indeed, throughout the day, quickly rising to a high maximum when darkness comes on, then more slowly falling off till midnight, and keeping at a low level until the next evening. The changes in the load are fairly gradual, giving time for the starting of additional engines and dynamos as the demand increases, but necessitating the full number of boilers being kept under steam during the 24 hours. The tramway load is of a different character. It comes on at about six o'clock in the morning, and maintains a fairly even average right up to 11 or 12 o'clock at night, when it ceases until the next morning. The changes in the load are very excessive and sudden, particularly when only a few cars are in use, so that while enough plant has to be kept running to meet the maximum demand, the average load may not be greater than one-half of the maximum. If the steam-producing plant be of the Lancashire type, with good steam storage, it may be worked at an economical rate all the time, but the electricity-producing plant would be working inefficiently.

In a combined lighting and traction works, the steam-producing plant and the steam-piping should be common to the two services, and for at least 18 hours out of the day the lighting load would only make a very small addition to the total load. But for several hours the lighting load would be heavy, and would overlap the traction load. Unless some other source of supply were provided, additional steam and electricity producing plant would be required for this short time, to be standing idle with large losses during the rest of the day.

Accumulators offer a ready way out of the difficulty. The writer endeavoured to show in a paper before this association last year that not only would they reduce the amount of tramway plant, but they would enable the same engines to be used for both lighting and traction at the same time, they would take the overlapping of the loads during the evening, and they would make it possible to have a nearly constant output for the whole of the plant during the 24 hours. How constant would depend upon the relative maxima of the lighting and tramway loads, but in any case the plant need not be called upon to do more than the maximum of either of the loads, whichever may be the greater, and not the sum of them. It has been said that these arguments are all very well for small works, having only half a dozen cars running, but that it would not be possible to use accumulators in the manner suggested when there are, say, from 50 to 100 cars to deal with. The writer would ask, "Why not?" Are not large batteries possible? And are they not more likely to be economical than small ones? Batteries are in use to-day of considerably greater size than were used 10 years ago, and the demand would quickly create the supply. In a traction works accumulators would be of great service, but they are at their best in a combined lighting and traction works, where their discharge could be used to take the overlapping of the loads. The tramway output can easily be much greater than the lighting output, not because the maximum load is greater, but because the tramway load continues for such a long time. The tramway plant may be much smaller than the lighting plant, and yet generate from five to ten times as many units during the day. Because the tramway output is very great is no argument against either the use of accumulators or a combined works. Without accumulators the combined lighting and traction works must have nearly as much plant as though the works were separate, and the only saving would be that one set of buildings and one staff would be required instead of two. The cost of production would certainly be much lower than in a purely lighting works, but it is doubtful whether it could be brought as low as in a works which had only a traction load to deal with. With accumulators, however, the case would be different. The amount of plant would be reduced, the efficiency of the boilers, piping, and engines would be brought as high as it would be possible to get it, and the combined works could produce current as cheaply as any separate works.

Even where the lighting works have offered to sell current for tramway purposes as cheaply as the tramways could produce it themselves, a great point has been sometimes made of the "divided responsibility" and the difficulties the tramways would be in in case of an interruption in the supply. Can any reasonable man affirm that there is any more likelihood of a breakdown when the current is produced in a combined works than when it comes from a separate station? Is not a failure of the lighting plant of far more serious moment than the temporary stoppage of the tramcars? And may not the engineers who are accustomed to keep up the lighting supply from one year's end to another, be relied upon to maintain the tramway supply?

In concluding this short paper, the writer would ask those corporations who own electricity works, and who are now considering the adoption of electricity as a motive power for their

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tramways, to look at the matter in a broad spirit. There should be one electricity works for the town, supplying current for lighting, tramways, and anything else for which current may be used. The tramway department should provide its own lines, the rolling stock, and the overhead (or underground) electrical equipment. The electricity department should feed into the overhead wires of the tramways, just as into the wiring of any building. All current should be supplied on the same terms, whether to the tramways, to public lighting, or to private consumers. But the terms should be on the "Brighton" system, with the initial price at a maximum, but for as short a period as possible, and the second price as low as could be managed. Each class of consumer would then be charged at rates in accordance with his use of the supply, and the "long hour" demand of the tramways would result in a very low net charge per unit.

Mr. C. H. WORDINGHAM, in opening the discussion, said that the question of the advantage of combining electric lighting and traction works in one had now, he thought, been satisfactorily answered in the affirmative. At Manchester he had strongly advocated this course, and he thought that no impartial judgment would be given in favour of separating the works. Of course, the size of the area to be supplied had to be considered when determining the system. At Manchester this amounted to 45 square miles. He believed that the best system to adopt was a high-tension one, with continuous-current distribution, which was suitable both for lighting and power. In smaller areas, where all the tramways could be supplied on the low-pressure system, there was equally as much gain in combining the electric lighting and traction plants. The saving was to be looked for in having the two undertakings under one roof and under one management. Again, by using the same type of plant for both lighting and traction, larger and more economical generators could be employed, while great economy was to be derived from the reduction of the stand-by losses. He would not say that the average cost per unit generated in the combined traction and lighting system would be less than with a traction station only, but he claimed that individually the costs were less, and that it was cheaper both for the traction and the lighting to combine the generating machinery into one station, provided the charges were made on the merits of the case. In Manchester they were charging the tramway undertaking a certain amount representing the capital expense, and adding to that a very small charge per unit taken. They did not seek to make a profit out of the tramway department.

Mr. A. S. BARNARD, of Hull, said he felt called upon to enter a defence for there being separate generating stations in his town. After a certain size of plant was reached, he considered that the saving from combination vanished. Still, at Hull they were using the same class of generator for both lighting and traction, and they had placed these stations each in the area where it could most economically serve its purpose. He certainly preferred a low tension for tramways.

Mr. W. A. CHAMEN, of Glasgow, asked if the author was quite sure of his ground when he advocated the use of accumulators. He had found that in the event of an all-day fog—as they often had at Glasgow—accumulators were quite unable to be economically used. It was cheaper in such cases to put in more plant. At Glasgow he had not had to consider the point of combining the traction plant with electric lighting, as the Tramway Committee preferred to keep the matter in their own hands. They were both huge concerns, and he was not sure that there would be much advantage from a combination. At Glasgow they were proposing to use one large generating station in a fairly central position, and to transmit to five sub-stations by means of the three-phase system. He proceeded to criticise the proposed scheme, thinking that the expensive site in the centre of the town was a mistake.

Mr. T. P. WILMSHURST, of Derby, pointed out the difficulties due to jealousies that often existed between the tramway committee and the electric lighting committee of the corporation. Unfortunately, these jealousies were sometimes also shared by the officials of the departments. He urged that a broad view should be taken of the matter, as in all moderately-sized towns the cost could be kept down by combining the generating works.

Mr. A. S. GILES, of Blackburn, said that in a combined station a great saving was effected, due to the same spare plant serving for both lighting and traction. If the quantity of spare provided was only 25 per cent., the saving soon became very considerable. They used the same staff for both lighting and traction at Blackburn, and up to the present had not found it necessary to make any increase due to the starting of the traction plant in the number of persons employed. Again, they did not find they had to steam any more boilers through the day than had previously to be at work for the lighting.

Mr. S. Z. DE FERRANTI considered the paper was full of interest, and that its discussion would be of great service to the profession. There could be no doubt that the combination suggested by the author was the right thing, and he thought that the system recommended by Mr. Wordingham, of Manchester, was also the one which would ultimately find favour universally. He assumed that those who did not agree with the combination were largely influenced by the fact that the lighting system they were working with was not well designed. He could not conceive of any business being so large that it would pay to divide it into smaller retail businesses. In fact, he had from the early days of electric lighting advocated the erection of very large generating stations outside towns rather than multiply the number of small generating stations in each of the towns themselves. The stations could then be so placed that cheap water and coal could be obtained. The great saving, in his opinion, was with stand-by losses. He thought that the jealousy between committees was sometimes fostered for private ends. A consulting engineer, as a business man, was rather apt to give advice which would lead to business being placed in his hands, and one could not but see that separating the electric traction plant from the lighting tended to such an end.

Mr. W. A. CHAMEN here explained that the four stations he advocated for the supply of power in Glasgow would each be of from 15,000 h.p. to 30,000 h.p.

Mr. W. HARPUR, the borough engineer of Cardiff, strongly deprecated the jealousy which had been spoken of as existing between different committees of the same corporation.

Mr. R. C. QUIN, of Blackpool, said that the experience in that town had been strongly in favour of the combination. The actual cost of working both the electric light and traction plant had been reduced by having them combined.

Mr. A. ELLIS, of Bolton, remarked that they were now equipping some 30 miles of track, and that they were changing the electric lighting system from the alternate current to the continuous current, in order that they might have the same spare plant. As regarded the accumulators, he preferred to wait until Mr. Rider had had experience, of them in Plymouth. He thought that the price to be charged should be the very lowest possible, and that ordinary motor loads should also be served in the same way. With the low tariff as suggested, he had obtained orders for 700 h.p. of motors in Bolton.

Mr. RIDER, in reply, said that where the fog was so persistent, as Mr. Chamen mentioned, there was not so much advantage to be derived from accumulators, but where a five hours' discharge would give the relief at the peak load he found that the cost of accumulators was equivalent to that of the steam plant. The better load they could get for their steam plant, the more economy they obtained from the boilers and the steam-pipes. As regards the question of price to be charged to the tramway committee, he thought that the Brighton system with properly selected constants would give equitable results. He then called upon Mr. A. B. Mountain to read his paper on

The Municipalisation of the Telephone.

BY A. B. MOUNTAIN, M.I.E.E., BOROUGH ELECTRICAL ENGINEER, HUDDERSFIELD.

In preparing a paper upon this important subject the author feels he is dealing with a question which has lately received the most careful consideration of many eminent authorities, but, unfortunately, the result of much deliberation and enquiry has not led to that unanimity of opinion which may be considered desirable. Parliament has decided that municipalities shall have power to undertake the management and development of telephonic matters. The Treasury minute dated May 8, 1899,

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upon the proposals for the development of the telephone system in the United Kingdom clearly indicates the policy proposed by Parliament, and forms the foundation upon which any scheme for municipalising the telephone system must be based. A copy of the Treasury minute is attached to this paper. It will be noticed that a general enabling Act has been introduced in Parliament to give power to local authorities to borrow money to establish telephone services, which will save each municipality the cost of promoting a Bill for the purpose, and will also allow the work to be commenced almost immediately, which is a matter of considerable importance. The licenses will be granted by the Postmaster-General, and will contain a provision that the local authority licensed shall connect their exchanges with the Post Office in order that persons using their telephones may, on payment of the usual charges, speak over the trunk lines, or to a post office, or call for the services of express messengers. Call offices will have to be established at post offices. If these provisions are carefully attended to and thoroughly advertised, they will add very much to the value of the system. In accordance with Clause 8, conditions will be attached to a license so that the Postmaster-General shall approve (1) the character and construction of the plant; (2) the system of charging; and make other regulations which will be to the advantage of the local authority who will have the greatest interest in co-operating with the Post Office.

MR. A. B. MOUNTAIN.

For several years great efforts have been made to improve the telephone service of the country, the first step being the purchase of the trunk lines by Government from the National Telephone Company, but this has not led to any noticeable improvement or reduction in the charges to subscribers. It is one of the most usual complaints of the telephone subscriber that the trunk service, or service between towns, is not of the value it should be, because of the difficulty of getting through communication, due probably to there being too few wires. It is also a general complaint that the time allowed for each conversation (three minutes) is too short. But the real point attacked has been the question of price, the fixed charge of £10 being prohibitive for all but a small percentage of business premises. Unfortunately all efforts to obtain a reduction in the price have hitherto failed, and hence the development of the telephone system has been retarded, and has led to the introduction of an immense number of private lines which are not connected to any exchange, and are therefore of very little general use, and which would certainly not have been erected as private lines if the price had been considerably lower. In the present system of charging in force in the United Kingdom, no difference is made between the subscriber who calls 100 times per annum and the subscriber who calls 10,000 times; in fact, the present system of charging is very similar to the American method of charging for electricity at so much per lamp per annum, instead of charging, as in England, for the actual quantity of energy used. This method applied to the telephone puts the small would-be subscriber in the most unfortunate position, and the author hopes to prove that the charge to subscribers may be very much reduced if the telephone service is controlled by the local authorities.

It may be urged that the telephone service would be better in the hands of a Government department, or controlled by a private company, but there are many good reasons why the local authority should be in a better position to control such matters. For example: (1) The local authority is responsible for the maintenance of streets, and should therefore be responsible for carrying out any work which will greatly disturb the streets. (2) As the owners of streets and public properties the local authority will not have such difficulty in obtaining wayleaves as would a Government department or a private company. (3) The service being to a very large extent local, it is reasonable to suppose the local authority will more accurately know the requirements of, and be more easily influenced by local conditions. (4) The healthy competition between the various local authorities which has led to the rapid advance of electricity undertakings will also be a strong factor in helping forward telephonic undertakings, and such competition will be certain to lead to reduced charges and high efficiency. (5) The increased use of the telephone will be of great assistance to the local authority as guardians of peace and property, as notice of fires, robberies, etc., may be instantly forwarded. At present the telephone system is in most towns supplemented by a special system of police call-boxes, which involve additional and unnecessary expense. (6) As local authorities are now in many cases responsible for the supply of water, gas, and electricity, and have tramways and other large undertakings under their charge, they can naturally assist in developing the telephone system by connecting up the offices of their various departments and chief officials.

In the author's opinion nationalisation would practically represent stagnation, as there would be no competition, no local control, and no inducement for the local authority to assist in developing the system. It is also generally admitted that the efforts of a company would be even less successful than the management by the State, chiefly owing to the difficulties a company would encounter in arranging wayleaves. The main point the author desires to emphasise is the urgent need of development. Appended to this paper are tabulated returns from other countries, and from these it will be seen that the British Isles are very far from being in a satisfactory condition, and that the telephone is, comparatively speaking, a luxury, used by the few who can afford the present high rate of charge. It may be interesting to examine the figures representing, approximately, the state of development in one of the telephone areas, containing a population of about 150,000. In this area there are about 600 subscribers who make about 24,000 local calls per week, or 2,080 calls per subscriber per annum. Very few residences are connected, consequently the calls per subscriber are very numerous, whereas if the charges were reduced residences and small shops would also become subscribers. This would reduce the average of calls per subscriber, would reduce the cost of attendance at the exchange, and would make the system of much greater value. Last year the author had the pleasure of staying a few days at Montreaux, a most pleasant spot on the banks of the Geneva lake, and had the curiosity to enquire the population and the number of telephone subscribers. He found practically everyone of any importance was connected to the telephone, including a very large number of working-men. In England it would be very difficult to persuade a committee to connect the whole of the electrical staff employed by a corporation, because of the prohibitive fixed high charge, whereas in many places on the Continent the charge is very low. Take the example, just mentioned, in Montreaux. Ten officials could be connected to this exchange at an annual cost of £16, or £1. 12s. each, plus five centimes, or say one halfpenny per call, which, allowing 500 calls per annum each, would equal £10. 8s. 4d., or a total of £26. 8s. 4d., as against a charge of £82 demanded in England. While most local authorities are making efforts to improve and cheapen the telephone system, the author thinks many are hesitating at municipalisation fearing the financial results may be unsatisfactory, and cause a further burden to the rates, especially if the charges be considerably reduced. The author thinks the immense importance of developing the telephone is fully recognised, as is also the fact that the local authority is responsible for providing a system so necessary to commerce, but unfortunately many of the figures which have lately been considered are so at variance that it is extremely difficult for even an expert to select the right from the wrong. The author has prepared the following estimates, from which it will be seen that even with a charge as low as £5 the financial result will be perfectly satisfactory.

Estimate of Capital Expenditure, Working Cost, and Revenue.—The author has prepared an estimate of the cost of constructing and working a telephonic system having 5,975 subscribers, five suburban exchanges, and 25 public call-boxes, which estimate is attached hereto. It will be seen that at the average price of £5. 1s. 8d. per subscriber there would be a balance of £6,417. 8s. 4d. available for the purpose of reserve or depreciation. The figures given may easily be applied to a smaller system, where the results should be in about the same proportion. In preparing the estimate the author has carefully consulted existing records, and would point out that in nearly all cases where the capital outlay exceeds £20 per subscriber the cost has been increased by reconstruction and preliminary investigations, which are not now necessary, since a local authority can easily obtain advice and put down a system for the amount stated which will satisfy the Postmaster-General, and without incurring the risk of having to reconstruct in a few years. Nearly all the existing records include the cost of first constructing single-wire overhead systems, and then converting these to either metallic overhead or metallic underground circuits. In such cases the first cost has been enormously increased, so that the figures are now of very little value. A

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further reason for the high capital outlay recorded against some of the systems is due to the cost of renewing instruments, or even the complete re-equipment of exchanges. The method of charging should be most carefully considered. It will be noticed the author proposes a fixed charge of £3 per subscriber, with a further charge of ½d. per call. In the author's judgment it is most desirable to reduce the first charge as much as possible ; in fact, to a figure which will just cover standing charges. If that is done more subscribers will be connected, and it is, of course, apparent that the utility of the system will increase in proportion to the number of subscribers, also that the number of subscribers will increase as the fixed charge is reduced. It would be advisable to fix the charge to cover the whole area instead of to charge an increased rate to those subscribers who happen to reside a considerable distance from the exchange. Objection may be taken to the 25 years allowed for repayment of capital, but the author has considered this matter in conjunction with Clause 11 of the Treasury minutes referring to purchase, by the Postmaster-General, and thinks 60 per cent. of capital cost may reasonably be expected, particularly if ample provision is made for depreciation. It is also almost impossible to consider this question of repayment of capital and the purchase clause without considering the future policy of Parliament, and it would be reasonable to suppose that if municipalities devoted their usual energy to the development of telephones, and are successful, as there can be no doubt they would be, that the Government may probably be persuaded to leave municipalities to continue their good work indefinitely, in which case the purchase clause, with its conditions, will have fulfilled its functions by assisting to keep the telephone finances in a sound condition.

Equipment of System.—In arranging for the installation of a telephone system local conditions must be most carefully observed, particularly in the selection of the positions of call-boxes and suburban exchanges. No two areas will be quite alike, and the number of call-boxes and suburban exchanges will depend not only upon the population, but to a large extent upon the size of the area supplied. It should be remembered that about 95 per cent. of the calls will be local, the remaining 5 per cent. being trunk-wire communications. In arranging the trunk-line switchboards and junction lines to the post office it will be sufficient to allow one pair of wires for 40 subscribers, or for an exchange having 5,975 subscribers, say 150 junction wires. Ample allowance must also be made for junction wires between the central and suburban exchanges. The selection of the switchboard will be a matter requiring great care, as the success of the whole system will depend very largely upon its design and construction. Some form of multiple switchboard will no doubt be provided, of which there are, fortunately, several excellent makers. The report respecting the telephone service in various foreign countries issued by Parliament in March last gives much useful information, including the names of the manufacturers from whom the telephone appliances used in the various foreign countries have been purchased. All circuits must be metallic, and the wires should as far as possible be underground, excepting in the outlying districts, where a smaller number of wires will be required, and where they may with advantage be carried overhead. Although the expense of putting wires underground is higher than erecting the same overhead, the cost of maintenance is considerably less, and a far more reliable service can be given. Overhead wires are liable to be injured by snow, wind, and frost, which elements account for very many of the faults so often a source of annoyance with the existing system. The wires are frequently in the way of building alterations, and have to be suddenly removed, causing an interruption to the telephone service, or the owner of certain property will not allow the supports to remain ; in fact, with overhead wiring the interruptions must be numerous, and therefore the service must seriously suffer. If the wires are drawn into 3in. cast-iron pipes laid under the roadway or footpath, care should be taken to ventilate junction boxes, so that gas may not accumulate and cause explosions. For the purpose of drainage, it will in most cases be sufficient to build a brick junction box without any bottom, so that water may soak away. When laying out the system of underground pipes, it will be necessary to decide whether each pair of wires to a subscriber shall be carried entirely underground, or if the pipes shall be laid to certain centres and from there distributed overhead to the subscribers in the immediate neighbourhood. The latter course, the author thinks, will be found both the cheapest and best, and it will not be difficult to divide the area to be supplied into sub-areas, each supplied in this manner. In many towns it might be possible to carry the wires (which would be made into the form of a lead-covered cable) in the main sewers ; this would obviate disturbing the surface of the road, and would very much reduce the capital outlay. As the wires would not require removing very frequently, all jointing being done at manholes, the interference with the sewers would be very slight after the wires were once fixed in position. From experience the author has had with lead-covered electric lighting wires in sewers, he does not anticipate any serious deterioration of the lead. Another method, which has, at any rate, been discussed, is that of running the wires in hollow kerbstones made of Doulton ware or cast iron, but the expense of this method would probably stop its introduction, except for those streets in which difficulties might be met with in laying pipes. The author looks forward to the time when a discussion may take place upon these and many other details, both of construction and management, together with a comparison of financial results, and hopes that very many corporations will come forward and help on the telephone development, so that the disgrace of being considered behind the whole civilised world may be removed.

Mr. H. L. P. Boot, of Tunbridge Wells, opened the discussion, and said he hoped that practical details on telephone exchange work would be given by various speakers. He thought that the Government should not do the telephone work themselves, because of the defects which had occurred in the telegraphic system of this country. Also the telephonic competition by the Post Office in the North of England had not been a success. He also complained of the trouble which existed with trunk connections now, and argued that the Post Office telephone exchanges in towns would be equally defective. He thought that complaints of defects would receive more attention in a municipal telephone system than in a Government one. As to the need of competition, and the demand with lower prices, Mr. Boot stated that at Tunbridge Wells the National Telephone Company had only some 120 subscribers, whereas 500 had promised to subscribe to a municipal exchange at a £5 annual rental. The automatic telephone was worthy of careful study, and should be inspected by all those who were taking up the telephone question. He thought that with pole distribution from underground cables, the estimated cost of £20 per subscriber was too high.

Mr. W. A. Chamen, of Glasgow, said that Mr. A. R. Bennett was advising his Corporation on telephone matters Personally, he thought the 11-year licenses which were to be granted to municipalities were likely to lead to confusion owing to their short period. Telephones being mostly for local use could, however, be well supplied and maintained by a municipality. An experimental exchange with automatic telephones was being erected in Glasgow, and he hardly need say that it was not being done at the Corporation's expense. The company supplying the instruments were to be paid only on their being approved.

Mr. C. H. Wordingham, of Manchester, thoroughly endorsed the remarks in favour of the municipalisation of telephones given by the author of the paper. As regards the question of whether it will pay, he thought there was no doubt but that it would. He believed that underground wires would be as cheap in first cost in a large town as overhead wires. The delay in trunk-line calls now was, he believed, due to the few trunk lines which had been provided by the Government. He would point out that with a telephone exchange the expense of installation per subscriber increased with the total number of subscribers. This arose from the need in the exchanges for connections from every line wire being within reach of each operator. In this respect it might be well to separate out the people making very few calls per day, and to group them on to a separate board with trunk connections to the main board. This would reduce the expense of the multiple board at the expense of a very slight worth of time per subscriber, with whom time was not such an important item.

Councillor Longbottom (Huddersfield) looked with favour on the penny or halfpenny-in-the-slot system. He hoped to see the day when the telephone would become so popular and cheap that every washerwoman would be able to communicate with her clients. There was something radically wrong that a telephonic service could be cheaply provided on the Continent and yet cost so much in England.

Mr. Sydney F. Walker, of Cardiff, favoured the municipalisation of telephones rather than the establishment of Government exchanges. The charge made per annum by the Government had in many places been equal to the total cost of the outfit. Again, the competition from a corporation would be much more effective. He held that a municipality should have complete control of its streets, and that even the Post Office should not disturb these without permission. He thought that the estimate of cost per subscriber given in the Government reports was too

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rosy, and suggested £60 per subscriber as an accurate average. He then proceeded to describe a parabolic law connecting the number of calls and the number of subscribers on any exchange.

Mr. A. B. MOUNTAIN, in reply, said he was glad he found so many in favour of the local control of telephone exchanges. As regards Mr. Wordingham's remarks, he would point out that the expenses of working per head did not increase with the number of subscribers, although the first cost might.

The next paper to be read was by Mr. C. D. Taite on

Notes on Distribution of Electricity.

BY CHARLES D. TAITE, BOROUGH ELECTRIAL ENGINEER, SOUTHPORT.

MR. CHARLES D. TAITE.

Now that the supply of electricity for lighting purposes has developed to so large an industry that no town in Great Britain with any pretensions to progress is without its electricity works, it may be of interest to briefly examine some of the changes in distribution, more especially in alternating-current practice, which have taken place during the last few years, and to observe how the general use of electricity is restricted by the burden of capital charges. A few years ago when a great number of alternating-current stations were being designed it was the orthodox practice to supply consumers, if not from house transformers solely, at any rate from a combination of house transformers and street transformers; the latter were buried in the ground, usually with their switch gear and fuses in the top of the cast-iron case containing the transformer, and were connected so as to feed in parallel into a common network. This system is now being rapidly superseded by the sub-station system, in which the transformers are banked together to supply as much as 150 kw. to 200 kw., or even greater power, from one centre.

The evolution is only a natural one, since the inconvenience and trouble of properly examining underground transformers, their fuses and connections, the difficulty of gauging the demand upon individual transformers, and the great increase in the demand for electricity have rendered a safer and more convenient method imperative. Those who have tried both sub-stations and street transformers will appreciate the advantages of the former: not only are all the switches and fuses available for examination at a moment's notice, but one is also able by inserting demand indicators in the transformer circuits to ascertain whether each transformer is doing its fair share of the load. All transformers do not bank properly together, not even if they happen to have come from the same maker; the author has experienced trouble in working 20-kw. and 30-kw. transformers together though made by the same firm; the latter would take a considerable overload before the former were more than half-loaded. The probability is that if these two transformers had been placed close together underground, the 30-kw. transformer would have eventually given out, whereas a demand indicator, so easily inserted in a sub-station, showed up the trouble immediately and prevented mischief.

Wherever possible, sub-stations should be above ground, or, at any rate, easily accessible, and there should always be a lamp fixed with its switch close to the entrance. If proper care is taken in the design of the switch gear, the sub-station can be made absolutely safe. The author's practice is to have no high-tension metal exposed, and to furnish a rubber mat and rubber gloves for use in each building, and in order to provide for the continuity of supply, every sub-station is served by two high-tension cables. Where the demand is too scattered to warrant the expense of sub-stations, pillar-boxes may be conveniently used. In these pillar-boxes, which are about the same size as an ordinary Post Office letter-box, are arranged the fuses and the rest of the gear controlling the transformers. Other switch gear may be added if thought desirable. In Southport, one of these boxes contains a high-tension switch controlling a main feeder, two high-tension switch fuses for protecting the transformers, low-tension links dividing the street distributing main, and two low-tension fuses for the transformer. An earthing device is also included. The transformer is sunk in the ground in a cast-iron case by the side of the pillar-box. These pillar-boxes can also conveniently be used for containing switches for arc or incandescent lighting.

In alternating-current working the distributing cables as well as the high-tension feeders are usually concentric, frequently being laid on the solid system. One of the most glaring defects in the past has been the omission of disconnecting boxes; in a neighbourhood where the demand is great disconnecting boxes should be used very freely, every 100 yards or so, thus inconveniencing as few consumers as possible when the supply is cut off in order to make connections, or for testing. The writer has lately heard of a modern station supplying by means of house transformers only, where there was not a single disconnecting switch outside the generating station; to connect a consumer the whole works had to be shut down. Where concentric cables are used for distribution it is customary to make the cable dead before making a joint; it is advisable to do so, though not absolutely necessary. In continuous-current systems supplying on the two or three wire system with single cables, it is considered advisable by some engineers to only make connections when the cables are dead; this is the case in Liverpool and probably elsewhere. Until comparatively lately service cables from concentric distributors were frequently twin; there seems to be nothing to recommend this system now that such excellent concentric terminal boxes are available; the system should be concentric throughout, or not at all.

The cost of connecting consumers is very heavy, and appears to vary in a remarkable degree in different towns. Thus, according to the returns published by the Municipal Electrical Association, the average cost of connecting a consumer at Hanley, inclusive of meter, joint, cable, etc., is £6, while at Huddersfield, what is presumably the same work, costs £15. In the same returns the cost at Southport of a connection ranks as a good second to Huddersfield with £14. 10s., but by the use of a similar though cheaper joint-box to that previously used, and by the increase in the number of 200-volt connections, this sum has now been reduced to an average of about £11. 14s. 6d., made up as follows:

	£	s.	d.
20ft. of cable at 1s. 6d.	£1	10	0
One joint-box, complete with compound	1	10	0
One house terminal box	0	17	6
One recording meter	5	0	0
One demand indicator	2	0	0
One meter board for mounting meter, etc.	0	2	0
Opening and making good ground, men's time, tiles, flags, and sundries	0	15	0
	£11	14	6

The average charge for similar work for gas service is £4 to £4. 10s. The interest and sinking fund at 6 per cent. on £11. 14s. 6d. is 14s., so that until the cast of services is very materially reduced it will not pay to supply quite small houses, since even if every house in a street in a poor neighbourhood were connected the total annual capital charges per consumer could hardly amount to less than 30s. to 40s., which is considerably more than the ordinary artisan pays for all his lighting. It might be added that at Southport the practice is to put in service cables up to 60ft. in length, and to supply meters without any charge to the consumer; the author thinks this is the only fair and reasonable system, especially as regards the meter, since it is installed in order to inform the undertakers how much they ought to charge the consumer, just as a tradesman furnishes himself with weighing apparatus to weigh the goods he sells to his customers.

Before electric lighting can become universal, meters must be made cheaply and more mechanically; gasmeters can be bought for less than £2, and when once fixed in position are frequently left untouched for years; if makers of electrical meters could only offer a similar article the cost of distribution generally would be much reduced. Although the costs of generation have been brought down to a figure which was only dreamt of 10 years ago, and the limit of economy in that direction is seemingly almost reached, reduction in the sale price of electricity is barred by the capital charges, which in many stations equal and in some largely exceed the cost of working—*e.g.*, at Southport the total working costs are 1·45d., which, it is hoped, will be still further reduced; the capital charges, on the other hand, are 1·44d. per unit sold, and are not likely to decrease for the next two or three years at any rate.

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It should, therefore, be the aim of every engineer to keep down the capital invested to the lowest limits consistent with economical and efficient working, and instead of paying large sums in aid of the rates, to build up a substantial reserve fund out of which to replace obsolete machinery, and so prevent the capital being watered.

Mr. C. H. NESBITT, in opening the discussion, said the paper was one it was very difficult to criticise. He thought that historically the author was wrong in placing the street boxes before the sub-station in matter of age. It was just as easy to determine whether transformers would work well in parallel when they were in street boxes or when they were in sub-stations. The length of main between transformers also assisted in their regulation. They had recently made some switch gear to Mr. Quin's design for Blackpool, which he thought was about the best of the kind. The switch was of the plug form and sheathed in ebonite, which plugs were so arranged that no metallic parts were exposed until the circuit had been broken. He advocated the more extended use of disconnecting box in networks, and thought that it would add very little to the expense to make a certain large proportion of the house service boxes also act as disconnectors. He saw no reason why a municipality should not do more than bring the electricity to a pair of terminals inside the consumer's premises, and thought they might just as well provide the whole of the wires and fittings and everything required for the lamps.

Mr. T. H. MINSHALL, of Croydon, remarked that it was his practice to have all services made on the live mains, and that it was not at all necessary to discontinue the service when putting on a new consumer. He had found a very great amount of difficulty with the connecting of transformers, and that two 20 kw. transformers with the same total drop when tested in the station did not share the load equally by 25 per cent. He had found it best to keep all the transformers in one sub-station of exactly the same make and output, and in this way had prevented circulating currents.

Mr. L. ANDREWS, of Hastings, advocated that all sub-stations should be above ground. This very much reduced the number of men required in the staff, as one man could go into a sub-station above ground in safety. It required two to visit an underground sub-station. He advocated the running of two feeders to all sub-stations with automatic non-return cut-outs to disconnect a faulty feeder if occasion arose. He thought that the cost of disconnecting consumers could be reduced by making wiped joints on to the cable, instead of using boxes. He found that a joint could be made of this character on a triple-concentric cable in from three to four hours. This cost from 6s. to 7s., instead of the 30s. required for a box. He made it a practice in Hastings not to put in maximum demand indicators unless the consumer asked to be supplied on the Wright system.

Mr. J. F. C. SNELL, of Sunderland, advocated the use of low-tension disconnecting pillars for a direct-current system. The want of these rendered the localisation of faults a rather long process, and he thought that the continuity of supply could be better maintained if such disconnecting boxes were employed.

Mr. R. C. QUIN, of Blackpool, remarked that it was not necessary to run duplicate feeders to each sub-station. If one feeder alone was used and two interconnecting cables ran from the sub-station to the extremities of two other feeders, perfect safety was obtained. In this way with a faulty cable two fuses supplied the current through one fuse to the cable, so that it was cut out without the device recommended by Mr. Andrews.

Mr. E. W. COWAN advocated that all transformers should be tried on identically the same load as they would be worked on. To test them on a water resistance did not give useful information, as the magnetic leakage caused a variation in the drop depending on the inductive character of the load. He believed in distributed transformers rather than in sub-stations.

Mr. J. E. EDGCOMBE, of Kingston, called attention to the trouble which would arise if the report of the Dangerous Trades Committee was adopted in its present form. Under this report all connections would have to be cut off from a sub-station before anyone was allowed to enter it. He also found it better to keep the old transformers in groups, and not to try to run them all in parallel with the newest types. He found that 200 yards of main between transformers helped them a great deal in running in parallel.

Mr. G. M. HARRIS, of Bray, referred to the experience he had had in that town, extending over seven years, and advocated the use of twin-wire cables for a supply of street lamps.

Mr. H. D. MUNRO, of Exeter, raised the question of the life of meters, and as to whether they would not become useless long before the period for which the loan under which they were purchased had expired. He therefore advocated the continuation of meter rents.

Mr. C. A. COWELL, of Hanley, said in very few towns was it possible for transformers to be placed in sub-stations above the ground without paying excessive rents for the space obtained.

Councillor JEVONS, of Southport, emphasised the need there was for reducing the cost of connection per consumer. Whereas the gas company could connect new premises at an average charge of £4, the electric lighting undertakings had put the charge at from £14 to £16.

Mr. W. A. CHAMEN, of Glasgow, referred to Mr. Snell's recommendation that street pillars should be used for disconnecting low-tension networks. He had tried to design a suitable apparatus to place in the base of the tramway pillars, but had been unable to get out a suitable arrangement. With 500 volts it was difficult to break from 600 h.p. to 800 h.p. without getting a bad flash. With joint-boxes which necessitated the cutting of all the conductors, he had had trouble from the cable drawing out and breaking the circuit.

Mr. J. H. RIDER agreed that it was difficult to get sub-stations aboveground in large towns, and said he did not think that pillar boxes were so good as street boxes for disconnecting purposes. Of the items making up the cost of connection, he considered that the charge for meters ought to be reduced to £2, and that a very good joint-box should be made for a sovereign.

Mr. C. D. TAITE, in reply, said that he thought the conversion of every service box into a disconnecting box, as advocated by Mr. Nesbitt, was impossible, on the ground of expense. He thanked the members for the kind way in which they had discussed his paper.

After the meeting adjourned, most of those present took cars to Old Market-street, where the directors of the tramways company had in waiting their handsome state car and another with a new-pattern electrical brake. The first was in charge of Mr. J. Clifton Robinson, engineer of the company, and Mr. Groves, who is carrying out the electrical installation of the new work; and the second was in charge of Mr. J. Challenger, traffic manager, and Mr. W. Wood, engineer of the power station at St. George. The company, numbering about 100, made a speedy journey to the Staple-hill depôt, a spacious and well-equipped building, with storage sheds and repairing shops. Here an excellent luncheon was provided for the party by the company.

Mr. J. CLIFTON ROBINSON presided in the absence of Mr. George White, the managing director. After the luncheon he proposed "The Queen," and announced that there were to be no speeches. In this he was mistaken, as Mr. T. P. WILMSHURST rose to tender the hearty thanks of the company to the directors of the Bristol Tramways Company for their kindness in inviting them to inspect their lines and power station, for entertaining them, and giving them so noble a reception. They must all have been impressed by the spirit of enterprise exhibited in Bristol, not only by the Corporation, but by other public bodies, especially the tramways company. He coupled the names of Mr. J. Clifton Robinson and Mr. Challenger with the toast.

Mr. J. CLIFTON ROBINSON said the directors were pleased to invite them to see their installation in Bristol, and to offer them hospitality. He regretted the absence of Mr. George White, who was kept away by important business. With regard to the Bristol electrical tramways, they were probably the pioneers of similar tramways in this country, and were the first to conform to Board of Trade rules. Nevertheless, the thing was only in its infancy—

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a boy of three or four years old—but he could promise them that if they came to Bristol a year hence they would be able to show them one of the most complete and most successful systems of electric tramways in this or any other country. Collectively, he was delighted to welcome them to Bristol. Individually, he had had the pleasure of meeting many of them before. He hoped shortly to introduce to them an infant whose birth would shortly take place—he meant the London United Tramways.

Mr. CHALLENGER also briefly replied.

The company having mounted the special cars were taken to Old Market-street, and then on to the power station at St. George, where they spent about an hour examining the fine generating machinery, the boilers, workshops, etc. Other members paid a visit to Bath, where Mr. Gustave Metzger, the borough electrical engineer, met the visitors at the station, which was thoroughly inspected. The visitors complimented Mr. Metzger upon the excellent plant he has now under command. Before leaving Dorchester-street, Alderman A. Taylor, the chairman of the Electric Lighting Committee, invited the visitors into the offices, where refreshments were served. Both Mr. Metzger and Alderman Taylor were thanked for their kindness.

Again, other members visited the works of the Bristol Wagon and Carriage Company to inspect the three-phase system of distribution installed there under the advice of Messrs. Geipel and Lange. Unfortunately, an accident to the high-pressure boiler prevented the plant being run at full load, but with the low-pressure steam available the large sawmill was being supplied with power electrically. The generator is wound to give 110 volts per phase, with about 190 volts between the power wires. The condensing arrangements also attracted interest, and both the Klein cooling-house and the Edwards air-pumps were inspected. The managing director informed us that as yet a full test of the plant had not been taken, but that from smaller trials he concluded that the introduction of the electrical distribution of power would save quite two-thirds of their previous coal bills.

The Annual Dinner.

The annual dinner took place in the evening at the Royal Hotel, College-green, under the presidency of Mr. J. H. Rider, owing to the absence of Mr. H. Faraday Proctor in London. He was supported by the Right Honourable the Lord Mayor, Dr. Ryan, Dr. Cook, Mr. S. Z. de Ferranti, and many others.

After the dinner Mr. Rider announced that he had received telegrams from Mr. H. Faraday Proctor (their president), Mr. G. Pearson, Sir William Preece, K.C.B. (who declared that he could not be in two places at the same time, and wished them a pleasant meeting), Mr. Alexander Siemens, and the Mayor of Cheltenham.

The following toast list was then gone through: "The Queen and Royal Family," proposed by the Chairman; "The Right Honourable the Lord Mayor and the Corporation of the City and County of Bristol," proposed by Mr. J. H. Rider and replied to by the Lord Mayor; "Scientific Institutions," proposed by Mr. Vesey Brown and replied to by Mr. S. Z. de Ferranti; "The Municipal Electrical Association," proposed by Mr. Mark Robinson and replied to by Mr. C. H. Wordingham; "The Visitors," proposed by Dr. Panton and replied to by Prof. J. Ryan; "The Press," proposed by Mr. W. A. Chamen and replied to by Mr. T. E. Gatehouse. During the evening Dr. Rose gave two songs, and Mr. T. E. Gatehouse contributed two excellent violin solos.

SATURDAY'S PROCEEDINGS.

The annual business meeting of the association was held on Saturday morning at the conclusion of the convention, Mr. Faraday Proctor presiding, and members only were allowed to be present.

The PRESIDENT opened the proceedings by expressing his very great regret at having been unable to be present at so large a portion of the discussions of the convention, but his attendance had been necessary in London before a parliamentary committee in connection with the Bristol Corporation's opposition to the gas company's Bill.

The treasurer's report and accounts and the secretary's report were received and passed. The financial position of the association is satisfactory, and there is an increase in the list of membership.

The report of the sub-committee and the recommendation of the council with reference to the Parliamentary Committee on Dangerous Trades, were received and adopted. The report formulates amendments suggested by the association in the proposed regulations for the greater security of employés, and these will be forwarded to the Home Office.

The following gentlemen were appointed a sub-committee for the association benevolent fund: the Chairman of the Barrow Committee, Mr. Wordingham (Manchester), and Mr. Faraday Proctor (Bristol). Mr. A. B. Mountain (Huddersfield) was elected president for the ensuing year, and it was determined that next year's convention should be held at Huddersfield. Mr. A. S. Barnard (Hull) and Mr. J. E. Edgecome (Kingston-on-Thames) were elected vice-presidents, and the following gentlemen were appointed to the council: chairmen of committees, Councillor Skinner (Hull) and Alderman Norman (Cheltenham); borough electrical engineers, Mr. W. A. Chamen (Glasgow) and Mr. A. Ellis (Bolton). A letter was read from the hon. treasurer, Mr. G. H. Cottam (Hampstead), resigning his office for the reason that he had not sufficient time to devote to it. The resignation being absolute was accepted, and Mr. J. H. Rider (Plymouth) was chosen as treasurer to succeed Mr. Cottam. The election of honorary auditor was referred to a committee consisting of the president and Mr. Rider. The remaining officers were re-elected.

Votes of thanks were passed to the president; to the Lord Mayor and Corporation of Bristol for their reception of the association; to the Museum Committee for the use of the lecture theatre; to the vice-president (Mr. Rider), who presided during the absence of Mr. Proctor; to the hon. secretary (Mr. Ruthven Murray) for the organisation of the convention; to the retiring hon. treasurer (Mr. Cottam); to the hon. solicitor (Councillor G. Pearson, Bristol); and to the hon. auditor (Mr. W. A. Godfrey, Hampstead) for their services.

INSTITUTION OF CIVIL ENGINEERS.

The Advantages, or Disadvantages, of Uniting the Lock and Block Signalling Appliances of Railways

BY ALEXANDER ROSS, M.I.C.E.

In opening a discussion on this subject it is desirable to consider shortly the interlocking of points and signals, and the block system, as worked by means of electric telegraph instruments. A railway is naturally divided into sections by the stations provided to accommodate the traffic at various places along the route through which it passes, and these form, with some supplementary places where the distances between stations are too long, convenient divisions of the line for controlling and working the traffic. A signal-box is placed at the end of each section, and in it is fixed the "locking frame" containing the levers for working the points and outdoor signals; and for a railway of two lines of way (one up and one down) there are also provided, inside the signal-box, two electric bells and four block telegraph instruments, one bell and two instruments for regulating the traffic in each direction. In addition to this, the signal-boxes are frequently in telephonic communication with each other. Each division of the line becomes a block section, and by means of these the line is worked on what is known as the absolute block system, which may be said, in short, to be a system by which a definite interval of space is maintained between all moving trains, instead of an interval of time, as in the early days of railways.

There are, however, two modifications of the above rigid rule permissible under certain circumstances—namely, one known as the permissive block system, by which, under strict caution arrangements, more than one train is admitted into a section, and which is chiefly applicable to the running of goods trains; and the other, known as section clear but station or junction blocked, by which a succeeding

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train, moving towards a junction at which it will diverge on to a different line from that on which the train preceding it is travelling, is allowed to proceed slowly to the home signal of the box in advance, but before entering on the section it is a condition that the signalman at the rear box must bring the train to a stand, and inform the engine-driver verbally of the state of the line ahead.

Every station is provided with the usual outdoor semaphore signals, generally for each line, a distant, a home, and a starting signal, and, where shunting takes place beyond the latter, an advance starting signal, with the usual complement of subsidiary signals, depending upon the number and nature of the sidings having connections with the main line. The points and outdoor signals are worked by the levers inside the signal-box, and the movements of these are controlled by the locking in the frame, and are guided so as to lock and interlock in such a way as to produce a definite sequence of events, and to ensure that the positions of the points must be in harmony with that of the outdoor signals, and that on the line being made for a passing train the points must be in their right positions before the corresponding signals can be lowered. Each block instrument in the signal-box usually consists of a case with a dial in front provided with a needle, which normally hangs vertically on the dial, and when in this position it indicates that the line is closed, and the words "Line blocked" are exhibited immediately underneath the needle. On the top right-hand corner are the words "Line clear," while on the top left-hand corner are the words "Train entered section." Each instrument is provided with a handle, and the block is generally worked on the three-wire system. On the handle being moved to the left a positive current flowing diverts the needle to "Line clear"; similarly, on the handle being moved to the right, a negative current diverts the needle to "Train entered section." Regulations, with a code for working the absolute block telegraph on railways, have been agreed to by the various companies, and are in general use.

The method of passing a train along the line may now be noticed. The signalman at, say, "A" wishes to pass a train on to the signalman in advance, say "B," and calls attention by giving one beat on his bell, which "B" acknowledges by repeating. "A" will then forward the "Is line clear" signal to "B" by giving a number of beats on his bell, varying with the class of train he is dealing with. The signalman at "B," having ascertained that the line is clear in advance, will repeat the bell signal to "A," and will peg over the needle of his dial to "Line clear," indicating thereby that "A" may allow the train to proceed. "A" will then give the signal "Train entered section" on both his bell and dial, which "B" will acknowledge, and will peg over his dial signal to "Train entered section." "B" then goes through a similar course with "C," the signalman next in advance of him, and so on throughout the line. As soon as the train has passed "B," he will give the signal "Train out of section" on his bell and dial to "A," and when acknowledged, he unpegs his instrument, thereby allowing the needle to assume its normal vertical position. If these operations are properly carried out, it is quite impossible for two trains to be in one section at the same time.

It may now be observed that the locking apparatus, with the levers working the points and outdoor signals, in themselves as perfect as human ingenuity and good workmanship can make them, are worked independently of the inside block telegraph signals, the only connecting link between the two being the signalman who works both; and there is no physical obstacle to prevent him, in a moment of forgetfulness, giving outdoor signals in conflict with his indoor block instrument; and the question raised for discussion is, whether it is desirable or not to unite and combine the two systems, either mechanically or electrically, into one complete system in such a way as to ensure, not only unity of action at one signal-box, but also with the next box in the rear and in advance.

The conditions which should be fulfilled by an efficient "lock" and "block" arrangement may be stated as follows—viz.: The rear signalman should not be able to lower his outdoor signals, or allow a train to proceed into the section in advance of him, until the signalman in advance has given him the necessary permission by unlocking the starting signal. The rear signalman, having received permission from the advance signalman to allow a train to proceed into the section, and having lowered his signals, and the train having moved forward on its journey, should be compelled to put his starting signal to danger; and the lever working the same, on being put back to the normal position, should become locked in such a way that it cannot be used again without the permission of the signalman in advance. This operation should free the home signal of the rear section, so that a second train may be brought forward to his starting signal; and, for the protection of this train, the home signal should be placed to danger, and, in the back stroke, become locked before a second train can be offered to the rear signalman. When the first train has arrived at the signal-box in advance, and has passed his home signal, and the signal "Train entered section" has been received from the signal-box still further in advance, the signalman must put his own signal to danger before he can give "Line clear" to the signal-box in the rear for a second train. This applies when the section is from starting signal to home signal, but if the section is from starting signal to starting signal, the condition will apply to the latter. The arrangements should be such as to admit of shunting operations, placing a train in a refuge siding, turning a train back, or slipping a carriage, taking place at any of the stations without break of continuity. The methods employed should be as simple as possible, and such as can be applied to the existing locking frames and block telegraph instruments, and be operated from within the signal-boxes in the ordinary working, and without additional electric wires. It should be possible to cancel a train by the ordinary operations of the levers without having to resort to special keys or releasers.

While long-distance locking must be made by an electric current, the moment this is effected the lock should be secured by a mechanical movement and the current cut off, and all succeeding movements should be mechanical. The use of treadles should be reduced to a minimum, by preference avoided altogether. The arrangement should be applicable not only to "absolute block working," but also to "permissive block working," and to the warning method known as "Section clear, but station or junction blocked," and should be equally applicable to single lines as to double lines of railways. It should be possible to apply the system to parts of railways effectively, such as at junctions or the outlets of loop lines, without disturbing the ordinary working of the other parts. The arrangements should be such as to render unnecessary the stoppage of trains proceeding under the warning rule by providing visual signals.

The real question at issue thus becomes the advantage or disadvantage of uniting the lock and block signalling appliances of railways. If the conditions enumerated above are secured, the advantages appear obvious, some of which may be stated to be as follows—namely: (1) the impossibility of the outdoor signals being at variance with the indoor block instruments; (2) the rear signalman being compelled to forward a train to the man in advance; (3) the advance signalman being unable to accept a second train before his first has cleared out of the section; (4) absolute protection for a train while in section; (5) impossibility of the signalman in the rear forwarding any train in error; (6) the co-operation of three men in signalling a train; (7) the possibility of passing trains more quickly out of the section by adopting visual signals under the warning rule instead of stopping the trains and communicating verbally with the drivers.

As to the disadvantages, they are somewhat difficult to enumerate. It is alleged that with a long section, extending from starting signal to starting signal, delays may be caused when shunting operations are being carried on at a station, and unnecessary complications. It has been the author's aim to state this important subject in as concise a manner as possible, and in such a form as he trusts will provoke discussion. There are a number of gentlemen and firms throughout the country who have made a special study of the subject of the union of the "lock" and "block," and it is to be hoped they will take part in the

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discussion and give their opinions freely, and that this meeting may lead to practical result.

Comparative Advantages of Electricity, Steam, and Compressed Air for Mining Purposes.

BY WILLIAM EDWARD GARFORTH, M.I.C.E.

The question of mechanical power for underground requirements connected with haulage, coal-cutting, pumping, etc., is at the present time occupying the attention of mining men perhaps more than any other subject. High-pressure dry steam is the most economical power for use on the surface. Electricity the most economical and convenient for transmission of power. Compressed air is the safest underground. A combination of the foregoing will probably prove to give the best results.

Whilst high-pressure dry steam is the most economical when generated on the surface in boilers of modern type, and supplied within a limited distance from the winding, pumping, dynamo, hauling, and other engines, yet this remark does not apply when the boilers, engines, etc., are placed underground. The expense of maintaining boiler flues, the danger of setting fire to the surrounding strata, the difficulty of dealing with the exhaust steam, and of obtaining suitable feed water, etc., makes this system unsuitable for use in the pit. Besides, there is also a serious interference in maintaining strict discipline amongst the workmen, and since the introduction of the Compensation Act, insurance companies have refused to undertake extra risks without increased premiums. These objections, amongst others, will in future prevent the erection of boilers underground.

Many instances can be given of the successful working of underground haulage by engines placed on the surface and ropes carried down the shaft and for long distances into the workings. Provided local conditions are suitable, and proper attention has been given to the drums, pulleys (of large diameter), ropes, and accessories, this system of haulage is probably the most economical that can be adopted, besides giving, as regards firedamp, the additional advantage of safety.

The statement that compressed air is the safest power conveys to those in charge of coal mines, which naturally and sometimes suddenly give off large quantities of firedamp, an impression of advantages which compensates to a great extent for the loss of economy. The latter can be ascertained, but it is almost impossible to estimate the loss sustained by the stoppage for some months of a large colliery consequent on an explosion. Even the most modern compressed-air plant, designed either on the wet or dry principle, single or double stage compression, water-jacketed, driven by engines and boilers of the most modern type, pipes of large diameter, numerous air-receivers, etc., show that the losses by heating, leakage, etc., are such that, from an economical point of view, compressed air cannot compare with electricity.

Before referring to the advantages to be gained by the use of electricity it may be pointed out that there are in a coal mine sufficient natural dangers (firedamp, etc.) without introducing artificial ones. As an instance of this, several collieries formerly forced artificial gas from the surface by means of a steam-jet down the pit to light the roads near the bottom of the shaft and where the traffic was greatest. So long as everything connected with the underground workings appeared satisfactory no complaint was entertained, but when an explosion occurred it was suggested the cause of the accident was an accumulation of artificial gas above the roadway timbers, due to leakage from the pipes. In the same way electricity is, by some engineers, being recommended for use at the coal-face in all mines on account of its greater economy as compared with compressed air. The danger connected therewith may not be fully realised in the case of certain deep mines until an accident takes places, attended with serious loss of life. Then, judging by other accidents, economy is forgotten in regretting the loss of life, and afterwards in considering the claims made by the relatives of the men who have been killed or injured. At the same time there are many mines in which it will be perfectly safe to use electricity, provided the cables, motors, and accessories combine the latest improvements.

By the use of electricity not only can high efficiency be obtained, but both generating and transmitting machines are exceedingly compact and require only a limited area; the cables are easily and quickly laid, occupy small space, and, being flexible, are not affected by the lifting floors of the mine. The cables do not require rigidly fastening underground, it is, in fact, preferable to suspend them by means of a cord from the props supporting the roof, so that in case of a fall of stone, etc., the suspension breaks readily, allowing the cable to drop, thus saving it from injury.

With regard to the two systems—polyphase and continuous currents—each has its advantages and drawbacks. The chief points of the three-phased current system are: (1) absence of commutators in both generators and motors, with consequent saving in wear, reduction of repairs and renewals, and less need of constant skilled attendance; (2) complete immunity from sparking; (3) no starting resistance required for motors up to 10 b.h.p. unless exceptionally large starting torque is required; (4) generators of inductor type have all windings fixed. The rotor windings of motors have low potential difference and are not liable to burn out. High pressure can therefore be transmitted without risk to generator or motor, and copper is saved in the line.

With respect to the continuous-current system, the following may be mentioned: (1) a single pair of conductors is required as against three conductors; (2) greater starting torque can be obtained with the motors; (3) accurate measurements can be more readily taken. From a pitwork point of view, the complete absence of sparking at the motor would at first sight seem a consideration in favour of the three-phase current. The best continuous-current motors for this work are, however, now usually boxed in, and for all practical purposes are gas-tight. Thus the danger attending the underground use of electric motors fitted with the latest improvements is reduced to a minimum. At the same time, before adopting electricity, every possible danger should be considered and guarded against, especially in the line of cables. A fall of roof or other accident may at any moment produce a short-circuit or sever the cable and result in serious sparking. Should this take place on the outskirts of an unventilated goaf, consequent on the method of driving, straight work, and working back the pillars, with a weighting roof and an atmosphere clouded with fine coal-dust, due to the coal-face being cut by a machine, then the production of an electric arc gives all the factors for a serious accident. The greatest care should consequently be bestowed on this portion of the electrical installation and the system involving the simplest arrangement and least number of cables should be preferred. The safety of a mine is only equal to the most unsafe lamp or appliance used in it in the same way that the strength of a chain is only equal to the weakest link.

With regard to the best form of cable for continuous current in mining work, concentric conductors seem to be the simplest and safest. The adoption of an earthed circuit is open to many objections. Safety is the predominant factor in planning all underground work, and a tight system is on this account to be preferred. Security from shocks is claimed for the earthed system, but in practice this has not always been found to be the case. For the cable which requires to be vertically suspended down the shaft, vulcanised rubber is the best class of dielectric. The very best qualities of rubber, such as are used for high-class underground street mains, are too soft for this, and a good insulating rubber containing more pigment and of increased thickness should be employed. The core should be lapped with tape and compounded and sheathed with galvanised iron wires of about No. 16 S.W.G. compounded, and coated with compounded jute. Lead-covered cables should not be used for pit work. All cables should be sheathed. As a prime source, steam, when used under the conditions previously described, possesses the greatest advantages. For the transmission of power to a distance electricity is the most economical, efficient, and handiest. In the presence or with the possible occurrence of gas, compressed air is the only one which can be absolutely

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relied upon. For the distribution of power to distant parts of the mine the writer has on many occasions suggested and advocated the employment of a combination of the foregoing—*i.e.*, generating the electricity on the surface, and by a cable down the shaft and along the main roads, conveying the same to an electric motor coupled by gearing or ropes to an air-compressor fixed in a well-ventilated position at a safe distance from the coal-face; then through pipes of suitable diameters conveying the compressed air to pumps, hauling engines, or coal-cutters as desired. As the coal-face advances the motors and compressors are moved. By this arrangement the surface engine-house and foundations are saved, and the motor, etc., can, with a little extra work, be fixed in a disused road. By a careful consideration of the circumstances and requirements, this combination of the best characteristics of each system should overcome all objections to the low efficiency of compressed air and the danger of electricity, and lead to a consummation of an economical and safe system for the distribution of power underground.

The Comparative Advantages of Electricity, Steam, and Compressed Air for Mining Purposes.

BY HENRY SLADE CHILDE, M.I.C.E.

The comparative advantages of electricity, steam, and compressed air for mining purposes opens out a large field for discussion; but for the purpose of this meeting it may be possible to lay down a few general principles without being accused of only skimming over such an interesting subject.

Surface.—Here in almost every case steam is the most adaptable and economical, and, therefore, most commonly used; and it can only be in exceptional cases where it is proposed to carry on some new branch of colliery work that electricity can successfully compete with steam, and then only when it is not possible to erect boilers, chimney stacks, etc., or carry the steam a considerable distance in large pipes, or not thought advisable to have the hauling engine in the mine. In this event it has been found that by putting the dynamo or generating plant near the boilers, and carrying the cable in the ordinary course, electricity can be used on the surface, or conducted down the shaft by putting the cable in 1½in. iron pipes.

In the Shaft.—There are some cases where steam-pumps are fixed in the shafts, below the water-bearing strata, where the water is caught and lifted to the surface. It is seldom possible to use steam for this purpose, except where the pumps happen to be in an upcast shaft, which is very infrequent; but where this is the case, of course, to some extent the heated steam-pipes and the exhaust steam assist the ventilation; but, on the other hand, the pump suffers by reason of being fixed in an atmosphere that contains many gases acting injuriously on the different metals. Compressed air has been tried for this class of work; but, although more advantageous than steam, it does not quite meet the difficulty. Electricity, however, has been found to answer admirably; and the writer knows of collieries where the pumps are actuated by this power, and are carrying out the work economically and with satisfaction.

Underground.—There are three main purposes for which the powers named will be required underground—viz., "hauling," "pumping," and "coal-cutting."

Steam for Hauling.—With regard to the use of steam for this purpose, the steam from the surface boilers is usually conveyed down the pit in properly lagged pipes, and then conducting it to the bottom of the downcast pit, where the engines are placed. The difficulty of getting rid of the exhaust steam is met by returning the steam to the upcast, or sending it through into some old return air-ways. Neither of these methods, however, can be considered as satisfactory, and there is always some escape of steam from engines and pipes which is picked up by the air current and carried in-bye; and for a considerable distance from the pit bottom there is a moisture which affects the roof and sides of the mine, and causes them to fall and slip.

Steam for Pumping.—The writer knows cases where steam has been taken in 6in. pipes to the distance of a mile from the pit bottom; but in his opinion this was most unsatisfactory, although it did unwater an area of coal that was below level. The pipes were taken along the return air-way, and, although protected, a great amount of steam was lost. The question of getting rid of the exhaust in the steam-pump is not so difficult, because it can either be turned into a condenser or into the rising main; but even this necessitates a few minutes' escape of steam every time the pump is started.

Coal-Cutting.—Of course, steam is entirely out of the question for this work.

Compressed Air for Hauling.—This has been found to be most useful when the hauling engine is placed at the shaft bottom, or in-bye, and the writer is conected with collieries where half a dozen hauling engines are used bringing coal up inclines and along levels to the main road, whence the main hauling engine, worked by compressed air, brings 30 or 40 tubs to the drawing-pit. The difficulty, however, of keeping tight joints for compressed air is very considerable, and the loss between the air-compressors and the engine amounts in some cases to as much as 70 per cent., and that within the distance of, say, three-quarters of a mile.

Pumping.—Whatever may be said of the advantages of compressed air for hauling apply equally so for pumping; and there are, of course, a great many instances of pumps in mines worked by compressed air.

Coal-Cutting.—Most of the coal-cutters in use at the present day are actuated by compressed air; and if the main pipes are sufficiently large, and joints can be kept tight, it is a question whether there is any power to beat it; it is easily controlled, and possesses one other feature that a mining engineer looks upon as of the utmost value—viz., safety—in addition to keeping the working places somewhat fresher and sweeter, and in a manner assisting ventilation; but, on the question of economy, it is not, in the writer's opinion, so cheap as electricity. The presence of a line of steam or air pipes in any air-way is inconvenient, irrespective of heat and escape of steam, and it must be borne in mind that the roadway of a mine is continually on the move, and that pipes are always leaking more or less, and take a good deal of time to make a perfectly tight line.

Electricity.—As stated under the first heading, this is not used much on the surface.

Pumps in Shafts.—See beginning.

Hauling.—For hauling at the pit bottom electricity is used at several collieries, and is coming more into operation, the ease with which a cable can be taken down and fixed in the shafts and roads of the mine being of great value.

Hauling and Pumping in-bye.—For small hauling engines and pumping engines electricity is most convenient; the motor can be easily fixed and removed, and the very great value of electricity in the main lies in the fact that the cables can be taken from place to place with such little trouble; it is difficult to say exactly the difference in time occupied between laying, say, a mile line of 6in. pipes for compressed air and a cable 1in. in diameter, but it will be about as 6 is to 1 in favour of the cable; and where hauling and pumping machinery are in main intakes there is no doubt, in the writer's view, electricity is by far the best agent. The writer is acquainted with a case where, in order to work an underground pump in a lower seam, a borehole was put down from the upper seam quite a mile away from the pit bottom, and the cable put through; this is once instance of the adaptability of electricity.

Coal-Cutting.—Here electricity has been much used; but it is a moot point whether its many advantages overcome the risk. At the present moment no explosion can be traced to electricity, because the users of it have been comparatively slight; but it stands to reason that if an explosive admixture comes in contact with an electric spark an explosion must result; it cannot, therefore, be used with complete safety, although, if the continuous current is converted into three-phase alternating current, no sparking will occur as there are no rubbing contacts; but even this is not quite satisfactory.

Summary.—For general surface purposes steam is undoubtedly first; for working in shafts and for all underground work (excepting on the one ground of safety) electricity has the advantage over compressed air.

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STANDARDISATION.

German manufacturers seem to be as much interested in this question as are their English *confrères*, for at the recent meeting of the Verband it formed one of the main topics for discussion. Like a good many other questions, it is one with an infinite number of solutions; in fact, each manufacturer believes his own standard to be the correct one and *better* than that of any other competitor. Naturally a manufacturer regards the requirement of new patterns as a nuisance, and would prefer to work to stock from standardised patterns rather than to work to order with constantly modified patterns. There are many bits of apparatus, however, which might without trouble and with great advantage all round be standardised. Such an object has the British Association in view in its endeavour to standardise screws. The whole secret of the value of standardisation depends upon the present position of the apparatus and the room there remains for improvement. If the apparatus is not close upon the confines of perfection, standardising means backwardising. It stops progress, limits competition, and keeps more imperfect apparatus that might be made more perfect. One part of the discussion at the Verband meeting related to the permeability of iron and steel used in dynamo construction. Perhaps the micrographic examination of the material will help forward the day when the ironmaster can predict the result of his labours, but at the present moment he is not in that happy condition. The road to be travelled is yet long in many directions before perfection is reached. To standardise permeability now would mean to place a particular works, or the works in a particular district, in the control of a monopoly. A particular manufacturer may standardise his own goods—that is his individual concern—but a natural or universal standardisation means the selection of the best, for anything below the best cannot be looked upon as a standard; and in many cases the best is known to be not yet. This was laughingly indicated in relation to meters during a casual conversation on the subject. It was suggested in the hearing of a well-known inventor of meters that a suitable question for discussion would be, What is the best meter in the market? His reply was that it was not invented yet. Suppose, then, some powerful institution should desire to issue a standard specification of a meter, it would be tantamount to saying, The meter is invented, and here is its specification. For these and other reasons we venture to suggest that no urgency can be proved to support any general system of standardising.

TOO TIMID.

If there is one thing more pronounced than any other in the counsels of committees controlling the design of central stations it is extreme timidity. The result is loss of efficiency and increase of cost. It is simpler to build a station of double the size in the first place than to find extensions must be built almost before the smaller station is finished. When the initial station is

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thus quickly found to be too small, the result, even when the extensions are complete, is to find the plant cramped into too small a space. It is desirable in central-station work to have enough room to swing the proverbial cat, not to say enough room for the due disposition of cables, etc., and for ventilating purposes. The cause of this timidity is probably to be found in the rigid regulations of the Board of Trade briefly referred to in our issue of last week. Hence in the majority of stations the earlier plant consists of too small units, and engineers well know that the efficiency of smaller steam-engines and of dynamos is worse than that of larger sizes. The time has surely come when a broader view of the matter can be taken, and the various authorities, if properly advised, will be found ready to agree to more extensive schemes even in the earliest stages. Such advice ought not to be given if the matter was one of a speculative character, but it is not; that stage is past, and ought to be forgotten.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

POSITION OF ACCUMULATORS.

SIR,—I shall feel obliged if any of your correspondents can give me information on the following points relating to an installation of about 100 lights in a country house:

1. The engine and dynamo being some 100 yards or more from the house, would it be better to fix the battery and switchboard at the house or near the dynamo, regard being had to the loss of volts in the mains, and also to the fact that as the lights would usually be run from the battery only, it would be inconvenient to have to go to the engine-house to switch in more regulating cells if required?

2. The best relative proportions of dynamo and battery capacities, all the lights fixed being occasionally used at one time, although generally not more than one-half to two-thirds?—Yours, etc., A. B.

INSTITUTION OF CIVIL ENGINEERS.

SECOND CONFERENCE.

(Continued from page 732.)

A discussion followed the reading of Mr. Walter Pitt's paper last Friday, at the conference of the Institution of Civil Engineers, on "Cranes, and the Power to be used with them." The paper appeared in our last issue.

Mr. R. HAMMOND, in opening the discussion, thought the question at issue between the use of electrical energy and hydraulic power was purely a question of cost. He also compared the use of electricity with that of steam in regard to cranes, and in doing so referred to the use of the switch as possessing an immense advantage over steam power.

In the course of the subsequent discussion, it was remarked by one speaker that it was surprising to see the enormous development which had taken place in electrical cranes on the Continent. At Hamburg there were 85 of these at work, and what struck one was that at an English port one would find a steam-crane, with steam up five or six hours, waiting for a ship to come in. This would, of course, mean great waste, but would be quite obviated by using electricity. Although steam-cranes were cheaper than those worked by electricity, yet the advantage of having the latter was immense.

Mr. F. W. TANNETT WALKER said he never received a more astounding shock in his life than in connection with this paper. If the author went around the docks and railways in England in search of electric cranes, unless he took great care where he walked, he would knock his head against a good many hydraulic cranes before he would see an electrical one. The simplicity and absolute control and reliability of hydraulic cranes could not be ignored. If Lord Armstrong or the speaker's father had been present when Mr. Pitt read his paper, he did not know what would have happened, nor could he understand what would be the feelings of Government and other officials when they perused the paper.

Mr. PITT, in his reply, still contended that electrical cranes were the coming thing.

There was only a brief discussion on the papers by Messrs. Garforth and Childe, in the course of which Mr. A. L. STEAVENSON pointed out the relative advantages possessed by electricity over compressed air in regard to drills. These papers will be found elsewhere in this issue.

MODIFICATIONS OF COMMON GALVANIC CELLS.

The following abstract of a paper by Mr. Emil Petersen, in the *Zeitschrift für Eletrochemie*, is taken from the *Journal* of the Chemical Society. The author shows that when the sulphuric acid in the Bunsen cell is replaced by a saturated solution of common salt, the E.M.F. is not altered, and the internal resistance is hardly changed; it is slightly increased if a solution of four parts of sodium nitrate in five parts of water is used. The nitric acid may be replaced by other oxidising agents, but the constancy of the cell suffers. A cell arranged as follows: Zn | NaCl solution (1 : 5), $FeCl_3,6H_2O$ solution (2 : 1) | carbon, has an E.M.F. of 1·72 volts. It will give a current of not more than one ampere for hours at constant E.M.F. The principal reaction is $Zn + 2FeCl_3 = ZnCl_2 + 2FeCl_2$; the secondary reaction, $3Zn + 2FeCl_3 + 6H_2O = 3ZnCl_2 + 2Fe(OH)_3 + 3H_2$, also occurs. When the ferric chloride is entirely reduced, the E.M.F. sinks to about 0·5 volt, and metallic iron is deposited on the carbon. The cell is now a very constant one of the Daniell type. If the porous cell is left out, the combination Zn | $FeCl_3$ solution | C gives 1·6 volts; Fe | $FeCl_3$ solution | C gives 0·9 volt. Potassium ferricyanide is an efficient substitute for the nitric acid in the Bunsen cell so long as no large amount of ferrocyanide is present. The E.M.F. diminishes gradually from 1·438 volts with pure ferricyanide to 1·105 volts with pure ferrocyanide. A convenient form of Daniell cell, in which magnesium chloride is used in place of zinc sulphate, is also briefly described.

THE GOVERNMENT TELEPHONE BILL.

On Tuesday last the Government Telephone Bill again came up for discussion in the House of Commons.

Mr. Hanbury, in moving the second reading of this Bill, said that the time which had elapsed since he introduced the measure had produced one result. Complete unanimity had been shown on one point—namely, that the present system could not possibly go on. There had not been a single resolution from a local authority, no memorial from a trading association, not an argument in the newspapers, which had supported the existing system. The company had itself introduced Bills, which was the clearest evidence that without fresh powers the present system could not go on; and he was sure that the House was not prepared to grant fresh powers to a company which had already very large powers, and which was absolutely uncontrolled. Authorities at Liverpool had requested the parliamentary representatives to oppose any extension of the powers of the National Telephone Company, and a resolution had been unanimously adopted by the Association of Municipal Corporations to the same effect. And surely there was very good reason for a step of that kind being taken, because the figures with regard to the state of the telephonic communication in this country were positively alarming. In Switzerland there was one telephone in use for every 100 population; Norway, one in 144; Sweden, one in 147; the United States, one in 132. In all those cases there was practically no State system, but one worked by local bodies or general competition. Taking the principal countries where there was State control and no competition, in Germany there was only one telephone for every 449 inhabitants; France, one in 1,432; Austria,

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one in 1,640. England, even as compared with Germany, was far behind, for she had only one telephone for every 636 of the population. Passing from the countries to the principal towns, he found that in Stockholm, where there were actually three systems in competition with one another—which was a considerable argument against those who said competition was impossible in this matter—the number of telephone users was one in every 14 of the population; Geneva, one in 23; Berne, one in 27; San Francisco, one in 27; Hamburg, one in 56; Berlin, one in 82; Vienna, one in 132; London, one in 433.

Sir J Fergusson (Manchester, N.E.): Where did the right hon. gentleman get those figures?

Mr. Hanbury: I got my figures from the chief engineer of the Post Office made up to date only yesterday. It was not necessary, however, to go beyond our own country for examples. The National Telephone Company's service has been established in Jersey for a considerable number of years, and there the telephone users were as one in 650 of the population. Now, in Guernsey, which was one of the places where the Post Office had granted licenses to the local authority, the proportion was 1 in 84, although the system had only been started about two years ago, and the number of subscribers was growing rapidly every day. He thought, therefore, their first essay in the direction of municipal telephones had not been unsatisfactory. He frankly recognised that the National Telephone Company had done good work, and wherever it had got wayleaves and could give an efficient service, serving all alike on equal terms, he should be sorry to see that system discontinued. What we wanted in this country was a general system that would extend itself over the whole country, but the National Company picked out the most densely populated parts of the country. Being a private company it naturally consulted its own interests. He would do the National Telephone Company the justice to say that wherever they got the opportunity they gave an efficient service—that was to say, where they had underground wayleaves and a double-circuit system. But there were a large number of municipalities which would not give these underground wayleaves, and in those towns the company could not give an efficient service. Parliament had always refused to give wayleaves, and no Government had ever supported the granting of them. But it did not follow because the company could not get wayleaves that the country was to go without an efficient telephonic service, which was so important to the trade and commerce of the country. Five-sixths of the present wayleaves could be terminated by those who granted them within six or twelve months, and it could not be permitted that a national service should exist on such a precarious footing as that. These being the requirements, a good many persons had jumped to the conclusion, on the analogue of the Post Office and telegraph service, that State telephones were the only solution of the difficulty. It was not surprising that the ingenious directors of the company should back those people up in that view. The indirect influence that the company was bringing to bear—where it was hard to say where public policy begins and private interest ends, where all kinds of preferences and trusteeships could be put into various hands—constituted one of the greatest arguments against an enormous monopoly like this. He fully admitted that the control of the whole telephone service must be in the hands of the Postmaster-General. It was necessary for uniformity, and under this Bill, for the first time, they should be able to get that uniformity, and they should be able to resist the imposition of terminals, which they could not do in the case of the National Company. He saw no reason, however, why the State should actually undertake work which could be just as well done by the local people on the spot. Something like 98 per cent. of the whole messages in the exchange never left the locality, and never came on to the trunk wires. There being no practical and technical advantages in State management, why should they incur an enormous and unnecessary increase in the staff of the Post Office, and the corresponding increase in wages? The Postmaster-General was already the greatest employer of labour in the world, and the staff was growing year by year. Again, the wages of the company's servants were, as compared with those paid by the Post Office, exceedingly small. In the case of the trunk wires which had been taken over, the wages had to be raised 40 per cent., and they would have to do the same by the others, in addition to providing for pensions in order to place them on the same footing as the telegraphists, who, as they knew, were not at all satisfied with their conditions of service. Nationalisation of the telephones meant immediate purchase at an accommodation price. It meant buying up the National Telephone Company as it was at the present moment, a monopoly—a monopoly which he thought ought never to have been allowed to grow up—and it meant that they should have to buy as a going concern a monopoly which would fall into their laps in 1911. While he was most anxious that they should treat the company with absolute fairness, he thought that to ask them to buy up that monopoly as a going concern was to ask too much of them. If they decided to buy up the company, he candidly admitted that the purchase would include much good work, as at Liverpool, where the service was as nearly perfect as it could be made, and where any change was unnecessary; but in other places the system was not so perfect, and he objected even more to buying up the latter than the former. Twenty-five per cent. of the company's system consisted of single wires, and in London and a number of provincial towns practically nothing but overhead wires prevailed, which would be absolutely useless to the State. They were made of very poor material, many were disused, and a large number were private wires outside the monopoly altogether. Another objection to nationalisation was that, owing to the improvements which have been effected in Liverpool and other towns, the State would be called upon to first buy up the wires with those improvements and then to replace them. If they were to spend money on the telephone system he should like, in the first place, to get value for it; to spend it, not in replacing and supplementing the company's system, but in bringing ourselves to the same level as other countries. The president of the Council of Associated Stockbrokers, who had taken such a very prominent part in that question—he did not know why—said that "Either the Government should assume sole control or enable those at present working the telephones full power of developing the same, subject, of course, to control." He had already explained that that could not be done in the places where the company had no wires already, and those were the very places where the State would have to provide them. To suggest that the Post Office should go through the form of calling the company its agent and then use its own powers over the heads of the municipalities in order to give them wayleaves was absurd. Having shown the practical impossibility of a State system, and that the company could under no circumstances supply places where there were no proper wayleaves, they were thrown back upon only two other sources of supply. One was the local authorities, which he proposed should include sanitary districts, thus carrying the telephone system to almost every part of the country. Corporations which were unwilling to grant wayleaves to a rich and powerful company might be willing to grant them to small local companies over which they could have more control. With such small companies fair conditions could be imposed, and preferences could be guarded against or the refusal to serve all alike upon equal terms. By that means he believed as good a service could be given in all respects as the State could possibly give, and any friction between the State and the local authorities would be avoided. The local service would supplement the National Telephone Company's system in very large areas, and would have the effect, he believed, of bracing up the company and making it give a better service even where a municipality itself would not compete or allow another company to do so. All that they wanted was to get an efficient service, and to see further, that it was fair to the company, who had done a great and useful work. It was admitted from the first that there was no unfairness, and he thought that would be admitted by his right hon. friend. It had never been a question that it was perfectly fair to start new companies in opposition. Then came the municipalities, to which the company raised great objection. The Government in this matter had tried to balance advantages and disadvantages, and they had offered, in a Treasury minute, the recommendations, arrived at, he believed, unanimously, of the Select Committee. They offered to purchase the plant, such as was suitable and fit, under certain conditions in 1911, and, considering that in 1911 they would be under no obligation to buy one pennyworth of the company's plant, that was a very large offer. In addition, under certain circumstances, they were going to impose somewhat stringent conditions upon municipalities, and there were also other proposals which, he thought, formed a large and fair offer. As he had said, what they wanted mainly was an efficient service. It did not matter whether that service was given by the company or the municipalities or other companies. Referring next to a resolution passed by stockbrokers declaring that the Government were attempting improperly to depreciate, so as to ultimately purchase the property at a low price, all that he had to say was that, as the Government had no intention of purchasing at all, the resolution was somewhat wide of the mark. Now what were the objections and who were the objectors to this proposal? In the first place, the main objection came from the large traders of the country, and it was remarkable with what unanimity and sameness of language all the resolutions were passed. In addition to the stockbrokers and lawyers they had the chambers of commerce, which represented the larger traders of the country; but at the utmost only 22 chambers out of 96 had offered any opposition to this Bill. The larger traders objected because they were getting uncommonly good value for their money. For a subscription of £15 in London and £10 in the provinces they monopolised the whole of the exchange and the trunk wires; and for this sum they had the unlimited right of sending messages. He asked them to imagine the telegraph system of the country worked on that principle. Men in that favourable position did not want to be disturbed. Thus they had one man getting £300 worth of messages for £15 to £20 a year. What was wanted was to make the service a popular one, as open to small as to large traders. Small traders had memorialised the Treasury time after time that this concession might be made. It was complained that the trunk wires were crowded; and he thought that they must, in order to remove the last objection, increase the number of trunk lines. As to the large towns, after all, the objection came from Liverpool and Nottingham; and they were in a minority. ("No.") Well, they were the only two Corporations which had memorialised the Government, and it so happened that they were the two who were exceptionally well off. They had made a good bargain with the National Telephone Company, and had got a very good service. But why should they stand in the way of other municipalities which had not got such an efficient service, and why should these big corporations, which were able to hold their own against a company like the National Telephone Company stand in the way of the smaller municipalities which were not so well able to fight their battle with the National Company? The only objection taken by the town clerk of Nottingham was that no other system but a national system would supply the country districts. He did not believe it. He thought companies would supply those districts just as well as the State. The town clerk of Liverpool admitted that he had no objection whatever to municipal enterprise in telephones where there was no service at

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the present moment and no competition with the National Telephone Company. Well, what an enormous area that was. Then, again, the town clerk opposed it on the ground of the limited use of telephones, and that it did not extend to the bulk of the population. It did not at the present moment, and as long as the present system went on it never would. But if the toll system were introduced there was no reason whatever why in a great number of their towns there should not be just as large a proportion of telephone users as in Stockholm, or Geneva, or Berlin. The information sent to him only a couple of days ago as to Guernsey furnished a remarkable illustration of what municipal enterprise would do. The States of Guernsey only started the telephone two years ago, and they had already got one telephone to every 84 of the population, and a tariff which met every class of subscriber. The result was that they were paying interest on their capital, a Government royalty of 10 per cent., and were also building up a sinking fund. Local authorities were, after all, the best judges of their own interests. They need not start a service if they did not want it or if they thought it was not to the interest of their ratepayers, especially now that they were giving them three alternatives. In Stockholm, where there were more telephone users per population than in any place in the world, they had three systems working side by side in opposition to one another. (An **Hon. Member**: At a great loss.) No, not at a loss. There was the State system and two companies. They had in this country got their own Post Office exchanges, but he was bound to say that owing to Treasury regulations they were not worked as they ought to be. That he perfectly admitted, but even so they had been paying a large interest on their capital. An intelligent Treasury had now abolished those regulations. It was true that the National Company was to a certain extent at a disadvantage in that it did not get underground wayleaves. But in Manchester they had those wayleaves, and yet there, though the National Company was giving an efficient service, a new company had applied for a license, with the support, he believed, of the Corporation. That did not look as if competition within the same area was such a dangerous thing for the municipality. Then there was another alternative. The local authority might buy up the National Company in any area, or—and he thought this was much the more likely course—there might be a connection between the service of the company and that of the municipality. The Government were offering them every inducement to do that, and the very able manager of the National Company had admitted that he did not think there would be any practical difficulty in carrying out such an arrangement. He believed, too, that the company would find it to its own interest to adopt such a course. It had been objected that corporations would not give a popular service. Corporations would have to please their constituents, and if their constituents wanted this service and did not get it they would turn out the corporation who refused it and put in one who would give it. What were the inducements to a popular service? Well, in America, within the last three years, since the service had been made a toll one, it had grown by leaps and bounds, and only yesterday he had read a statement to the effect that Germany had also introduced the toll system, and was popularising its service, not only in Berlin, but throughout the country. It had been urged that they did not give corporations sufficient time to recoup their expenditure. He thought that even 12 years was a considerable time for that purpose, but the House must recollect that under the conditions which they were offering they would only have to redeem 50 per cent. of their capital by 1911. They did not regard it as by any means a certainty that 1911 would see the end of the licenses of their new licensees. If nationalisation were as unpopular with the Government of that day as it was with the present Government, municipalities would retain the service long after 1911. He hoped he had made the case perfectly clear. He hoped there was no impression that they were anxious in any way to take an unfair advantage of the National Company. On the contrary, he thought he had shown the House that, if their proposals were accepted, that company would be in a better position than they had ever been before—they would at least be in a much more certain position. Not only so, but they would get a popular service and a service not dependent on a precarious tenure as it was now. He hoped the House, looking at the emergency of the case, and to the fact that the United Kingdom lagged far behind other countries in the matter of telephonic communication, which was so essential to their trade and commerce, would agree to the second reading of the Bill, and to passing it through its other stages without any unnecessary delay.

After the usual interval the following discussion then took place:

Sir J. Joicey (Durham, Chester-le-Street) said that as a member of the Telephone Committee he was bound to say that the evidence given before the committee bore out to a considerable extent the statement just made by the Secretary to the Treasury. He recognised that while the National Telephone Company had done good work its service was inefficient and certainly inadequate. Undoubtedly the company had to contend with the difficulty of developing a new service. Many of the patents were untried, a good deal of the work was new to those who had to perform it, and under such circumstances some allowance should be made for the company. He confessed that he was astonished at the policy pursued by the Post Office. He should have thought that if the Post Office believed competition to be a good thing they would have done all they could to develop competition instead of encouraging the National Telephone Company to get rid of the only competitors they had. Doubtless the Post Office felt that some day they would have to purchase the telephones, and that it would be much better to have to deal with one company instead of many. He felt that there were many disadvantages in the course provided by the Bill. It would be to the interest of the community that there should be a national telephonic system worked on the same principle as the postal and telegraphic system, but he objected to the Bill because it was not based on the report of the committee. The committee distinctly recommended competition as the best means of extending and popularising the system. What did they say at the end of their report? "On reviewing the whole of the evidence, your committee is strongly of opinion that genuine, immediate, and effective competition by either the Post Office or the local authorities is necessary, and considers that a really efficient Post Office service affords the best means for securing such competition." He was bound to say that the Bill did not carry out that recommendation. He looked forward to the time when the whole telephone system would have to be taken over by the Post Office, and, holding that view, he thought it would be disastrous to allow municipal authorities to have licenses to work telephone systems. He was afraid that the municipal authorities might make it a very profitable business, and would require enormous compensation if the Post Office took over the telephones. He contended that the profits realised in the large towns ought to go into the hands of the Post Office, so that the outlying agricultural districts might be developed. He could not support the Bill without further consideration, and he thought the Government had been rather hasty in coming to a conclusion on this important question. He hoped that the Government would withdraw the Bill in order that further consideration might be given to the question.

Mr. Griffith-Boscawen (Kent, Tunbridge) said that he could not understand any member of the Telephone Committee complaining that the Government had not attempted to carry out the recommendations of the committee. The committee recommended general, immediate, and effective competition by the Post Office or the local authorities; and that was just what the Bill would make possible. As to the relative position of the telephone in England and Germany, his right hon. friend had already quoted figures.

Sir J. Fergusson: It is perfectly ridiculous.

Mr. Griffith-Boscawen said that he could not accept the view of the right hon. member for North-East Manchester. The statements he referred to were official statements, made in evidence and not contradicted. The National Telephone Company, in their own comparisons, included private wires with exchange telephones, which was obviously unfair, as the private wire was not a public benefit. But it remained true that while this country was ahead in most mechanical appliances it still lagged behind in respect of the telephone. This was the result of the unregulated monopoly which the Bill would break down. The cost of the telephone in England was much higher than in most foreign countries. Mr. Forbes put the average cost in London at £14. The cost in Berlin was £7. 10s. In Jutland there were 300 exchanges, and the subscription varied from £2. 10s. to £4. 3s. per annum. Why was not the telephone developed in our country districts as it was in Jutland? Because it was in the hands of a company which would not move without the prospect of an immediate return. Attempts had been made in this country, so far unsuccessfully, to introduce a different system. An enquiry, for example, was held in Glasgow, and the charge suggested there was not £14, but five guineas. The reason why we lagged behind other countries was on account of the rates charged. Those rates were charged for two reasons—first of all, because the company had a monopoly, and naturally was making as much out of the monopoly as it could; next, because the company was bound to pay interest on an amount of capital which was altogether too large. Was it right, fair, or in the interest of the public that the National Telephone Company should be left with an absolute monopoly, and that the rate should be determined, not by the actual cost of the service, but by the amount of "water" contained in the capital? It was said that they were dealing unfairly with the company in bringing forward this Bill by suggesting Post Office competition. But the fact was that throughout the whole of this business the Post Office had always retained to itself the right of competition either by itself or by the licensing of other companies or municipalities. The real strength of the opposition to the Bill came from the statement which had been circulated by the agents or friends of the National Telephone Company, that the promoters were acting in an unfair way in asking for this competition; but there was no truth in this suggestion of unfairness. The opposition to the Bill came from a variety of sources. Some persons held that municipal trading was a bad thing. It was, however, rather late in the day to suggest this objection, because many municipalities were now responsible for their gas, water, and electric lighting, and his experience showed that as a rule they provided these things very well indeed. The telephone was not to be worked by the municipalities at a profit. There were other persons who objected to competition by stating that it would be far better that the telephone should be in the hands of one authority. Probably one unified system for the telephone would be the best plan, but the step was not taken at the start of the movement. Were they then to waste money buying up obsolete plant at an inflated price in order to obtain theoretically what was considered to be the best system? Others objected to the proposal because they thought that local authorities were not the proper bodies to develop the system in the country districts. He did not suppose that local authorities would be likely to develop the system largely in the country districts, but if they allowed large municipalities to develop the system in their own districts, then they left the

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Post Office free to go into the country districts and to develop the system there. By the provisions of the Bill—which allowed not merely local authorities, but the Post Office also, to supplement the present inadequate service—they would cover the country with telephones, which had never yet been done. The proposal to refer the Bill to a Select Committee was the most transparent device for delay ever heard in the House of Commons, and there was nothing which the National Company would more desire. He hoped the Government would listen to no such suggestion, but pass their Bill as quickly as possible.

Sir J. Lubbock (London University), referring to the surprise which had been expressed by the right hon. gentleman that the stock exchanges should take so much interest in this matter, said the stock exchanges represented the feelings of English investors. Personally he looked at the question from the point of view of the general interest of the community. From that standpoint he questioned the contention that the service of the National Company was inefficient. The only case enquired into was that of Glasgow, and the Sheriff of Perthshire found that the admitted inefficiency of the service in that city was not the fault of the company, but was due to the fact that the municipality refused to allow them the necessary wayleaves. Although the telephone system was much more recent than telegraphy, 540,000,000 messages were last year sent through the telephone, as against 80,000,000 by telegraph. Comparisons as to the expense of the telephone system were difficult, but Sir W. Preece had stated that he believed that in Germany, although there was no night service, the State worked it at a loss. In this country a night service had to be maintained; wayleaves had to be paid for; the Government received 10 per cent. of the gross receipts; and, lastly, the company, under existing conditions, had to amortise its stock by the year 1911—a circumstance which had restricted its expenditure on the upkeep and extension of the system. Notwithstanding those disadvantages, Sir W. Preece had stated in his evidence before last year's committee that this country was before Germany, and that the condition of the telephones in England was very advanced indeed. Many of the complaints against the telephone arose from inexperience in its use, and Sir W. Preece had expressed the opinion that if one quarter of the intelligence of the operator were transferred to the subscriber, 99 per cent. of the complaints would cease. As to the clauses which authorised and encouraged municipalities to engage in the telephone business, manufacturers and chambers of commerce viewed with alarm the growing tendency of municipalities to enter into trading operations. That tendency would inevitably lead to an increase of the rates, because municipalities were almost certain to make a loss if they continued in the course they had adopted. The fact that the debt of municipalities was going up by leaps and bounds also made many of them reluctant to see the municipalities advance in this direction. Already that debt was increasing, and must in any case increase, but if the municipalities, in addition to their other duties, were to undertake the working of building societies, to run tramways and omnibuses, to carry out gas and electric lighting, to work telephones, and to become manufacturers of appliances used in these trades their debt would arrive at portentous proportions. At the present time municipal stocks were regarded as safe investments, but if municipalities embarked in these trading and commercial operations they would have some municipal stocks which would be very good investments and others which they would have to watch as they watched the stocks of a company which was not succeeding. He would only touch lightly on the subject of corruption, but in New York they had an example which ought to make them careful how far they gave rise to temptation. Then there was the question of the multiplication of employés in the service of municipalities. Councillors were directly elected by the very people whose wages they would have to determine, and it would be almost impossible for them not to pay more than a fair rate of wages in these circumstances. In February last the Government promised the chambers of commerce that a joint committee of the two Houses of Parliament should enquire into this question, but now before that committee was appointed they were prejudging the whole question and proposing an immense extension of municipal enterprise. With regard to the proposal of the Government to institute a telephone service in London and ultimately to work the whole system, he urged that the objections to municipalities undertaking this form of trading applied with even greater force against the Government embarking upon it. There was the risk, indeed, he might say the certainty, of loss, which would fall on the taxpayers generally for the benefit of the few who used the telephones. This had happened in the case of the telegraph service. According to the last return the country had lost £7,200,000 by that service. It was often said that this loss was due to the fact that too much had been given to the private telegraph companies in the first instance for the system; but that was not the case. The interest on the money paid to the private companies was £298,000; the loss on the service last year was £600,000, so that even if the system had been handed over to the State for nothing there would still have been a loss of £300,000 a year on its working. A committee appointed by the Government in 1875 to enquire into the reasons of this loss reported it was due to salaries and wages, especially for subordinate work, having been raised 30 or 40 per cent., and since then the loss had been further increased by the lowering of the charge for messages from 1s. to 6d. Resolutions condemning the Bill had been passed by all the principal chambers of commerce, and it should be remembered that the members of those bodies where the persons whom the measure most concerned. He maintained that the telephone was nationalised already. The State received one-tenth of the receipts. It gained £100,000 a year by the telephone and lost £600,000 a year by the telegraphs. Moreover, the gain by the telephone was increasing and the loss by the telegraph was increasing. They were now asked to abandon the system by which they profited and to replace it by the system under which they lost. He doubted whether the Government had considered fully the course on which they were embarking. The hon. member for Battersea knew his own mind and held that all private property should be in the hands of the State or the municipality. This was, indeed, the logical conclusion from the proposals contained in the Bill. Bread was more necessary than the telephone. Why should not the Government supply Londoners with bread? It seemed to him that there was more to be said for taking up the business of bakers than that of telephones. This Bill was opposed by the Society of Arts and Manufactures, by the Society of Electrical Engineers, by all the great chambers of commerce, and by several of the stock exchanges—all, in fact, who had expressed any opinion on the subject. He believed the State would lose heavily by the telephone as they had by the telegraph, but he based his case on the broad ground that it was unwise, and contrary to the public interests, that Government should undertake business for profit. That was not the true function of government. The proposals in this Bill were unjust and impolitic, and would check both private enterprise and scientific progress. The committee of last year only enquired into one part of the subject, and being convinced that the subject required further study and enquiry, he proposed after the second reading to move that it be referred to a Select Committee.

Sir J. Woodhouse (Huddersfield) said he should have thought, had it not been for the empty state of the front Opposition bench, that this was the most important measure the Government had yet introduced. The aim of this Bill was to reflect the opinion of the Select Committee, and he offered his humble support to the measure proposed by the Government. The *Times* in a leading article said that the telephone was a modern and most essential adjunct to their commercial life; and, notwithstanding what had been said by the right hon. baronet, the service was inadequate. Give them a good service and the telephone would be as successful here as it was in Berlin. The only remedy for the monopoly was competition, and the committee recommended that the competition should be in two forms—by the State and by local authorities. There was no analogy in their public services for the monopoly in the telephone service; and this monopoly, which the public never expected, should be brought about was unrestricted and aggravated. What had been the effect? Why, that telephonic enterprise had been retarded so that the United Kingdom was only tenth in the great countries of Europe in regard to telephonic enterprise. They were put to shame in this matter of telephonic communication even by their own colony of New Zealand. The remedy for the present condition of things was that prescribed by the Bill—competition—and the only issue between them was as to the nature of that competion. Their first desire was to see the monopoly of the National Company broke down, and when competition came the effect would be, first, to reduce the charges; and, secondly, to improve the service. His opinion was that the best competition that could be introduced, at any rate in the case of the great municipalities, was municipal competition. There could be no more difficulty in a municipality working the telephone locally and within the area prescribed than in their supplying gas and water and working tramways, all of which they had admittedly done with great advantage to the community. With so many examples in the reports before the House he could not understand the objections to a municipal service. He could quite understand the fight made by the National Telephone Company, who were making most strenuous efforts to prevent the Bill being carried, using their great influence upon members of the House, upon the Stock Exchange and elsewhere; but he earnestly appealed to members to disregard Stock Exchange resolutions and the interests of a private trading company, and look only to the public interest, doing justice, of course, to private interests, as Parliament should. Municipalities had to regard public interests solely; they had no paid board of directors, they had a large staff, they could supply a cheaper service, and extend the telephone system as the trade of the country demanded it should be extended.

Mr. C. McArthur assured the House that Liverpool opinion was solid and undivided in objection to the Bill. The objections had not proceeded from one quarter; they came from the Chamber of Commerce, from the mercantile body, from the Corporation, the Dock Board, the Shipowners' Association, and even from the professional classes. All these sections of opinion united in expressing the desire that the Bill should be withdrawn, and that a proposal should be formulated on the principle of nationalisation. He had no interest, direct or indirect, in the National Telephone Company, and when the deputation which waited on the Secretary to the Treasury was formed, care was taken to see that no one who proposed to speak for the deputation had any interest in the company. It was said this was a movement of wholesale traders to keep the telephone monopoly they had got. This was altogether a mistake, because wholesale traders were not so narrowminded as to suppose that what would benefit retail traders would not also benefit them. They knew that what was for the benefit of trade was for the benefit of traders whether large or small. It was the desire of the chambers of commerce to popularise the telephone. While he considered that the present system should not continue, the National Telephone Company should be dealt with justly, because, after all, they were the pioneers of telephones in this country. In the system of the future there must be uniformity

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and central control. The second section was still more objectionable. The United Kingdom was mapped out into territorial areas, and if the proposal of the right hon. gentleman were carried out in its entirety the result would be that each of the areas would have a separate authority and a separate system; there would be a multiplicity of authorities competing with one another. He did not think that any municipal authority would enter into competition with the National Telephone Company upon the terms offered. What, for instance, was the prospect held out to a municipal authority to embark on such a scheme? It was that the plant would be taken at a fair market value at the time of purchase. What was a fair market value of a system which had lost its license to work? Surely it was practically nil. The true remedy was the nationalisation of the telephones, and he saw no practical difficulties in the way of the adoption of such a plan.

Mr. Faithfull Begg (Glasgow, St. Rollox) said that references had been made to stockbrokers and the Stock Exchange, and it had been insinuated that they had had a great deal to do with this question lately. As a member of the Stock Exchange, he would be glad if the House would take the assurance from him that in any line he had taken on this subject he had been actuated purely by public motives. This Bill proposed to carry out the recommendations of the committee which reported last year, but in his view it certainly was not justified by the report of that committee. That report recommended that there should be competition either by the Post Office or the municipalities, and it went on to say that a really efficient Post Office service was the best means of obtaining competition. This Bill did not provide for an effective Post Office competition. He laid stress on the fact that the high officials of the Post Office in their evidence before the Select Committee stated that, in their opinion, the telephone service should be undertaken by the Government, and that such was always the view of the Department. No more remarkable series of resolutions had ever been passed in regard to any measure affecting trade and commerce than those of the chambers of commerce, the stock exchanges, and other large bodies. The Association of Municipal Corporations had strongly protested against any Act being passed which would tend to delay the Government undertaking the telephone service. Nothing, indeed, could exceed the absurdity of getting up in large centres or country districts a series of different competing bodies all endeavouring to serve the public in the matter of telephones. The result of the competing system established under the Bill would be to cause great expense owing to the competition which would ensue to obtain the services of the limited number of skilled operators and experts available. The proper telephone service in the future must be a Government service under the control of some central authority like the Post Office established on a uniform system, and made as cheap as possible in the interest of the public. But the proposal of the Government was no remedy for the state of affairs which existed, while the whole policy embodied in the Bill was a new departure on the part of the Government. There was no way out of the muddle into which the Government had got except by a policy of purchase.

Mr. Lawrence (Liverpool, Abercromby) continued the debate, and was still speaking when midnight was reached, at which hour the debate stood adjourned.

The adjourned debate was resumed on Wednesday, when

Mr. Balfour (Manchester, E.) said: I was an interested auditor of the debate last night, and it may be convenient if I explain to the House the impression left upon my mind by that discussion. I gathered that in many parts of the House there was a strong and, indeed, a very clearly-expressed objection to much of the Government's proposal, and I quite recognise that in a Bill of this character we should be sacrificing more time than we have at our disposal if we were to attempt to force against such opposition the measure which my right hon. friend has introduced and so ably defended. I do not, however, think that this need be necessarily fatal to the further progress of the measure. I do not believe as far as I am able to understand it, that there is any impossibility of smoothing away the difficulties which at first sight seem almost fatal to the further progress of the measure. I would suggest that the best course the House can pursue is to accept the second reading of the Bill. If they are prepared to take that course my right hon. friend would at once move that it be referred to the Grand Committee. for, unless it can go before that committee, there will be little chance of our being able to find time to pass it through the remaining stages. I shall not propose that motion for the Grand Committee this afternoon; I shall adjourn it, and I hope and believe it may be found possible to smooth away some of the difficulties which I have referred to. I think, if the Bill went before the Grand Committee it would go through the different stages without taxing the patience of the House or unduly drawing upon the time still at our disposal. If that course meets with the approbation of the House, as I hope it will, I trust that without further discussion they will consent to the second reading. I will then make a motion, and we should see whether we could carry out the remainder of the programme I have ventured to sketch to the House. It is better to make the motion that this Bill be referred to the Grand Committee now, because it is not possible to alter our course subsequently, and if after the second reading we say the committee shall stand on such and such a day, that finally commits the House to discussing the Bill in committee of the whole House, and it is not possible, if we take that course, to subsequently modify it. In my judgment to discuss this Bill in committee of the whole House is to give up all hope of passing it in the course of the present session. I hope the House will adopt the course I now press upon them. If they do, we may have good hope that before the end of the session this Bill may become law.

Mr. Stuart (Shoreditch, Hoxton) said he had listened with consternation to the statement of the right hon. gentleman. It meant nothing more nor less than the killing of this Bill for this session. Two committees had already exhaustively dealt with this question, and now it was to be referred to the Grand Committee.

Mr. Balfour: It is only by this process of shortening the procedure that we can pass the Bill.

Mr. Stuart said he was sorry to differ from the right hon. gentleman, and he hoped they should hear some protest against this proposal from the front Opposition bench. He also complained of the "lobbying" that had been going on about this Bill. It was of such a character that the House ought to repudiate it, and the best way in which they could repudiate it was to go on with the committee stage of this Bill in the whole House.

Mr. Hanbury (Preston): It is impossible to give all the reasons for the course we have adopted to-day. I think the House generally knows the great interest I take in this Bill, and I do firmly believe that the motion which has been made by the leader of the House is the very best way of endeavouring to pass this Bill this session.

Mr. Caldwell (Lanark, Mid.) asked whether, after a Bill had been sent to a committee, it was not possible for the House to order that committee to be discharged and to remit the Bill to the Grand Committee.

The **Speaker** said that if the order were to stand on the paper for committee simply, it would be competent to move to discharge the order and substitute a notice of motion to send the Bill to a Standing Committee.

Sir H. Campbell-Bannerman (Stirling Burghs) said the House had been taken by surprise by the announcement made. But he quite appreciated the difficulties that had arisen owing to the various interests involved and the strong opinions which prevailed in regard to the Bill. But, wishing well to the Bill, he accepted the declaration of the leader of the House that it was the full intention of the Government to proceed with the Bill, and that they had adopted this novel course to make the success of the Bill more certain. He hoped it was not to clear the boards for another Bill which had been announced and which might occupy a good deal of time. The Opposition would strongly oppose the reference of this Bill to a committee if they thought it would be prejudicial to the interests of the Bill. But he accepted the assurance of the leader of the House that that would not be the case.

Mr. Balfour reminded the House that he said the great desire of the Government was to pass the Bill. It was the ordinary practice that a Bill of this kind should be referred to a Grand Committee.

Mr. Labouchere said the leader of the House was under a misapprehension as to the scope of the opposition to the Bill. The proceedings on the Bill on Tuesday night were a perfect scandal. They had speeches from, amongst others, the right hon. member for London University, who was a trustee for the debenture-holders of the Telephone Company, and his speech, an hour in length, was intended to obstruct the Bill.

Sir J. Lubbock said he was not trustee for the company but the debenture-holders, and he was not a shareholder in the company.

Mr. Labouchere said the other speeches made from the Ministerial side were simply obstructive speeches, and he wondered the closure was not moved. The same tactics would be pursued on report. Let the House decline to agree to the second reading unless the Bill were referred to an ordinary committee and discussed on its various stages in that House.

After some remarks from **Mr. Bartley** (Islington, N.), the second reading was agreed to.

Mr. Balfour moved that the Bill be referred to the Grand Committee on Trade.

On the motion of **Mr. Labouchere** the debate on this motion was adjourned.

[We are indebted to the *Times* for the above report.]

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. Questions may be sent at any time. Answers must be written on one side of the paper only, and should be kept as concise as possible.

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QUESTIONS.

177. Describe a method of determining the efficiency of conversion of a small gas-engine driven dynamo, wound series or shunt, with change-over switch. The only apparatus available consists of voltmeter, ammeter, rope brake, speed counter, and tub with lead electrodes ?—L.

178. Describe, giving detail sketches, of the best form of carbon brush gear for motors.—E. R.

ANSWERS.

Question No. 171. Discuss the best practical method of calculating the size of cables required for transmitting energy to any specified distance by means of three-phase alternating currents, the voltage at the generating end of line being known, and the maximum percentage loss of voltage allowable on the line being a fixed quantity.

Best Answer to No. 171 (*awarded* 10s.).—Besides the ordinary continuous-current considerations there are two or three additional points that occur with alternating-current lines. Thus the alternating line has to carry a current corresponding to the *apparent power* transmitted $\left(\frac{\text{Real power}}{\text{Power factor of the circuit}}\right)$ instead of the real power used. The voltage drop is not merely the C R loss in the ohmic resistance of the line, but is increased by an additional drop due to the inductive back voltage of the line. This addition is never very great, so that, except for long lines with the wires fixed widely apart and carrying large currents, it can be neglected, though some small margin should always be included for it in determining the permissible C R drop. Then, as regards insulation, for the same *effective* voltage between lines or to earth the alternating line is subjected to a maximum pressure 1·4 times as great as the continuous-current one. In practice, however, it is usual to neglect this consideration and put in the same insulation for a given effective voltage, whether continuous or alternating. Three-phase currents are usually transmitted by three wires of equal section. When, however, it becomes impossible to arrange the lamps, etc., so as to equally load each of the three phases, it is necessary to add a fourth wire (of smaller section than any of the other three) and to connect all the lamps between this neutral wire and one of the other three lines (see Fig. 1). Sometimes, instead of using a fourth wire,

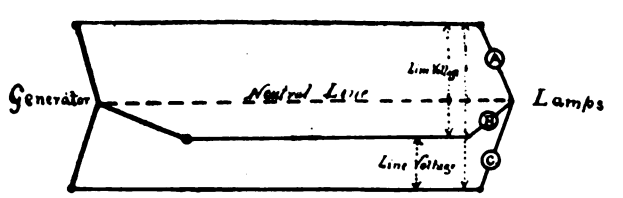

FIG. 1.

the neutral points are simply earthed everywhere. When the loads on the three phases are equal, the fourth wire will carry nothing, but as soon as one phase requires more current than the others, the fourth wire carries the difference, so that its section depends purely on the evenness with which it is possible to divide the load between the three phases, and must be determined separately for each case according to the circumstances.

The required section for each of the three main lines can be determined in this way :

1. Find the apparent watts to be transmitted by dividing the real watts required at the lamps, etc. By the known power factor of the circuit (which will lie somewhere between ·5 and 1), one-third of this number of apparent watts will be the apparent watts per phase.

2. Referring to Fig. 1, the voltage across each lamp is $\frac{\text{Line voltage}}{\sqrt{3}}$, because the vectorial sum of the voltages over two such lamps as A and B must be equal to the line voltage, and the vectorial sum of two voltages differing in phase by 120deg. (as they do in this case) is $\sqrt{3}$ times either voltage. Therefore, the current in each of the three lines

$$= \frac{\text{Apparent watts per phase}}{\text{Line voltage}} \times \sqrt{3},$$

or,

$$= \frac{\text{Total apparent watts}}{\text{Line voltage} \times \sqrt{3}}.$$

This expression for the line current is quite independent of the method of connecting the lamps, etc.—*i.e.*, whether "star" (as in Fig. 1) or "mesh" coupling is used, or whether the fourth line is used or not.

3. Calling the line current $C = \frac{\text{Total apparent watts}}{\text{Line voltage} \times \sqrt{3}}$, and the resistance of any one of the three lines R, the total watts lost are $3\,C^2\,R$, and the volts lost in the ohmic resistance of each line are C R; or for a complete circuit consisting of two lines they are $\sqrt{3}$ C R (the vectorial sum of the volts lost in the two lines). From which the resistance of each line R =

$$\frac{\text{Permissible watts lost}}{3\,C^2},$$

or,

$$\frac{\text{Permissible drop in volts}}{\sqrt{3}\,C}.$$

From which the size of the necessary mains can be obtained directly by the help of a wire table. It is worth noting that the percentage drop in volts is equal to the percentage of useful watts lost only when the power factor is 1, and is less for lower power factors. Also that for the same percentage drop in volts the current density in three-phase lines is greater than in continuous-current lines in the ratio of 2 : ($\sqrt{3}$ or 1·73).

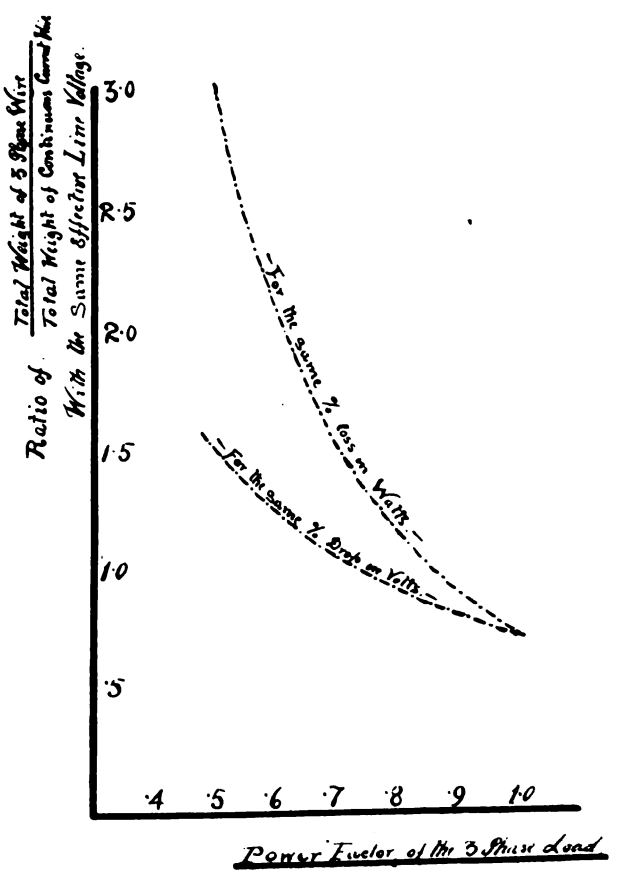

FIG. 2.

Another method often used for calculating out three-phase lines is to first determine the size of wire necessary to transmit the required amount of actual energy as an ordinary continuous-current line with the same voltage between the lines, and then to multiply this section of wire by a constant to give the equivalent three-phase wire. The curves in Fig. 2 give such a constant in the form of the ratio

$$\frac{\text{Total weight of the three lines of the three-phase system}}{\text{Total weight of the two lines of the continuous-current system,}}$$

for the two cases of "equal watts lost" and "equal drop in volts."—Q.

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Answer to No. 171 *(awarded* 5*s.).*—The following method may be used to calculate the cross-sectional area of the cables to be used under the conditions stated in the question:

Let a = the cross-sectional area of one line in square inches;
r = the resistance of one line;
i = the current in the line of the system (virtual amperes;
V = the voltage (virtual) at the generating end between the lines;
K V = the permissible voltage drop (K being the maximum percentage drop);
d = distance of transmission in miles;
R = resistance of one mile of copper, one square inch in section.

The power lost per line is evidently

$$i^2 r;$$

and hence the total loss of power is

$$3 i^2 r.$$

Now if the system be a "mesh" system, the current per limb of the "mesh" is $i \div \sqrt{3}$, and the total power developed per limb is

$$V i \div \sqrt{3}.$$

And also if the system be a "star" system, the voltage between the ends of a branch of the star is $V \div \sqrt{3}$, while the current per branch is i, and hence the total power per limb is again

$$V i \div \sqrt{3}.$$

Hence the part of this power lost in the line may be expressed, from the above, as

$$K V i \div \sqrt{3}.$$

since a voltage $K V$ is required to send the current i through the lines only.

As there are three lines, the total power lost is $3 K V i \div \sqrt{3}$, or $\sqrt{3} K V i$.

Hence $\sqrt{3} K V i = 3 i^2 r$

and $\therefore K V = \sqrt{3} i r$

$\therefore \quad r = K V \div \sqrt{3} i.$

But $r = R d \div a$

Hence $K V \div \sqrt{3} i = R d \div a,$

and $\therefore a = \sqrt{3} R d i \div K V.$

But all the quantities on the right hand are either constants or given quantities; and hence the value of a, the sectional area of *one* of the three equal wires of the transmitting cables, is completely determined.—T. C.

Question No. 172.—Describe, with sketches, some simple, accurate, and easily-made form of frequency meter.

Best Answer to No. 178 (*awarded* 10*s.*).—The instrument depicted in Figs. 1 and 2 fulfils most of the conditions required by the question. It consists of a pliable steel strip, A B, capable of being moved backwards and forwards in the clamp, C, by means of a rack and pinion, to which is also attached a pointer moving over a graduated scale. At the end, A, of the strip there is an electromagnet, M, with a laminated core, which is connected up to the circuit whose frequency it is desired to ascertain. The distance of A from the clamp is varied until it is set into strong vibration by the field of M, the point where this is a maximum being reached when A is of such a length that it vibrates with double the frequency of the current in A, and at this point a loud note is emitted. To ascertain more easily the exact position for maximum vibration, there is a pointer, P, capable of being set at such a distance that it just jars against A, when the latter's oscillations are of greatest amplitude.

Fig. 2 shows the commercial form of the instrument with a range extending from 40 to 150 ⌒⌒ per second. The milled head at the top of the case is turned until a loud note is heard, when the frequency can be directly read off on the scale. The small nut at the side is for actuating the pointer, P, as explained above, when very accurate readings are desired; the instrument, when the latter is used, being correct within ½ per cent. The whole is enclosed in a polished wood box, about 5in. by 4in. by 3½in., and is about as simple and cheaply constructed an instrument as it is possible to obtain. Another good form, the theory of whose working is rather more involved, is shown in Fig. 3.

Its working depends upon the fact that the heat generated by hysteresis in a wire magnetised by an alternating current is proportional to the frequency of the latter. It consists of a fine steel wire, F, lying in the field of the solenoid, M; one end is rigidly attached to R, while the other is fastened to the lever, L, and pivoted at P. The wire is thus kept stretched by means of the spiral spring, S.

A reflecting prism is attached to L at its fulcrum, and by means of a telescope and suitably arranged scale the amount of rotation of L, and thus the extension of the wire, is determined.

FIG 1.

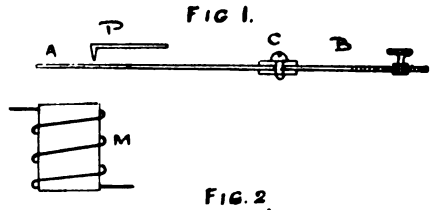


FIG. 2.

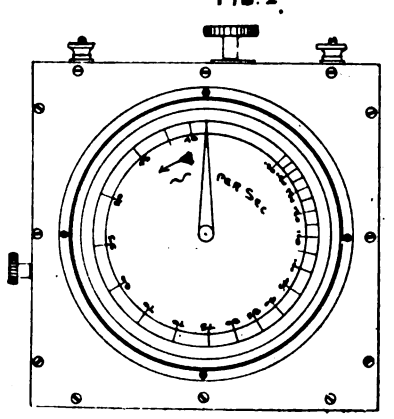
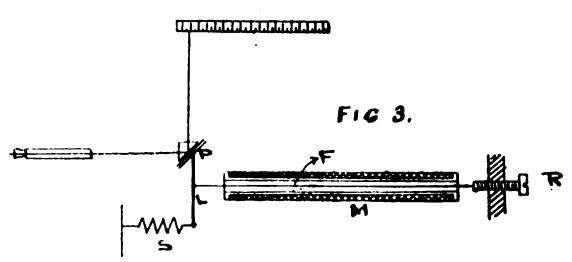


FIG 3.



This instrument is more suitable for currents of relatively high frequency, as the inaccuracies caused by eddy currents at lower periodicities are considerable. There are many other forms of meter to be obtained depending upon a variety of principles, a very good one consisting of a simple synchronous motor brought into phase by means of a small handle and suitable gearing, the frequency being then read off by an ordinary tachometer or other speed counter; but for all practical purposes the one shown in Figs. 1 and 2 is the most preferable.—H. F. S. B.

Answer to No. 172 (*awarded* 5*s.*).—The following meter, the principle of which is due to Prof. Ayrton, satisfies all the conditions demanded by the question. Its accuracy is well within one-tenth per cent., the materials required to make it cost only a few shillings, and it can be put together by any unskilled mechanic. In Fig. 1 all the apparatus is shown. L K is a steel wire securely fastened at C and passing over a pulley at K. The tension of the wire can be measured by the spring balance, E, and the tension can be varied by putting weights on the pan, F. For low frequencies (30 to 100) a No. 24 steel wire is very suitable, but for very high frequencies a thinner wire is desirable. R is a bunch of iron wires well rusted and wrapped round with one or two hundred turns of No. 18 copper wire. This alternating-current electromagnet is actuated from the mains, A and B, the frequency of the current in which is to be measured. It is placed close to the wire, and the weights

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on F are adjusted until it gives out a loud note. The tension at which it does this is very sharply defined, a slight increase or diminution of the tension stopping the vibrations, and consequently the note. In getting the tension

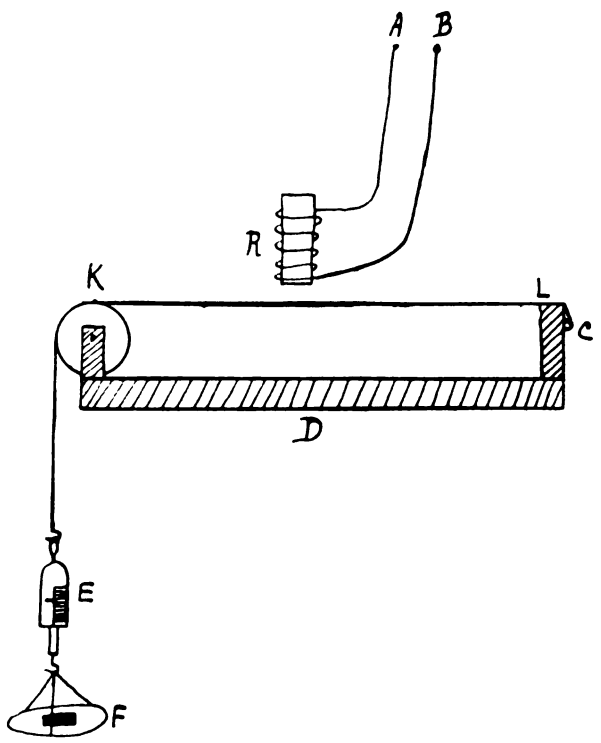

FIG. 1.

we have to add on the weight of the spring balance, E, to the reading on it. If this tension be in pounds weight we have to multiply it by $453{\cdot}6 \times 981$ in order to get it to dynes. Let the tension in dynes of the wire be T when it is sounding its fundamental note (1) in Fig. 2, and let m

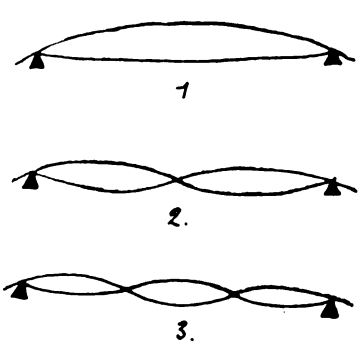

FIG. 2.

be the mass in grammes of 1cm. length of the wire, then the frequency equals $\frac{1}{4l}\sqrt{\frac{T}{m}}$ where l is the length of the wire in centimetres from L to K. When the wire is vibrating as in 2 (Fig. 2), the note is the octave, and the frequency is given by $\frac{1}{2l}\sqrt{\frac{T}{m}}$. Similarly, when it vibrates as in 3 (Fig. 2), the frequency is $\frac{3}{4l}\sqrt{\frac{T}{m}}$. In general, when it vibrates in n segments the frequency is $\frac{n}{4l}\sqrt{\frac{T}{m}}$.

J. C. R.

CARDIFF.

A meeting of the Cardiff Lighting and Electrical Committee was held on Tuesday, when Mr. W. Evans presided. At the previous meeting the committee recommended that the most experienced fitter in the employ of the Corporation be engaged on trial as an electrician in the place of Mr. Phillips, who has resigned through ill-health, but, on the motion of Alderman Carey, the question was referred back for further consideration.

In reply to Mr. Fox, the **Electrical Engineer** (Mr. Appelbee) stated that he had not acted upon the resolution of the committee. He had waited for the confirmation of the Council.

The **Chairman** asked Mr. Appelbee if he was still of the opinion that there was not a fitter at the works capable of doing an electrician's work.

Mr. Appelbee: I am still of the same opinion.

Mr. Lewis Morgan: As it is the wish of the committee that this fitter (Mr. Melhuish) should be tried for a month you should test him, and give him some advice.

Mr. Appelbee: I have talked to the man.

Mr. Morgan: When?

Mr. Appelbee: Two or three days after the last committee meeting.

Mr. Fox: Did you let him know that he was supposed to get a month on trial?

Mr. Appelbee: I think the man knew perfectly well.

Mr. Morgan: I want to know whether you have taken the slightest trouble to see whether this man is competent for the position we wish to put him in.

Mr. Appelbee: I know the man is not competent.

Mr. Morgan: How do you know?

Mr. Appelbee: Because he has had no training.

In answer to further questions, **Mr. Appelbee** said he could not remember when it was that he told Melhuish of the decision of the committee.

Mr. Morgan: Was it the Saturday before the Council meeting?

Mr. Appelbee: I cannot say.

Mr. Good: Oh, nonsense.

Mr. Morgan: Did you tell him to say he would not accept the position, if appointed.

Mr. Appelbee: I recommended him not to.

The **Chairman**: Why?

Mr. Appelbee: Because I think he is not suitable for the job; he will be more comfortable where he is.

Mr. Morgan: Why should he not get on in other work?

Mr. Appelbee: Why should not a fitter become a boilermaker, or a boilermaker an engineer?

Mr. Morgan: If you are wishful for him to get on, don't you think the first step you should take would be to help him?

Mr. Appelbee: I don't know that I am wishful for him to get on.

Mr. Morgan: Why?

Mr. Appelbee: I want the same peace of mind there, and I would not get it if I appointed a man who is not fit for the work.

Mr. Morgan told Mr. Appelbee that it was his duty to carry out the instructions of the committee; they would take the responsibility.

Mr. Appelbee: Thank you. That absolves me of all responsibility for what the man does.

Mr. Morgan: The committee ask you to assist this man and give him a month's trial, to know whether, with a little training, he will be efficient for the position.

Mr. Appelbee: I have no objection to let the man have the run of the place for a month, and to answer him any questions he asks me.

The **Chairman**: That is not what the committee require. They don't want the man to have the run of the place, but they want you to assist him.

In reply to Mr. Fox, **Mr. Appelbee** stated that Mr. Ruddock, who was mentioned for the position, was an electrical as well as a mechanical engineer, and had been running machinery at Bath. He thought a mechanic with electrical knowledge was the best man to appoint. Melhuish had been dismissed by the Corporation and then reinstated.

Mr. Morgan: Why?

Mr. Appelbee: Because he made false statements.

Mr. Good: No, no; I deny that.

Mr. Fox: He was dismissed (with others) because the committee were not cognisant of the whole of the facts.

Mr. Morgan: Has there been a little feeling between you and Melhuish?

Mr. Appelbee: None whatever.

Mr. Morgan: Since last meeting have you spoken to him in a friendly way?

Mr. Appelbee: Yes.

Mr. Morgan: As often as before?

Mr. Appelbee: No; I don't suppose I have, because I have not been in the works so much. I was away nearly the whole of last week.

Mr. Morgan: Is he a useful sort of man?

Mr. Appelbee: Yes, in his trade.

Mr. Morgan: Has he offered to work overtime to learn the duties required of him in the position of electrician?

Mr. Appelbee: No; I would be very pleased to see him there if he would come.

Mr. Morgan: Why didn't you tell him that the committee desired to appoint him to the position?

Mr. Appelbee: It is not my duty, as I understand it, to carry out the recommendations of a committee before they are confirmed.

Mr. Morgan: That is quite right, but I am told you have taken a lot of trouble with men that you want to get on.

On the motion of **Mr. Fox**, seconded by **Mr. Morgan**, the committee reaffirmed their previous recommendation to the Council to appoint Melhuish as electrical engineer on a month's trial, and Mr. Applebee was requested to give him any reasonable assistance.

Mr. Appelbee: Do you want this man to start before the next Council meeting.

Mr. Morgan: No. You know the feeling of this committee, and if you have no feeling against the man you will give him some assistance before the Council meeting.

Mr. Good again denied that Melhuish had been dismissed for making false statements. All that was said against him was that

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he made mountains out of molehills. It was a serious thing for a man to say that he was dismissed for making false statements, and he (Mr. Good) was prepared to move a resolution condemning Mr. Appelbee for making such a charge.

The **Chairman**: I think we had better let that drop.

Mr. Good said Mr. Appelbee desired to disobey the instructions of the committee.

The **Chairman** replied that he was within his rights in not appointing the man before the meeting of the Council.

The above report is from the *Western Mail*, and needs little comment, the whole matter resolving itself into the question as to whether the chief engineer is to be allowed to choose his own tools or not.

SOUTHPORT ELECTRICITY WORKS.

The following is the annual report of Mr. C. D. Taite, borough electrical engineer, on the working of the electricity station, for the year ending March 31, 1899, and is addressed to the chairman and members of the Electricity Committee:

Gentlemen,—I have the honour of laying before you herewith my third annual report on the working of the electricity estate. During the period under review the progress has been remarkable, completely eclipsing as it does the progress made in any preceding year since the commencement of supply. Before, however, calling your attention to the figures tabulated in the schedules at the end of the report, it will be useful to briefly review the extensions which have taken place during the past year, well as the working of each branch of the estate.

Boiler-House.—Two additional boilers, both of them manufactured by Messrs. Tinker, Shenton, and Co., of Hyde, have been installed, making the full complement of six boilers for which the boiler-house was designed. Plans are now in hand for extending both the boiler-house and engine-room to accommodate the new plant which will have to be put down to meet next year's demand. During the autumn Sandy Brook, the source from which the water supply is obtained, became contaminated with sea-water, owing to the high tides following on a dry summer. The salt water was fed into the boilers, causing a thick deposit on the bottom and on the furnace tubes of No. 4 boiler in particular. Eventually the tubes of this boiler collapsed, though fortunately no fracture occurred. After a thorough examination by the Manchester Steam Users' Association, with whom the boilers are insured, the damaged tubes were replaced, the boiler being again under steam about Christmas, since when it has been working satisfactorily. Precautions have been taken to prevent a recurrence of a similar accident, the water being tested every day. After the salt in the water was discovered, the boilers were fed from the Southport Waterworks Company's mains. The cost of this supply is, however, quite prohibitive for general working, being at the rate of nearly £1 a day. When the reservoir which is now under construction is completed, an absolutely reliable supply of water will be available, and it is anticipated that not only will the general quality be much softer, but it will be to a large extent, at any rate, free from the mineral and vegetable constituents which detract from the value of the water drawn direct from the stream. Superheaters have been fixed to the two new boilers, and there is evidence that they have effected very considerable economy. This is seen in the great reduction in the cost of coal per unit sold, a reduction brought about in the face of an increase of nearly 5 per cent. in the price of coal. Inasmuch as the price of fuel in many districts has now advanced as much as 20 to 25 per cent., it is particularly gratifying to find that the efforts made to keep down the expenses on coal account are being attended with such conspicuous success.

Engine-Room.—The main switchboard has been doubled, and now consists of 20 panels; the two middle panels have been so arranged as to render it possible to divide the board into two separate and complete boards without interfering with the continuity of supply; the two halves can be synchronised together again as soon as the necessity for working them separately has passed. The whole of the work was accomplished with only two or three hours' cessation in the supply. The engines and alternators have been kept in excellent condition, as testified by the manner in which the three larger machines have worked together night after night on the town mains without a hitch. The rope-driven plant has only been used on rare occasions since last October, when it became too small for even the day load. By disposing of it you render available for other machinery a valuable space of 40ft. square. It is ultimately proposed to instal in this space three machines for electric traction of a combined output of 1,000 h.p., as against the 250 h.p. at present generated by the other machinery. The erection of a plant of 1,000 i.h.p., with an electrical output of 600 kw., is now in progress, and will shortly be completed. Allowing for the sale of the rope-driven plant, you will then have machinery of a total capacity of 2,000 i.h.p., and capable of generating 1,150 kw. per hour. An extension of the buildings, rendered necessary by the ever-increasing demand for light, is also in hand. It is estimated that they will accommodate some 4,000 h.p. or 5,000 h.p. The rectifiers continue to run satisfactorily.

Distribution.—I have once again the pleasure of recording almost complete immunity from troubles in connection with the cable system. There have been no failures at all on any of the cables, the two or three mishaps which have occurred being confined to local circuits, and being caused by the overloading of transformers, coupled with the appearance of moisture inside the transformer cases. With the great increase in the number of sub-stations, and the consequent removal of the underground transformers, the liability to breakdown is being constantly diminished, the difficulties with moisture being removed, and inspection being rendered so much easier. During the year four new sub-stations have been built and equipped, three being in Lord-street, in conjunction with the cabstands in Eastbank-street, Hill-street, and Union-street. The fourth has been built in a corner of the cellar of the gas offices in Eastbank-street. All have been thoroughly equipped with modern switch gear, and are found to be very convenient. Two new feeders from the works to the town were laid last summer, together with pilot wires for indicating the pressure in the various parts of the town. After being laid the feeders were tested up to 10,000 volts, and in no case was there any failure. They have been working regularly since last August. The rapid increase in the number of consumers has rendered it necessary to order two additional feeders in anticipation of the coming winter. A contract for these has been placed, and they will shortly be laid. A duplicate high-tension supply is now available in all the sub-stations in Lord-street, and also in the majority of the others, by means of a ring main. The low-tension networks have been further subdivided, so that a faulty section can be easily disconnected. Several more consumers have been changed over to the higher pressure, and it is pleasing to note how great a number of the new applications come from residential houses. Few new houses in the best residential districts are now built without being wired at the same time, and there are encouraging signs that the smaller houses will soon follow suit. New shops in the centre of the town are almost invariably wired as they are built, and a better job is thereby obtained. Existing consumers cannot be too careful in remembering that the greater the number of new connections the more rapid will be the reductions in price. Distributing cables have been laid in the following streets: Park-road, Preston-road, Rawlinson-road, Leyland-road (part), Lathom-road (part), Queen's-road, Hoghton-street, Church-street, Union-street, Derby-road (part), Pilkington-road, Duke-street, Part-street (part), Talbot-street (part), Cross-street (part). There are now about 35 miles of cable laid—viz.: ·3 low-tension cable, 6,230 yards; ·2 low-tension cable, 600 yards; ·1 low-tension cable, 15,800 yards; ·1 high-tension cable, 12,900 yards; $^7/_{16}$ high-tension cable, 6,570 yards; arc mains, 11,500 yards; services, 8,000 yards.

Street Arc Lighting.—There are no extensions to record in this branch of the undertaking, but the arc lamps already installed continue to work satisfactorily.

Wiring.—That the hire-purchase system of wiring inaugurated two years ago is beginning to be appreciated and understood is shown by the fact that 29 contracts have been entered into and carried out, as against 13 last year. The value of the work has increased from £590 to £932. Several persons have availed themselves of the system in order to obtain the benefit of the advice of your staff, and upon the completion of the work they have paid cash for the whole. Further, there is no doubt that, apart from the comparatively small number of contracts undertaken, the extra supervision which has been given has been the means of improving the general standard of wiring throughout the town.

Criticism of Annual Returns.—From a financial point of view the year just closed has been a highly successful one. A net profit of £2,027 has been earned, as against a profit of £643 on the previous year's working, being an increase of £1,384. The gross profit—*i.e.*, the balance left after paying working costs but before meeting the capital charges—is £5,561, equivalent to a return of 8·08 per cent. on the capital invested at the end of the year. Of this sum £1,920 is required for the interest on loans, while £1,613 is the contribution towards the sinking fund. This fund now stands at £4,636, being the amount paid in redemption of capital. The surplus of £2,027 has been appropriated as follows: £630 in aid of rates, £203 to wipe off disallowances of Local Government Board, £1,204 reduction of capital. The increase in the sale of electricity is very satisfactory, the units sold to ordinary consumers having risen from 291,277 to 501,005, being an increase of 72 per cent. The total units sold have advanced from 376,490 to 589,350, and the net income from £6 350 to £9,119. The total working costs have at the same time increased only £706—viz., from £2,852 to £3,558. In other words, the additional 212,860 units have been generated at an additional cost of £706, or ·79d. per unit. It has been customary when making this annual statement to compare the Southport returns with the returns of other municipalities employing a similar system of generation. As, however, the results obtained this year have so far improved upon the results obtained during preceding years that the Southport electricity works now lead the way as regards economy amongst similar works, I have thought it advisable to include for the sake of comparison not only alternating-current stations, but also those working on the continuous-current system, the former being printed in larger type. Both companies and municipalities are included in the list, which therefore contains the pick of the electrical undertakings in the United Kingdom. Only 30 of the most economical towns are tabulated, all the 68 remainder being run at a higher cost per unit. It is satisfactory to note that out of a total of 98 undertakings Southport ranks third in economy, being passed only by Edinburgh and Bradford, in both of which towns the output is considerably more

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than double than obtained here. The latter of the two places is assisted by its tramway load, and by the great number of motors connected to its mains, while Edinburgh has more street-lighting than any other town in the kingdom. Both are supplied on the continuous-current system. The most important reduction appears to me to be in the item for fuel. Last year this stood at ·40d.; it has now been brought down to ·31d. per unit sold, although the price of coal increased during the year above 4 per cent. The total improvement is, therefore, not less than 25 per cent., and may be traced to the following causes; (*a*) improved load factor; (*b*) economical plant; (*c*) use of superheaters; (*d*) careful firing. As additional superheaters are being installed, and as the load factor is continually improving, still better results might be looked for if only the price of fuel remained stationary. As, however, that is more than can be hoped for, it is probable that under the circumstances the increase in the cost of coal will about counterbalance the further economy expected from the use of additional steam-saving apparatus. The other items do not call for any special comment, though it may be noted that in spite of the increased output there is no great increase in the wages account, owing to the very reliable character of the plant installed. The repairs item likewise keeps within very reasonable limits. Referring to Schedule C, it will be seen that the average price obtained from private consumers is 4·07d. You have already decided on a further reduction in price from July 1, when the maximum rate will be 6d. per unit instead of 7d. The number of consumers has increased during the year by nearly 200, while over 10,000 lamps have been added to the mains, bringing the total number now connected up to 36,147. As applications continue to come in at a satisfactory rate, there is every reason to hope that these figures may be equalled, if not exceeded, during the present year.

REVENUE ACCOUNT.

Expenditure.	£	s.	d.
Generation of Electricity.			
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£781	7	10
Oil, waste, water, and engine-room stores	222	3	6
Wages at generating station	1,002	8	6
Repairs and maintenance: buildings, £46. 1s. 9d.; engines and boilers, £190. 17s. 11d.; alternators, dynamos, and exciters, £1. 3s. 2d.	238	2	10
		2,244	2	8
Distribution of Electricity.			
Wages and other remuneration to linesmen, fitters, and labourers	134	8	6
Repairs and maintenance of mains	56	15	11
Repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises	72	9	6
		263	13	11
Public Lamps.			
Attendance and repairs	201	16	10
Renewals	61	4	11
		263	1	9
Rents, Rates, and Taxes.			
Rents payable	211	2	0
Rates and taxes	65	0	8
		276	2	8
Management Expenses.			
Salaries—Engineer's department	300	0	0
Clerical staff	92	2	6
General office	45	0	0
Stationery and printing	102	3	6
General establishment charges	143	6	11
Cooking apparatus	20	0	0
Interest on deposits	0	4	0
Bank commission	10	3	0
		712	19	11
Special Charges.			
Insurance	36	12	9
Law expenses	24	17	2
		61	9	11
		3,821	10	10
Gross profit carried to net revenue account		5,561	0	9
		£9,382	11	7

Income.	£	s.	d.
Sale of current per meter at 7d. per B.T.U.	5,081	12	11
" " " 4d. "	2,323	6	8
" " " 2d. "	1,558	16	8
" " " under contract	8	9	3
	8,972	5	6
Less discounts, £397. 15s. 5d.; bad debts and allowances, £72. 19s. 11d.	470	15	4
	8,501	10	2
Street-lighting	840	0	0
Rental of meters and transformers	29	9	6
Moiety of premiums	11	11	11
	£9,382	11	7

WOLVERHAMPTON ELECTRICITY ACCOUNTS.

The following is the report of the Lighting Committee, together with an abstract of the accounts for the year ended March 31:

Your committee are pleased to report that the operations of the year have again been successful. From the accounts it will be seen that a profit of £1,004. 5s. 10d. has been made, after payment of interest and sinking fund charges. Of this amount £588. 0s. 6d. has been applied to clear the deficiency on the working of the previous years, and the department has now in hand a sum of £416. 5s. 4d., which it is proposed to carry forward to revenue account for next year's working. In presenting this report, your committee desire to call attention to the satisfactory growth of the undertaking, the number of consumers, the number of lamps connected, and the amount of electricity sold since the commencement of supply being as follows:

Year	Consumers	Per cent. increase.	Lamps connected.	Per cent. increase.	Units sold.	Per cent. increase.
1	113	—	8,941	—	191,701	—
2	154	36	11,307	26	224,709	17·2
3	208	35	14,151	25·2	291,233	29·55
4	276	32·7	19,932	40·8	371,830	27·5

Financial Result.

		£	s.	d.	£	s.	d.
First year and three months	Loss	1,403	9	3	—		
Second year	Profit	—			225	14	5
Third year	Profit	—			589	14	4
Fourth year	Profit	—			1,004	5	10
		£1,403	9	3	£1,819	14	7

There are satisfactory signs that this progress will be continued, and electricity, as an artificial illuminant, is gradually becoming more popular in the town. There is now a demand arising in the better residential districts, to meet which your committee are extending their area of supply. It is interesting to note that many of the large new buildings erected in the town are being lighted electrically from the Corporation mains, prominent among these being the two new factors' warehouses and offices in Fryer-street, belonging to Messrs. T. W. and J. Walker and Messrs. John Shaw and Sons, and there is every probability of the negotiations now pending with Messrs. Chubb for the electric lighting and supply of electric power for their new premises being brought to a successful issue. Up to the present date, two alterations have been made in the tariff charged to consumers. The first of these resulted in 71 customers out of a total of 164 (or 43 per cent.), obtaining a rebate. The second alteration has resulted in 176 out of a total of 267 (or 65 per cent.), obtaining a rebate. The average price paid by the consumers for lighting during the past year was 5 24d. per unit, and for power and heat 1·7d. per unit. The object of the committee in effecting these alterations has been to encourage the use of electric lighting by those people who use artificial light for periods of several hours daily, and also to encourage shopkeepers to extend the light into the back part of their shops and residential quarters, many shopkeepers only using the light in their windows. Your committee are desirous of expressing their regret at the two breakdowns of electric light which have occurred during the past 12 months, and to assure the Council and their consumers that every precaution is being taken to avoid a recurrence of a similar mishap. At the same time they would point out that it is not to be assumed that Wolverhampton is the only town in the country in which breakdowns have occurred, and it may be instanced that on the occasion during the same week in which the first breakdown occurred last October, that not less than six towns in various parts of the country had similar failures, including even such old-established stations as Brighton and Manchester. Your committee take this opportunity of stating that in their opinion none of these breakdowns are in any way attributable to neglect or mismanagement on the part of their staff, but that a certain risk of accident is inseparable from the high-tension continuous-current system. The conversion of the system to the three-wire principle, the expenditure for which was recently sanctioned by the Council, will, when complete, provide such an amount of spare plant and electrical storage as will enormously reduce the possibility of further breakdowns.

REVENUE ACCOUNT.

Expenditure.	£	s.	d.
Generation of Electricity.			
Coal	£950	9	7
Oil, waste, water, and engine-room stores	336	0	9
Wages at generating station	997	7	9
Repairs and maintenance, as follows:			
Buildings	12	14	10
Engines, boilers, transformers, other machinery and plant	261	6	10
		2,557	19	9
Distribution of Electricity.			
Repairs and maintenance of mains	5	11	2
Ditto of meters, switches, etc.	0	15	10
Ditto of apparatus at distributing stations	19	9	3
		25	16	3
Public Lamps.			
Attending, repairs, and carbons		218	1	10

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Rents, Rates, and Taxes.			
Rents	0 1 0		
Rates and taxes	132 18 4		
		132 19 4	
Management Expenses.			
Salaries—Engineer's department and collector	713 15 2		
Ditto, accountant's staff (proportion)	50 0 0		
Stationery, printing, and advertising	92 16 5		
Cost of management of proportion of Corporation 3 per cent. stock	31 16 5		
General establishment charges	129 7 6		
		1,017 15 6	
Law and parliamentary charges		22 6 0	
Special Charges.			
Insurances, etc.		134 0 4	
Bad debts		12 18 1	
		4,121 17 1	
Balance carried to net revenue account		3,636 14 5	
		£7,758 11 6	
Income.		£ s. d.	
Sale of current per meter :			
At 6d. per Board of Trade unit		5,408 13 6	
,, 3d. ,, ,,		911 17 0	
,, 2d. ,, ,,		11 15 0	
,, 1d. ,, ,,		2 11 10	
Ditto, under contract		1 10 0	
		6,336 7 4	
Public lighting (street lamps)		1,275 0 0	
Rental of meters, etc.		138 16 0	
Works executed on account of customers		8 8 2	
		£7,758 11 6	
Balance-Sheet.			
Liabilities.		£ s. d.	
Redeemable stock—Wolverhampton Corporation 3 per cent. stock, £32,314. 16s. 11d.; less amount appropriated for extinction of stock in loans fund, £4,518. 10s. 1d.		27,796 6 10	
Sundry creditors at March 31, 1899		564 5 10	
Cash balance, March 31, 1899, due to treasurer		16,159 18 3	
		44,520 10 11	
Surplus—loans repaid out of revenue, £806. 13s. 8d.; loans fund contributions from revenue with accumulations to March 31, 1899, £4,518. 10s. 1d.		5,325 3 9	
		49,845 14 8	
Sundry creditors at March 31, 1899		330 2 7	
Sundry consumers' deposits		7 0 0	
Interest accrued, but not paid at March 31, 1899		111 11 0	
Cash balance, March 31, 1899, due to treasurer		2,351 14 7	
Net revenue account—balance, profit for year ended March 31, 1899, £1,004. 5s. 10d.; less deficiency to March 31, 1898, £588. 0s. 6d.		416 5 4	
		£53,062 8 2	
Assets.		£ s. d.	
Capital expenditure, as per capital account		49,429 18 5	
Cost of issue of stock, as per capital account		403 18 9	
		49,833 17 2	
Sundry debtors at March 31, 1899		11 17 6	
		49,845 14 8	
Stores on hand, March 31, 1899 : coal, £33. 9s. 6d.; oils, waste, etc., £66. 11s. 2d. ; general, £80. 14s. 5d.		180 15 1	
Sundry debtors for current supplied to March 31, 1899, £3,012. 15s. 11d.; other debtors, £23. 2s 6d.		3,035 18 5	
		£53,062 8 2	

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units			470,836
Quantity sold	Public lamps	80,443	371,830
	By contract	60	
	Private consumers by meter	291,327	
Quantity used on works			4,051
Total quantity accounted for			375,811
Quantity not accounted for			94,955
Number of public lamps			51
Total maximum supply demanded			19,932

LEGAL INTELLIGENCE.

THE BRISTOL TRAMWAYS AND CARRIAGE COMPANY, LIMITED v. THE NATIONAL TELEPHONE COMPANY, LIMITED.

This was the trial of an action heard on affidavit evidence brought by a tramways company to restrain the National Telephone Company from laying telephone wires in the street, in such manner as to disturb their tramways, without the leave of the plaintiffs, and was heard in the High Court of Justice (Chancery Division) before Mr. Justice North. The question between the parties depended on the construction of clauses in the Telegraph Acts, 1863 and 1878, and the Tramways Act, 1870. The plaintiffs are the owners of an extensive system of tramways in the city of Bristol and neighbourhood, some worked by horse power, some by electricity. The defendant company are licensed from the Postmaster-General under power to grant licenses conferred by the Telegraph Act, 1892. This action relates to the breaking up of the road in St. Augustine Bridge, an open space which is the centre of the tramway system in the city of Bristol. The Telegraph Act, 1863, provides that telegraphs are not to be placed along a street without the consent of the body having the control of the street, and by Section 13 it is provided that where a street is maintainable by a landowner or other person not the road authority his consent is also necessary. Section 28 of the Tramways Act, 1870, throws the burden of repairing streets between and immediately by the side of the lines of a tramway on tramway companies. Section 32 enacts : "Nothing in this Act shall take away or abridge any power to open or break up any road along or across which any tramway is laid, or any other power vested in any local authority or road authority for any of the purposes for which such authority is respectively constituted, or in any company, body, or person for the purpose of laying down, repairing, altering, or removing any pipe for the supply of gas or water, or any tubes, wires, or apparatus for telegraphic or other purposes, but in the exercise of such power every such local authority, road authority, company, body, or person shall be subject to certain restrictions." By the Telegraph Act, 1878, provision is made that where a body or person has power to refuse consent to the Postmaster-General placing a telegraph line over or under a street or certain other places, the Postmaster-General can require consent to be given on terms to be fixed by arbitration in manner provided by the Act.

Mr. C. A. Cripps, Q.C., Mr. Stewart Smith, and **Mr. Pepys**, for the plaintiff company, argued that the defendants had no power to interfere with the street under the tramways without the consent of the tramway company ; that even if they had the power to compel such consent under the provisions of the Telegraph Act of 1878 in favour of the Postmaster-General, they could not do so in a summary manner.

Mr. Swinfen Eady, Q.C., and **Mr. Roskill** *contra*.

Mr. Justice North, having referred to the section of the Acts mentioned above, said he came to the conclusion that by reason of the saving clause of Section 32 of the Tramways Act, 1870, it was not necessary for the Telephone Company to get the consent of the tramway company before breaking up the street where the tramway was in order to lay their telephone wires. In the result, he dismissed the action.—*The Times.*

THE BREAKING OF A LEEDS TRAMCAR TROLLEY.

In the Queen's Bench Division on the 19th inst. Mr. Justice Bruce resumed the hearing of the action brought by Mr. Blackwell, of London, against Messrs. Greenwood and Batley, Albion Works, Leeds, to recover £608, the price of trolley standards and other goods supplied for the electric tramway of the Leeds Corporation.

The defendants, it was stated, had contracted with the Corporation to supply trolley standards for the cars, and these they had obtained from the plaintiff. In August, 1897, one of the standards broke, injuring three passengers, and the Corporation was held liable for damages. They in turn claimed and received the amount, £525, including costs, from Messrs. Greenwood and Batley, who now counterclaimed the sum from the plaintiff.

Mr. Blackwell denied that the trolley standard was not of adequate strength, and pleaded that the fracture was due to abnormal and excessive pressure, or to a collision prior to the date of breakage.

His Lordship reserved judgment.

DAMAGES TO A SUBMARINE CABLE.

The case of the Eastern Extension, Australasia, and China Telegraph Company *v.* Weir, which came before Mr. Justice Bigham in the Queen's Bench Division on Wednesday, was an action brought against the defendants as owners of the ss. "Oatlands" to recover damages for injuries done to a submarine cable in the Straits of Bali in order to get the ship's anchor clear.

Mr. Joseph Walton, Q.C., for the plaintiffs, stated that his Lordship would not be troubled with the case, as the parties had arrived at a settlement, the defendants having consented to judgment against them for £500 and costs. Counsel added that the plaintiffs had felt it their duty to press the claim as a warning to masters of ships that they must use proper care to avoid injuring telegraph cables, in the safety of which not only the company but the general public were largely interested. Judgment was given for the plaintiffs accordingly.—*Financial Times.*

COMPANIES' MEETINGS AND REPORTS.

SOUTH STAFFORDSHIRE TRAMWAYS COMPANY.

The ninth ordinary general meeting was held on Monday at the Cannon-street Hotel, Mr. W. S. L. Schuster presiding.

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The **Chairman**, in moving the adoption of the report, which was adopted, said that the tramways were progressing satisfactorily. The repairs to the permanent way had cost £730 in 1895, £1,293 in 1896, £2,369 in 1897, and £2 466 in 1898. A dividend of £2. 7s. per cent. on the 6 per cent. preference shares was declared. The Bill before Parliament concerning the Company which was promoted by the British Electric Traction Company, Limited, in the Company's name, had now passed the committee of the House of Lords in a very different shape to that which was approved by the shareholders at the Wharncliffe meeting. In consequence of opposition on the part of the local authorities, the whole of the purchase clauses in the Bill affecting those authorities had been struck out, and it was now, to put the matter shortly, a Bill authorising the Company to grant a lease to the electric company and to increase the borrowing powers of the tramways company. It transpired in the evidence on the Bill in committee that the electric company had been approaching one local authority and making arrangements whereby the latter was to exercise its right of purchase and then grant a lease direct to the electric company. If this took place with the other authorities it would become a serious matter for the Company.

A resolution was unanimously passed authorising the directors to call a special meeting at their convenience at an early date to discuss the position of the shareholders.

NERNST ELECTRIC LIGHT, LIMITED.

The statutory meeting of the shareholders was held on Wednesday at the registered offices of the Company, 82, Victoria-street, Westminster, S.W. Sir Henry C. Mance, C.I.E. (chairman of the Company), presided.

The **Secretary** (Mr. G. Opitz) having read the notice convening the meeting,

The **Chairman** said they had secured the services of Dr. von Recklinghausen, who had worked for a considerable time with Prof. Nernst. They felt that it would be folly to rush on with the manufacturing of the lamp immediately, and place it on the market when it had only just merged from the laboratory state. When the Company was first started it was believed that the chief use of the Nernst lamp would be for street-lighting, but their experiments during the last two or three months showed that they could look forward to introducing the light for extensive use indoors. They had also a lamp which could be used for military purposes. Patents had been granted already in 20 countries, and 21 applications relating to 16 countries were still pending.

Mr. B. M. Drake, M.I.E.E. (managing director), said that when first he took over the management of the Company he had to devote himself to the practical requirements of the invention and the securing of machinery suitable for manufacturing the lamps in large quantities. When he took office the lamp could only be automatically heated in 30 seconds, while they now possessed a lamp able to work 1½ watts per candle-power, which would last 500 hours, and which could be automatically lighted in six seconds — in fact, it gave some light immediately. They had lamps of 11 c.p. working 1½ watts on 200 volts. Prof Nernst had during his recent visit informed the directors that he had been round to the several concessionnaires, and he was quite satisfied that this Company was well ahead of any of the other companies in the world.

Mr. James Swinburne, M I C E. (consulting engineer), made a few remarks relating to the Press criticisms which were made when the Company first came out, and as regarded the patents he said the general position was very good. Messrs. J. Fletcher Moulton, Q.C., M.P , and A. Colefax had stated with reference to the patents, "the invention is, in our view, fundamentally different from anything that preceded it."

A vote of thanks to the chairman closed the proceedings.

GUERNSEY RAILWAY COMPANY, LIMITED.

The report of the directors for the year ending Dec. 31, 1898, states that the expenditure on capital account has amounted to £292. 7s. 1d. This expenditure completed the construction of the new car shed and car pits, and the rearrangement of the drainage of the generating station and yards, which had previously given considerable trouble, but is now satisfactorily improved. From this amount has been written off the sum of £30. 13s. 5d , realised by the sale of obsolete equipment materials. The gross receipts of the railway have amounted to £6 253. 14s. 4d., as compared with £6,346 5s. 11d. in 1897, being a decrease of £92 11s. 7d. The railway working expenses show a decrease of £199. 18s. 8d. Two large motorcars and two trailers have been thoroughly repaired and strengthened, electric light fittings added to two trailers, new spring couplings fitted to seven cars and six trailers, and the siding at the Vale-road Station has been extended at the cost of revenue. The omnibus department shows a decrease of £48. 1s. 2d. in gross earnings, and an increase in expenses of £74. 10s. 10d. The increase in expenses is due to the loss by death of two horses, and an exceptionally large expenditure upon the renovation of the omnibuses and cars in present use. Had the L'Islet route been worked at a fare of 2d., as was the case previous to the amalgamation of the tramway and omnibus companies, there would be a difference in favour of the omnibus department of £66. 11s. 4d. The directors, after serious consideration, decided to raise the fare to Rohais, and to make the experiment of running a service to Cobo during the winter. In both cases their hopes have been realised, and the results have been exhibited in an increase of receipts that has justified the alteration in fares and the additional service. In the case both of the railway and the omnibuses, the comparison of gross traffics is unfavourably affected by the large traffics of the Jubilee holidays in 1897. The 6 per cent. debentures fell due an June 30, and the opportunity was taken to consolidate the whole of the prior charges ; £12,000 of 3 per cent. debentures and 3,182 ordinary shares were issued. With the proceeds, the £6,500 6 per cent. debentures, the £6,000 of floating loans, and the £476. 3s. 10d. of ground rents were paid off, and a sufficient balance provided to obviate the necessity of overdrawing with the Company's bankers. The cost of and the commission upon the issue of the 3 per cent. debentures, amounting to £174. 12s. 7d., have been charged to the general and renewals reserve account. Out of the amount at credit of net revenue account, £2,154. 3s. 8d., after paying the debenture and loan interest £375. writing off £505. 6s. from improvement account, omnibus undertaking, and stock of rails, placing £200 to general and renewals reserve account, and providing for a dividend of five per cent. on the preference shares, the directors recommend a dividend of 4 per cent. on the ordinary shares, leaving the sum of £78. 7s. 8d., to be carried forward to next year's accounts.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Hammersmith.—The Vestry invite tenders for the supply of transformers, etc., by July 5.

Barrow-in-Furness.—The Corporation invite tenders for an engine and generator by 28th inst.

Glasgow.—The Corporation are prepared to receive tenders for the supply of 80 electric tramcar bodies by July 22.

Bristol.—The Visiting Committee invite tenders for the wiring and supply of lamps for lighting the asylum by electricity. Tenders by June 30.

Glasgow.—The Corporation are prepared to receive tenders for the supply and erection of boilers, steam-engines, three-phase generators, etc., by July 22.

Wallasey.—The Urban District Council are prepared to receive tenders for the supply and delivery of alternating-current transformers. Tenders by July 20.

Wallasey.—The Urban District Council are prepared to receive tenders for the supply and erection of a 300-kw. alternator with engine combined. Tenders by July 20.

Barrow-in-Furness.—The Corporation invite tenders for erection of extension to the existing electricity works in Buccleuch-street. Tenders by 12 noon on 28th inst.

Rathmines and Rathgar.—The Electric Lighting Committee invite tenders for the supply and erection of various plant for the municipal electricity works. Tenders by July 14.

Pembroke (co. Dublin).—The Electric Lighting Committee invite tenders for the supply and erection of various plant for the municipal electricity works. Tenders by July 14.

Stowmarket.—The Urban District Council invite tenders for lighting the streets with gas, oil, or electricity, from Aug. 15 next to May 15, 1900, inclusive. Tenders by 24th inst.

Cardiff.—The Corporation invite tenders for the purchase of a 40-kw. Paxman-Siemens steam alternator, 2,500 volts, 16 amperes, 40 periods, at 200 revolutions. Tenders by July 6.

Warrington.—The Corporation are prepared to receive tenders for the supply, delivery, and erection of the various work in connection with the electric lighting of the borough by July 18.

Kingston-upon-Hull.—The School Board invite tenders for the electric light wiring and fittings at the Central Higher-Grade School in Brunswick-avenue, Beverley-road, Hull. Tenders by 27th inst.

Grimsby.—The Corporation invite tenders for the supply, delivery, and erection, and the carrying out of various work in connection with the electric lighting of the borough. Tenders by noon on July 10.

Harlow.—The Lighting Committee invite tenders for lighting with gas or other well-known light the above district from Sept. 1, 1899, to May 14, 1900, inclusive, from one hour after sunset until 11 p.m. Tenders by 28th inst.

Nelson.—The Gas and Electricity Committee invite tenders for the supply of an engine and dynamo (output from 25 kw. to 50 kw.), either new or second-hand. Further particulars can be obtained from Mr. W. Foster, gas manager, Nelson. Tenders by July 5.

Manchester.—The Electric Light Committee invite tenders for the erection of offices and battery sub-station at their new works in Strawberry-road, Pendleton. Specifications, etc., may be obtained from the architect, Mr. John Holt, C.E., 6, St. Mary's-gate, Manchester, upon payment of a fee of £2 2s., which will be returned on receipt of a bona fide tender. Tenders by 10 a.m. on 30th inst.

RESULTS OF TENDERS.

Salford.—The Corporation have accepted the tender of the Leeds Steelworks Company, at £100,625, for supply of 5,000 tons of steel tramway rails.

Islington.—The Highgate-hill Infirmary Building Committee have recommended the acceptance of the tender of Messrs. Frank Suter and Co., Limited, for electric lighting, at the sum of £7,794.

Taunton.—The Electric Lighting Committee have accepted the tender of the Direct Coal Supply Company, at 14s. 2d. per ton,

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for 1,000 to 1,500 tons of Dynevor Duffryn through and through coal.

St. Pancras.—The Vestry have accepted the tender of Messrs. Siemens Bros., Limited, at £11,194 10s., for supplying a trunk main for cables to connect the two electrical stations—viz., Regent's Park and King's-road.

Manchester.—The Electricity Committee have accepted the tender of the Westinghouse Electric Company, Limited, for the supply and erection at the Bloom-street generating station of four 1,800-kw. combined engine and dynamo machines.

Southampton.—The Tramways Committee have received the following tenders:—Motorcars and equipment: Milnes and Co., car bodies £1,350, and Brill trucks £385 (accepted); Westinghouse Company, electrical equipment, £1,694 (accepted); there were eight other tenders for this contract. Extension of the Shirley Depôt: H. W. Bull, £3,346 (accepted); F. Osman, £3,400; Krauss and Son, Bristol, £3 468; Stevens and Co., £3,733; Jenkins and Sons, £3,764. Overhead electrical equipment of lines, Prospect-place to Shirley section: Macartney, McElroy and Co., £2,949. 19s. 4d. (accepted); Dick, Kerr, and Co., £3,120. 19s. 11d; British Thomson-Houston Company, £3,224. 15s. 6d.; Blackwell and Co., £3,261. 15s. 8d.; Laing, Wharton, and Down, £3 735; Crompton and Co., £3,843; Brush Electrical Engineering Company, £4,175.

BUSINESS NOTES.

Leeds.—A successful trial run of an electric car was made from Boar-lane, Leeds, to Headingley, on Saturday.

Chesterfield.—The Corporation have decided to proceed to provide a supply of electricity for light and power.

Weston.—The Parish Council have decided not to agree with the proposals of the promoters of the electric trams.

Swansea.—The Local Government Board have sanctioned the loan of £52,000 for the Corporation's electricity scheme.

Whitehaven.—The Town Council have agreed to borrow £9,858, sanctioned by the Local Government Board for electric lighting.

Hythe.—The Folkestone Electricity Supply Company intend to apply for a provisional order to supply electricity within the borough of Hythe.

Leicester.—On and after July 1 next the price for electric current will be reduced to 4d. per unit for lighting and 2d. per unit for power purposes.

Aberdare.—The Urban District Council have decided to oppose the British Electric Traction Company's proposal for a light railway through the district.

Portrush.—A meeting of the Urban Council was held on Monday to consider correspondence received in reference to the overhead electric traction system

Edinburgh.—The Electric Lighting Committee are making arrangements for the Lord Provost laying the foundation stone of M'Donald-road central power station.

Bedford.—The Council have decided not to entertain an application from the British Electric Traction Company, Limited, to lay an electric railway from Bedford to Kempston.

Worksop.—The Urban District Council have appointed a committee to visit various towns where electric lighting is in vogue with a view to the appointment of an electrical engineer.

Sir E. Ashmead-Bartlett's Tour.—Sir Ellis Ashmead-Bartlett has been granted a concession for electric lighting and electric traction in Salonica, and for electric traction only in Smyrna.

Devonport.—The Electric Lighting Committee have not yet selected a site for the electrical station, but hope shortly to lay before the Council a proposal which would be very pleasing to them.

Eastern Extension, Australasia, and China Telegraph Company.—The directors have declared an interim dividend for the quarter ended March 31 last of 2s. 6d. per share, free of income tax.

Nuneaton.—Letters from Messrs. Dewes and Brock Harris offering, on behalf of the electric company, to sell the undertaking at a lower figure than previously mentioned, is before a committee.

Newcastle-on-Tyne and District Motorcar Company, Limited. This Company has been registered with a capital of £10,000 in £10 shares, and the object is to carry on the business of motorcar proprietors, carriage manufacturers, etc.

County of London and Brush Provincial Electric Lighting Company.—The transfer books and register of holders of debenture stock will be closed until the 30th inst. inclusive, preparatory to payment of the interest due on 1st prox.

Bridgwater.—At their last monthly meeting, the Town Council passed a resolution affirming that the time was come to carry out the provisional order obtained in 1898 for municipal electric works. Notice has been given to rescind this resolution.

Hull.—A report from the electrical engineer of the city with regard to the installation of electric light in the workhouse and a report as to the establishment of a telephone call office has been adopted by the Guardians of Sculcoates Union.

Shildon.—The Urban District Council having received offers from eight firms with regard to the proposed electric lighting scheme, are now about to furnish particulars to these firms, and the surveyor has been instructed to meet their representatives.

Wellingborough.—A committee of the whole Council have considered the offer of the Electrical Power Distribution Company, Limited, and the report of Messrs. Clark Forde and Taylor, and the latter will be circulated amongst the members of the Council.

Auction.—The plant, machinery, loose tools, and stock-in-trade at the London and Lancashire Electric and General Engineering Company's premises, Kingsland-green, Dalston Junction, N.E., will be sold by public auction, in lots, on Friday, June 30, 1899, at one o'clock.

Road and Tram Car Electric Traction Company, Limited.—This Company has been registered with a capital of £12,000 in £1 shares, and the object is to acquire patents and rights, to manufacture machinery, etc., and to carry on the business of electric and other tramway proprietors.

Ince.—The Highways and Streets Committee of the Rural District Council will meet the Wigan Tramway Company's representatives at the committee's next monthly meeting in order to discuss a letter similar to that referred to in a note on Ashton, which will be found in another column.

Kensington and Notting Hill Electric Lighting Company.—The Bill promoted by this Company has been sanctioned by a Committee of the House of Lords in the form in which it recently received the sanction of the House of Commons. This Bill will now in due course receive the Royal assent.

Chatham.—The Corporation intend to apply for a loan of £7,500 for the completion of the erection of the town hall and municipal offices of the borough, and the furnishing and fitting up of the same. This sum includes the cost of electrical work and fittings for the lighting of the building with electricity.

Brighton.—The piercing of a cable in Western-road by a workman engaged in road excavations led to a breakdown of the electric light on Thursday week. The cables were quickly disconnected, but it is stated that considerable damage was done to the incandescent lamps by the burning of the wires.

Croydon.—The Council at their meeting on Monday passed a resolution to purchase the whole of the tramways undertaking in the borough for the sum of £50,000. The question of working the trams was deferred, it apparently being the present intention of the Council to continue horse traction for the time being.

Hanley.—The Council have accepted a report from the Finance Committee recommending that, with the consent of the Local Government Board, the Council should create a further amount of stock, part of which (£18,880) will be on account of the money the Council has authority to raise for the purpose of electric lighting.

Bath.—At the meetings of the Surveying and Electric Lighting Committees on Monday, the minutes of the joint committee on electric traction, already referred to by us, were adopted without discussion. In these minutes appears a recommendation to the Council to dissent from the scheme now before the Light Railway Commissioners.

Huddersfield.—The Town Council have decided that applications be made in the ensuing session of Parliament as follows: for borrowing powers to enable the scheme of electric traction prepared by the borough engineer to be carried out in such sections as may be determined, and for powers to construct and work tramways outside the borough.

A Channel Fleet.—The Great Eastern Railway Company have just issued an illustrated booklet entitled "A Channel Fleet," by Percy Lindley, descriptive of the steamers now running upon the Royal Mail Harwich route, and also of some of the more popular Dutch, German, Swiss, and Norwegian tours arranged for this season *vid* Harwich and the Hook of Holland.

Morecambe.—A public enquiry is to be held to-day into the District Council's application to borrow £5,000 for a refuse destructor at the electricity works. On the minutes of the Electric Light Committee coming up for confirmation last week, it was stated that business people could have electricity supplied for business purposes during the day at 3d. per unit.

Elmore's Amalgamation.—A joint meeting of the shareholders of Elmore's Patent Copper Depositing Company, Elmore's Wire Manufacturing Company, Elmore's Foreign and Colonial Patent Copper Depositing Company, and Elmore's American and Canadian Patent Copper Depositing Company is to be held on the 29th inst. to consider proposals for amalgamation.

Lynn.—With regard to the question of service connections to consumers' premises, it has been resolved that in future service lines be laid free to consumers for a distance not exceeding 40ft. from the boundary wall of their premises, and that any consumer requiring a longer distance to be laid be required to guarantee 10 per cent. per annum on the additional outlay required.

Radcliffe.—At a recent meeting of the Electricity Committee it was suggested that Radcliffe should supply electricity for lighting and traction to Whitefield and Little Lever districts, or that the three districts combine for the creation of a scheme to serve the said districts. It is now stated that they expect to receive their official order in the course of a short time, when application will be made to the Local Government Board for borrowing powers.

Bristol.—Complaints have been made as to the damage to vehicular traffic caused by an elevated guard rail in connection with the electrical tramlines laid in the Blackboy-hill. A claim for compensation has been sent in for damage done to a trolley. It appears that the length of the guard rail is about 60ft., and its height above the level of the ordinary rail is 3in. The company has been called upon to alter the rails so as to reduce the risk to vehicular traffic.

Accrington.—A meeting of shareholders of the Accrington Tramways Company has been called on account of the difficulties which have arisen referring to the sale of the company's under-

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taking to the British Electric Traction Company for £55,000. The three Corporations of Accrington, Haslingden, and Rawtenstall desire to municipalise the lines and refuse to grant any extension of the lease, a condition upon which the traction company insist before purchasing.

London Gazette.—The first meeting in the estate of G. T. Godfrey (also carrying business as Godfrey Bros., Balham and Tooting) will be held 26th inst. at 11.30 a.m. at 24, Railway-approach, London Bridge, S.E. The date of the public examination at the Court House, Wandsworth, is July 6, 12 noon.—Application for discharge has been refused and discharge suspended for two years *re* P. Crosby Pope, Hayton, near Burnley, Lancs., under date of May 20.

Lewisham.—At the last meeting of the District Board a notice by the Blackheath and Greenwich District Electric Light Company, Limited, of intention to lay a main from the north corner of Grote's-place, Blackheath, to the north corner of Lloyd's-place in Tranquil-vale, was approved. A similar notice with regard to the laying of mains in Tranquil-vale and Royal-parade, Blackheath, and cables under the footpaths in Montpelier-vale and Montpelier-row, Blackheath, was referred to the Local Committee.

Middlesbrough.—The Local Government Board are prepared to sanction the borrowing of £36,000 for electric lighting purposes. The North-Eastern Railway Company have asked when the Middlesbrough electric plant would be ready for the supply of electrical power, as they required power to drive 20 electric cranes which they propose to erect at the new Middlesbrough docks. A meeting is to be arranged between Mr. Hammond, who has charge of the undertaking, and the engineer to the North-Eastern Railway.

Bexhill.—The Urban District Council have resolved that the power to purchase the Bexhill and St. Leonards tramways, to be authorised by the Bexhill and St. Leonards Tramroads Bill, shall not extend to the portion thereof situate outside the urban district of Bexhill, provided that the promoters give an understanding to obtain an insertion in the Bill of a clause securing to the Council, in the event of their purchasing the portion of the undertaking within their district, power to run carriages over the portion thereof within the borough of Hastings.

Bournemouth.—The Electric Light Committee having considered the surveyor's report with reference to an installation in connection with the proposed additional refuse destructor, recommended at last week's meeting of the Town Council that the scheme be approved, and the surveyor instructed to prepare detailed plans, specifications, etc. An amendment that the report be referred to an expert having been withdrawn, the question was referred to the whole Council. The committee hope to be ready to light the pier with electricity on June 28, and ask the Mayoress to turn on the light.

Oswestry.—At a special meeting of the Town Council on the 20th inst., the committee appointed to negotiate for the purchase of Oswestry Electric Lighting and Power Company's undertaking reported that they had agreed to purchase the property at the sum of £11,250. The committee also reported that Mr. Bremner Smith had offered his services gratuitously as consulting engineer for a period of five years. The report was adopted, and it was resolved that application be made for sanction to borrow a sum not exceeding £18,000 for the purpose of completion of purchase and to carry out the undertaking.

Dundee Tramways.—At a meeting of the Tramway Committee on the 19th inst. it was agreed that an electric tramway should be laid down connecting the present system in Ward-road at the new post office, and joining the Fairmuir line at Main-street. The burgh engineer was instructed to prepare plans showing the alterations and widenings required on the streets *en route*. It was also decided to approach the infirmary directors with the view of widening Barrack-road. It was agreed that the gradient of the road should be made a uniform gradient of 1ft. in 11ft. if the Board of Trade would approve of it. The line is to be double all the way.

Incandescent Electric Lamp Company, Limited.—The employés of the "Robertson" Lamp Factory held their annual excursion to Margate on Saturday, 17th inst., when a party of about 200, accompanied by the managers and heads of departments, left Victoria at 9 o'clock and arrived at Margate about 11.15 a.m. After dinner the various toasts were proposed, and in replying to the toast of the firm the chairman incidentally remarked that the numbers had more than doubled since the excursions were first started three years ago, and in the same period the output of the factory had increased in the same proportion.

Aston Manor.—At their last meeting the Council resolved, in view of some action being taken by them in relation to their electric lighting order, and having regard to the right of the Council to purchase the tramways of the Birmingham and Aston Tramway Company on the expiry of the tramway provisional order, that the question of the electric lighting of the district, as also the acquisition of the tramways of the above company in the district, be referred to the General Purposes Committee with instructions to consider and report thereon and for this purpose to employ such professional or other assistance as they may deem necessary.

Leamington.—The Midland Electric Lighting Company are pressing the Corporation to come to an immediate decision on the course they intend to take with regard to the electric lighting of the town. They state that at the recent enquiry it was admitted that a considerable sum must be spent at once in order to maintain an adequate service, and, as the company could not be expected to make such outlay in the present state of uncertainty, ask the Corporation to either give immediate notice of their intention to acquire the undertaking under the arbitration clause inserted by the Board of Trade in the Corporation order, or to formally waive such right.

Glasgow.—At a recent meeting of the Tramways Committee of Glasgow Corporation, Mr. John Young, the general manager, submitted a draft report and financial statement for the year ended May 31. It showed that the gross revenue for both the horse and the electric tramways amounted to £439,000, while the working expenditure was £318,000, leaving a surplus of £121,000. The figures are subject to final audit. A special meeting of the Tramways Committee will be held this week to decide upon a recommendation to the Town Council as to the disposal of the surplus. A year ago the surplus amounted to £100,538 on a revenue of £394,111.

Stirling.—A draft agreement showing the terms upon which the Free Wiring Company would agree to introduce their system into the burgh is before the convener and clerk for consideration. The terms of advertisement and rates to be charged for lighting have been discussed, and will be submitted to Prof. Kennedy. The Public Works Loan Commissioners have resolved to grant a loan not exceeding £25,000. The Telephone Company are prepared to pay half the cost of trench-cutting, provided they are allowed to lay their wires alongside those for electric lighting. The matter is in the hands of the sub-committee for further report. A deputation from Alva has been asked to meet a committee in regard to electric tramways.

Southport.—A net profit of £2,027 has been earned by the Electricity Committee during the last year as against £643 on the previous year's working. The Health Committee have invited Messrs. Horsfall, Beaman and Deas, Manlove and Alliot, and Goddard, Massey, and Warner to submit plans, specifications, and tenders for a six-cell destructor, etc. The Highway Committee is considering the draft agreement, relating to the privilege of laying wires under the streets of the borough, from the National Telephone Company, containing a clause granting the privilege for a term of five years, determinable if and when the Corporation shall obtain a license to establish a telephonic service themselves in the borough. The Corporation in that event will take over the wires, etc, of the company in the borough at their then structural value.

Bootle.—The report of the Watch Committee shows: liabilities incurred on lighting account, £35,493; liabilities incurred on tramway account (exclusive of paving and engineer's remuneration), £24,078—a total of £59,571; further expenditure required on lighting account, £20,293; further expenditure on tramway account (exclusive of paving and engineer's remuneration), £17,215—or a total of £37,508 and a grand total of £97,079. Mr. Miller's reports on estimated cost of extensions is £5,607 for feeders and £9,786 for distributing mains in various streets, to which is added public lighting in these streets, 48 arc lamps and 336 incandescent lamps, £2,964—making a total of £18,357. It has been decided to advertise inviting applications for the post of permanent borough electrical engineer at a salary of £300, increasing to £400.

Parliament.—In the House of Commons during the past week the following Bills were read a third time: Brompton and Piccadilly circus Railway, Darwen Corporation, Dublin Corporation, Blackpool Improvement, Derby Corporation Tramways, etc., Bexhill and Rotherfield Railway, and Bradford Tramways. In the House of Lords the Wolverhampton Tramways Bill was read a third time and passed. The Cheltenham Electric Lighting Bill has been reported for second reading in the House of Lords, and the Leamington and Midland Electric Corporation for third reading in the House of Commons. The House of Lords Committee appointed to consider the Southport and Lytham Tramroad have decided to reject the scheme, except as regards tramroad No. 1, which was a short line from Southport to the edge of the estuary, and as to which there is no opposition.

West London and Provincial Electric Supply Company, Limited.—This Company has been formed with a share capital of £150,000 preference shares of £1 each (preferential also as to capital), and 70,000 ordinary shares of £1 each, and the object is to acquire the beneficial ownership in the right of electric supply to the district of Chiswick, London, W., and the town of Aberystwyth; to complete and equip the generating station and lay the mains at Chiswick, and to improve and extend the existing system of supply in Aberystwyth. The Company will also seek to obtain, as opportunity may offer, similar rights and undertakings in other districts. The directors are Messrs. T. H. Brooke-Hitching, J.P., C.C.; Maurice Ansell; J. Courthope Peache, C.E.; and W. B. Esson, M.I.C.E., M.I.E.E. Messrs. Kincaid, Waller, and Manville, and Mr. R. W. Weekes, M.I.E.E., A.M.I.C.E., Wh.Sc., are the consulting engineers.

Chester.—The Corporation are considering the advisability of acquiring the local tramway system on the expiry of the lease. Mr. Thursfield, the city electrical engineer, has prepared a report on the practicability of running the tram system by electricity, in which he recommends the adoption of the open conduit system, failing the adoption of a cheaper one. He speaks very favourably of the overhead trolley system, but points out that some people might object to it on the ground that it would be a disfigurement of the architectural features of the streets, a question of paramount importance in Chester. If the committee consider that the objection to the overhead line is insuperable, he suggests that a short length of open conduit be laid in the centre of the town, the remainder being on the overhead trolley system. The expenditure for permanent way and cars would be £16,452, and the estimate for the combined overhead trolley and open conduit system £29,150.

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London County Council.—The application of the Vestry of Fulham for a loan of £25,000 (part of £108,166) towards defraying the cost of the installation of the electric light within the parish has been granted; also the laying of mains, etc., by the County of London and Brush Provincial Electric Lighting Company, under the Holborn and St. Giles Order, and under the County of London (North) Order, 1892; by the London Electric Supply Corporation (at Westminster); and by the Kensington and Knightsbridge Electric Lighting Company (Princes-mews and Ennismore-gardens mews). There was also a notice by the Vestry of Hammersmith, under the Hamersmith Electric Lighting Order, 1893. The Vestry being the undertaker under the order, the Council has no power of approval or disapproval of the works.

Removals.—The Cruto Incandescent Lamp Agency, Limited, sole agents for the Società "Cruto," Turin, have removed to more central and convenient offices at 2, Tower-royal, Cannon-street, E.C.—We are informed that owing to the great number of works now in hand, which include lighting and power plants for the Chatham Corporation, the Bedford Music Hall, Messrs. Thorne Bros., Limited, Messrs. G. H. Leavy, Limited, also a large electrically-driven refrigerating plant for the Birmingham Cold Stores, Limited, etc., Messrs. Harrap, Hewett, and Duffield, of 34, Queen-street, have removed to 5, Budge-row, the whole of which has been acquired by them. The new premises have been altered throughout to suit the requirements of the firm and suitably accommodate the increase of staff needed.—The Fuller-Wenstrom Electrical Manufacturing Company, of 28, Bush-lane, E.C., are removing to 9, Red Lion-court, Cannon-street, E.C.

Ashton.—The Wigan and District Tramways Company have forwarded to the Urban District Council a copy of the following resolution: "Resolved that, in the opinion of the Board, it is desirable that the scope of the tramways be extended to such portions of the townships of Abram, Ashton, Ince, and Pemberton as may be considered advantageous to the interests of the company and of the townships, and that the secretary of the company is instructed to open up negotiations with the respected Councils with a view to arrange routes and terms of such extensions, and that, in the event of satisfactory negotiations being concluded, the British Electric Traction Company, Limited, be called upon to provide the necessary capital for the construction of works and carrying out such extensions under the terms of their agreement with the company." The Council have decided to meet the company and confer with the directors on the subject.

Blackpool.—Major Cardew, on behalf of the Board of Trade, inspected the electric tramways last week. During the proceedings the inspector suggested that guard stone kerbs be placed at certain points to prevent the nave of wheels of passing vehicles catching the plinth of cars. This will be done. Provisional sanction to run the cars was given pending the Board's decision. The conversion of the cars is being rapidly proceeded with, and, sanction received, everything can be ready for the change in about a week. The contractors have been Messrs. Lowdon Bros. and Co., of Dundee, Edinburgh, and Glasgow, for the columns, overhead wire, trolleys, and all visible work, the "silvering" of the pillars being let as a sub-contract to Messrs. Smith, Simpson, and Co., of Deansgate, Manchester, and the British Insulated Wire Company, Prescot, for the mains, cables, and general underground work. The contracts have been carried out under the general superintendence of Mr. Balfour (for Messrs. Lowdon Bros.), with Mr. McCaffy as the representative on the site, and Mr. Cartwright for the British Insulated Wire Company.

Hammersmith.—At the Vestry meeting on Monday the Electricity and Lighting Committee submitted a report on a letter from the Fulham Vestry objecting on principle to the laying of mains in their parish by the Hammersmith Vestry, but at the same time stating that they were willing to meet the Hammersmith Vestry, and to allow the wires laid by the Hammersmith Vestry to continue within the Fulham parish if the Hammersmith Vestry would undertake to remove them should the Fulham Vestry at any time have the lighting this portion of the streets within their own parish. The committee recommended that the Fulham Vestry be informed that, inasmuch as there were only three short lengths of cable laid across the Hammersmith-road for the purpose of supplying the three arc lamps in the Fulham portion of Hammersmith-road, and that the Vestry had no intention of supplying electricity within the parish of Fulham for private purposes, and, moreover, that as there were no cables laid under the path within Fulham parish, the Vestry was not prepared to enter into such an agreement as the Fulham Vestry desired. Mr. Ebbs has been elected chairman and Mr. Glasier vice-chairman of the committee.

Fulham.—The Vestry have instructed their solicitor to take counsel's opinion as to the legal rights of private individuals to lay electric lighting mains under streets. A loan of £25,000 (part of the loan of £108,166) has been granted by the London County Council. The report of the Lighting, Electric Lighting, and Dust Destructor Committee, submitted on Wednesday, stated that the question of further negotiations with regard to the supply of electricity to the flats erected and being erected in FitzGeorge and FitzJames avenues had been referred to the chairman and vice-chairman, in conjunction with the consulting engineer and solicitor. The Thames Conservancy had given permission for the use of Thames water for condensing purposes in connection with the electric light station. The committee had received a satisfactory letter from the Board of Trade giving a description of the system to be adopted by the undertakers for the supply of energy under the Fulham Electric Lighting Order, 1897, and their formal approval of the connection of certain parts of the electric circuits with earth. They have also had under consideration the question of the stoppage of the works, and had instructed the consulting engineer in future cases of stoppage of work to immediately request the clerk to the Vestry to summon a meeting of the committee, the solicitor to be in attendance. A draft contract between the Vestry and the General Electric Supply Company had been examined, and the matter left in the solicitor's hands to settle in the best interests of the Vestry. They had taken steps to obtain information from the Acton District Board, and from companies and corporations, as to the result of the circular issued by them as to free wiring for supply of electricity.

Barking.—The official opening of the electricity supply works took place on Thursday week. Owing to want of space we were unable to report the event in our last issue. We had, however, previously given a description of the works. The contractors entertained about 70 gentlemen connected with various public bodies of the town at a banquet, which was served in the Council-chamber. Mr. J. N. Reeson (chairman of the District Council) presided. The Barking town band played a selection of music in front of the public offices. After dinner the Chairman said it had been unanimously resolved at a meeting of the Lighting Committee of the Council to call upon their late chairman (Mr. W. R. Marriott) to perform the ceremony that night of switching on the electric light. He referred to an informal opening which took place some time ago, but the lamps in the streets were not then sufficiently advanced to allow of a formal opening. Mr. Marriott then switched on the light from the balcony, and upon the company's return to the Council-chamber was made the recipient of a handsome key on behalf of Mr. Hawtayne. The Chairman, in proposing a vote of thanks to Mr. Marriott, said that but for his persistency the electric light would never have been started in Barking. Mr. Marriott replied, and then proposed "Success to the Electric Light Undertaking." Mr. H Berry proposed the health of the contractors, to which Mr. T. O. Callender and Mr. J. Dale responded. Mr. E. A. Davies proposed the toast of "The Consulting Engineer, Resident Engineer, and Officials of the Council." This was responded to individually by Messrs. Hawtayne, Hoadley, Lister, and Dawson. Other toasts followed, in the intervals of which some capital songs were sung by Messrs. A. B. Cole, Mack Ollive, and Tom Taylor, whilst a banjo solo was played by Master George Berry, and a banjo duet by Mr. L. Viney and Master G. Berry. The pianoforte accompaniments were played by Mr. A. W. Hume.

PROVISIONAL PATENTS, 1899.

JUNE 12.

12183. Improvements in cut-outs for electrical purposes. Thomas Taylor, 24, Temple-row, Birmingham. (Complete specification.)

12249. Improvements in telephone systems and in apparatus therefor. Arthur Thomas Milner Thompson and Percy Warnford-Davis, 22, Southampton-buildings, Chancery-lane, London.

JUNE 13.

12279. Improvements in electric telegraphs for ships and other purposes. Evershed and Vignoles, Limited, and Sydney Evershed, Woodfield Works, Harrow-road, London.

12294. Improvements in and connected with magneto generators. Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Actien-Gesellschaft Mix und Genest, Germany.)

12297. Improved means for controlling electric motors, the invention being particularly adapted to the motors of elevators. Otis Elevator Company, Limited, 55, Chancery-lane, London. (Otis Bros. and Co. (Incorporated), United States.) (Complete specification.)

12309. Improvements in storage batteries and methods of preparing electrodes therefor. Philip Arthur Newton, 6, Bream's-buildings, Chancery-lane, London. (The Knickerbocker Trust Company, United States.) (Complete specification.

12315. Improvements in cord grips for electric light fittings. Andreas Peter Lundberg and Gustaf Charles Lundberg, Bradbury Electrical Works, Bradbury-street, Kingsland, London.

12350. Improvements in or relating to electric railways. Oscar Howard Baldwin and Isaac Emerson Winslow, 322, High Holborn, London.

12353. Improvements in or relating to conduits for electric conductors. Frank Jones and Frederick Arthur Pocklington, 6, Lord-street, Liverpool.

JUNE 14.

12393. Improvements in clockwork mechanism for automatically controlling and operating electrical switches, gas, water, steam valves, or other similar devices at any predetermined hour or hours. Henry Thomas Crewe, 17, Sunning Hill-road, Lewisham, London.

12417. Improvements in supports for conductors for electric railways. William Richard Wynne, 322, High Holborn, London.

12420. Improvements in wireless telegraphy. Ferdinand Braun, 322, High Holborn, London.

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12419. Improvements in or relating to electrically-driven sheep-shearing and like apparatus. John George Packe and Frederick Edward Brittain Johnson, 322, High Holborn, London.

JUNE 15.

12473. The electric newspaper. William Thomas Cunningham, 6, Suffolk-street, Pall-mall, London.

12478. Improvements in electrical accumulators or secondary batteries. Oskar Behrend, 47, Lincoln's-inn-fields, London.

12490. Improvements in and relating to electrical pendulum contacts for the operation of time-measuring pendulums. Alfred George Brookes, 55, Chancery-lane, London. (L. Sell, Germany.) (Complete specification.

12493. An improved insulating material for electrical purposes. Maurice Lachman, 6, Bream's-buildings, Chancery-lane, London.

12535. An improved filament for incandescent electric lamps. Louis Gabriel Patrouilleau, 45, Southampton-buildings, Chancery-lane, London.

JUNE 16.

12542. An improved cap for electric glow lamps and the like. John Ignatius Bolton, 54, Dynham-road, West Hampstead, London.

12559. Improvements in and relating to appliances for straightening electric battery plates and the like. Andrew Haig and Joseph Edgar, 96, Buchanan-street, Glasgow.

12565. Improvements in connection with the windings of dynamo machines and induction motors for enabling two rotary phase current pressures to be obtained therefrom. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Victor Karmin, Austria-Hungary.)

12566. Improvements in the arrangements and connections of the windings of dynamo machines for effecting the halving of the continuous current pressure and for obtaining the star centre of the rotary phase current pressure when continuous current and rotary phase current are to be taken off simultaneously. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Victor Karmin, Austria Hungary.)

12582. Improvements in and relating to electromagnetic measuring and indicating or registering instruments. Pierre Ernest Weiss, 11, Southampton-buildings, Chancery-lane, London.

JUNE 17.

12635. Electric meter. Edward S. Halsey, 1022, Benson-avenue, Evanston, Ill., U.S.A. (Complete specification.)

12668. Improvements in earthed coverings or electrical tubular conductors. James Yate Johnson, 47, Lincoln's-inn-fields, London. (The firm of Hartmann and Braun, Germany.)

12696. Improvements in telephones. Ernest Wilson and Charles John Evans, 64, St. John's-park, Blackheath, London.

SPECIFICATIONS PUBLISHED.

1898.

12911. Electric gas igniters. Deimel, Lehmann, and Sylten.

12325. Apparatus employed in wireless telegraphy. Marconi and Wireless Telegraph and Signal Company, Limited.

14361. Coupling of alternating-current dynamos or alternators and the like. McMullen.

16449. Conduits for electrical conductors. Kenney and Morten

17371. Electric battery and bell combined. Markt. (Markt Bros. and Co.)

17507. Switch devices for electric tramways. Andreas.

26191. Electric switchboards. Cowan and Still.

26790. Current-conducting connection between electrical conductors. Feeny. (Allgemeine Elektricitäts-Gesellschaft.)

1899.

4774. Electrical cut-out or fuse. Heaton and Smith.

6028. Process for the production of electrical resistances with small heating capacity. Feeny. (Allgemeine Elektricitäts-Gesellschaft.)

6439. Combined telephonic jacks and call indicators. Siemens Bros. and Co., Limited. (Siemens und Halske, Aktien-Gesellschaft.)

7579. Distributing electricity and switches therefor. Liddle. (Cloos))

7580. Switching apparatus for controlling electric circuits. Liddle. (Cloos.

7883. Means for supplying current to electrically-propelled vehicles. Wheatley. (Stoughton.)

7886. Apparatus for producing electric sparks. Lake. (Shattuck.)

8060. Electrical furnaces. Lance, de Bourgade, and Schmitz.

8820. Electric signals or indicators. Staveley and Parsons.

8857. Quicksilver electric current interrupter. Hirschmann.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Returns for week Ending	1899.	Corresponding week 1898.	Increase or decrease.	Total receipts for half-year. 1899.	1898.
		£	£	£	£	£
Birmingham Tramway Co.	June 17	4 351	3,744	+ 607	95,211	87,181
Blackpool and Fleetwood Tramroad	,, 17	698	—	—	8,709	—
Bradford City Trams	Feb. 5	145	—	—	6,733‡	—
Bristol Tramways and Carriage Co.	June 16	3,165	2,835	+ 330	—	—
City and South London Railway	,, 18	899	974	− 75	26 017	25,532
Dover Tramways	,, 17	189	152	+ 37	3,819	2,906
Dublin U.T., elec. cars	,, 16	1,388	1,077	†+ 310	24,250	24,250†
Dublin S.D. Electric Tramways	,, 16	1,189	741	+ 448	17,960	11,629
Halifax Corporation Tramways	Mar. 29	312	—	—	10,712*	—
Liverpool Overhead Railway	June 18	1,496	1,440	+ 56	34,582	35,503
South Staffordshire Tramways	,, 16	640	608	+ 32	15,169	14,481

* Since June 30, 1898. † Including horse cars. ‡ Since July, 1898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	23½-24½
Bournemouth and Poole Electric Supply, Limited, Ord.	10	13½-13⅝
—— 4½ per cent. Cum. Pref.	10	10½-11½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	18¼-19¼
—— 6 per cent. Cm. Pf., 30,001-40,000 (all paid)	10	14-14½
—— 6 per cent. Cm. Pf., 40,001 60,000	10	13½-14½
—— 5 per cent. Perpetual Debenture Stock	100	126-129
Brush Electrical Engineering, Limited, Ordinary	2	1¾-2¼
—— Non. Cum., 6 per cent. Pref.	2	2¼-2½
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	103-106
Callender's Cable Company, Debentures	100	114-117
—— Ordinary	5	14-15
Central London Railway, Ordinary	10	10-11
——	8	8½-9
—— Pref. Half-Shares	8	8-8½
—— ,, ,,	5	5½-6
Charing Cross and Strand	5	11-12
—— 4½ per cent. Cum. Pref.	5	5½-6½
Chelsea Electricity Company	5	8-9
—— 4½ per cent. Debentures	100	114-116 xd
City of London, Ordinary	10	14-16
—— 6 per cent. Cumulative Pref.	10	13-15
—— 5 per cent. Debenture Stock	100	125-130
City and South London Railway, Consolidated Ordinary	100	67-69
—— Ordinary	2	4¾-5½
—— 2 per cent., 501-60,000	2	1-2
—— 4 per cent. Debenture Stock	100	132-134
—— 5 per cent. Pref. Shares	10	14½-15½
—— ,, ,, '96	10	13½-14½
County of London and Brush Prov. Elec. Light Co., Ord.	10	11-12
—— 6 per cent. Cum. Pref.	10	14-15
—— 4½ per cent. Prov. Certs.	—	54-56
Crompton and Co.	2	3¾ 4
—— 5 per cent. Debentures	—	99-102
Crystal Palace District, Ordinary 5 per cent. Stock	100	133-138
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2-2½
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	97-99
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5½-5¾
Electric Construction, Limited	2	2½-2¾
—— 7 per cent. Cumulative Pref.	2	3-3½
—— 4 per cent. Perp. 1st Mort. Deb.	100	103-106
W. T. Henley's Telegraph Works, Ordinary	10	24½-25½
—— 7 per cent. Preference	10	18-20
—— 4½ per cent. Debentures	100	113-115
House-to-House Company, Ordinary	5	7½-8½
—— 7 per cent. Preference	5	9-10
Imperial Tramways, Limited	6	24½-25½
India Rubber, Gutta Percha, and Telegraph Works	10	21-22
—— 4 per cent. Debentures	100	101-106
Kensington and Knightsbridge Ordinary	5	12½-13½
London Electric Supply, Ordinary	3	3¼-4
—— 6 per cent. Pref.	5	6¼-7
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	104-106 xd
Metropolitan Electric Supply, Limited, Ord., No. 1-62,500	10	16½-17½
—— ,, ,, No. 62,501-85,000	10	15½-16½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-121
National Telephone, Ordinary	5	4½-5
—— 6 per cent. Cum. First Pref.	10	11-12
—— 6 per cent. Cum. Second Pref.	10	11-12
—— 5 per cent. Non. Cum. Third Pref.	5	4½-5½
—— 3½ per cent. Deb. Stock, Red.	100	100-103
Notting Hill Electric Lighting Company, Limited	10	16-17
Oriental, Limited, 1879	1	1¼-1½
—— £5 Shares	5	7½-8
—— £4½ Shares, New	4½	6¾-7
Oriental Telephone and Electric Company	1	¾-1
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6¾-7¼
Royal Electrical Company of Montreal	1½	160-180 x
—— 4½ per cent. First Shares Mortgage Debentures	100	105-107
South London Electric Supply, Ordinary	3	4¼-4¾
St. James's and Pall Mall, Limited, Ordinary	5	17-18
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	13	37-41
—— 5 per cent. Bonds	100	105-108
Waterloo and City Railway, Ordinary	100	105-108
Westminster Electric Supply, Ordinary	5	14½-15½

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NOTES.

New Use for Motorcars.—Experiments, we understand, are to be made by the Signal Corps of the United States Army with electric motorcars for paying out wire for field telegraphs and telephones.

Rontgen Society.—The annual meeting of this society will be held at 11, Chandos-street, Cavendish-square, on Tuesday, July 4, at 8 p.m., when C. W. Mansell-Moullin, Esq., M.D. Oxon, will deliver his presidential address.

Magnetic Survey of India.—Prof. Rücker probably knows more about the magnetic survey of the United Kingdom than any other individual at the present time, and the Indian Government has sanctioned the coming to England of Captain Fraser, R.E., in order to consult with him in regard to the magnetic survey to be started in India next season.

Sir W. H. Preece and Carnarvon.—A resolution was unanimously adopted by the Carnarvon Town Council last week conferring the freedom of the borough on Sir W. H. Preece, K.C.B., who is a native of that town, and whose father had been mayor of Carnarvon. Additional interest attaches to this resolution, as this is the first occasion on which the freedom of Carnarvon has ever been conferred.

Santoro Prize.—During his inaugural address at the Academia dei Lincei, Prof. Luzatti announced that the prize for the best electrical invention had been adjudged to the system of distribution of electrical energy invented by Galileo Ferraris and Prof. Riccardo Arnò. The prize was worth 10,000 lire, but as Galileo Ferraris was a member of the institution no payment could be made on his behalf, and 5,000 lire have been allotted to Prof. Riccardo Arnò.

The Inverted Arc.—A new use seems to have been found in Sydney, Australia, for inverted arcs. The cycle track there has been lighted by them in conjunction with incandescent lamps. Fifty-five arc lights and 70 incandescents are placed around the track at intervals of 35ft., the lamps being inverted, with the reflectors immediately over the arc. There is said to be absolutely no shadows cast, and cyclists using the track are of the opinion that it is safer to ride at night under this light than by daylight.

Electrical Apparatus in Japan.—A statement has been made elsewhere that the Japanese prefer American to British electrical apparatus. The reason given is that Americans execute their orders more promptly than do European firms, and also that the goods supplied are found superior. If there is any justification for the latter statement, it is is quite time the matter was investigated more closely, so far as it concerns English manufacturers, for if we fail to retain our reputation gained of old for superiority, it will be a poor look out for our future trade abroad.

Pacific Cable.—The *Melbourne Age* a few days ago contained a lengthy article in which the Pacific and Cape cable routes were respectively considered. Speaking of the Cape route, our contemporary considers this as being strategically the more valuable to the mother country, and says that it cannot be claimed that the Australasian colonies have, or are likely to have, any important trade relations with Canada, where the long land service has drawbacks, communication being frequently interrupted by blizzards and snowstorms. The Cape route, adds the *Age*, certainly offers advantages over the Canadian Pacific. Moreover, trade between the Australasian colonies and South Africa is steadily increasing, and points to still further expansion, which greater facilities for communication by cable will tend to increase.

The South Pole.—It must be gratifying to all interested in England's geographical discoveries, both in the North and in the South Polar regions, to find that the Government when approached to assist the proposed expedition to the South Polar regions were finally convinced that such assistance was desirable, because of the information which might be gained with regard to the earth's magnetism and the movements of the earth's magnetic poles. We imagine that the Geographical Society will be able ere long to announce that the expedition is fully determined.

Wireless Telephony.—The *Sydney Bulletin* has a note referring to the fact that about 13 years ago the officers at the termini of the Milton-Milburn line (New Zealand) found their telephonic conversations frequently interrupted by a voice, which, as was subsequently discovered, belonged to the postmaster at Outram, some 30 miles away. The telephone wire from Outram to Japanni runs for some miles on the same posts as the telegraph wire from Outram to Mosqiel; it then branches off, and for some miles it is parallel with the Milton-Milburn telephone line, both lines being about three-quarters of a mile apart. Experts said, "Induction"; but, as they could not find a way either to control or utilise the phenomenon, the mysterious voice continued to contribute by its interruptions to the already somewhat flowery language of the country.

Systems of Distribution.—In discussing four-wire three-phase systems of distribution our New York contemporary, the *Electrical World and Engineer*, proclaims as by far the simplest and undoubtedly the most satisfactory distributing arrangement the so-called four-wire three-phase star or branch connection, which consists simply of three single-phase two-wire circuits, differing from each other by 120deg. in phase, and with one leg of each in common forming a fourth or neutral wire, in which under-balanced loads no current flows, just as no current flows under the same conditions in Edison three-wire systems. Strange as it may seem at first sight, continues our contemporary, the economy of copper on such a system, although there is no multi-wire arrangement of each individual phase, is even greater than that of the Edison three-wire system with the same difference of potential between the neutral and outer conductors.

Motorcar Exhibition.—We are informed that over 100 intending exhibitors have sent in their names for the Motorcar Exhibition, to be opened at the Agricultural Hall, Islington, on Monday, July 3, when the latest foreign and English productions in this line will be shown. The exhibition has been promoted by Messrs. Cordingley and Co., proprietors of the *Motorcar Journal*. In addition to awarding certificates and gold medals, there are to be offered prizes of £25 each for electric carriages weighing under one ton, to carry two persons; electric carriages weighing under one and a-half tons, to carry four passengers, such passengers to average a minimum of 10 stone in weight. The stipulation laid down is in respect to the longest distance made over ordinary roads at a maximum speed of 12 and a minimum speed of 10 miles per hour, the same carriage, with the batteries, to be eligible for speed tests for any road with a gradient of not less than 10 per cent. on it.

Electric Traction in London.—The fetters which have hitherto prevented the introduction of electric traction to any considerable extent into our Metropolis except for underground lines are now happily removed. After many years of plucky contest the London United Tramways

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Company has at length succeeded in acquiring permission to introduce the overhead trolley system of electric traction on its lines within the district of the London County Council. As is well known, the company obtained similar powers last year for the whole of its lines in the county of Middlesex, and on Friday last the Bill to authorise the overhead trolley system of working within the county of London passed the House of Commons unopposed. Now that this last obstacle has been removed, nothing remains to prevent the whole of the United Company's extensive system from being operated electrically, which is understood to be the company's intention, certain works of reconstruction, etc., being, indeed, already well forward since the above result was anticipated.

Cruto Lamp.—The company owning these lamps are setting a good example to their competitors in issuing a well-got-up catalogue printed in various languages. The specimen we have before us gives its information in Italian, in French, and in English. Quite recently some of the English firms have paid far more attention than used to be the case in the production of their catalogues, and we think that they will receive their reward. In the olden days any kind of illustration, any inartistic arrangement, anything, in fact, which merely quoted sizes and prices, was thought sufficiently good to serve as a catalogue. The Americans have in this direction taught us better. While upon this subject we may call attention to a pamphlet which is a sectional reprint from an excellently-illustrated work on the industries and manufactures of Wolverhampton and South Staffordshire. This particular portion of the publication deals with the Electric Construction Company's works at Wolverhampton, which are admirably illustrated and clearly described.

Electric Lighting in Sydney.—The Sydney City Council have decided to adopt electricity for public and private lighting purposes. The committee who reported on the matter, and whose report was adopted by the Council, decided, says the *New South Wales Railway Budget*, that a thoroughly efficient electrical installation would successfully compete with any known system of lighting by gas. The question of obtaining water power for generating purposes was considered, but the unreliability of this method at all seasons, coupled with the expense, rendered it too experimental to warrant recommendation by the committee. Nor was the establishment of a power-house at or near a coal mine considered feasible on account of the distance, difficulty, and expense of efficient control. Again, the committee did not fall in with the idea of utilising heat from a garbage destructor for generating purposes, but in further recommendation of their report they pointed to the fact that the experience of modern cities proved indubitably that public electric lighting installations are carried out with highly satisfactory financial results to the citizens.

Absurdities.—It is usual, when a tradesman is unfortunate enough to take a spurious coin, to nail it to the counter. It is a pity it is not possible to do the same with all the spurious electrical information that is floating about and appearing in the ordinary newspapers. One day we have a scientific disquisition on wireless telegraphy, and it is pointed out that within certain limits signals will be common to receiving instruments within those limits. The next day one or other of the suppliers of news receives a telegraphic message from France, America, Australia, or other country, stating that some unknown individual has devised means whereby wireless messages can only be received by a particular receiver, and that they will be as isolated as are the telegraphic messages under present conditions. The worst of it is that the ordinary reader believes all these things. Indeed, the ordinary reader of a newspaper is in a state of ecstasy as regards electrical matters. Knowing some of its wonders, they believe that by its aid everything is possible. What a wonderful world this would be if everything attributed to electricity was possible.

Big Blasting Operation.—In the twenty-third annual report of her Majesty's Inspectors of Explosives, just issued, special mention is made of a big blasting operation that was carried out on Dec. 7 at the quarry of the Welsh Granite Company, Limited, at Trevor. The quarry is situated 600ft. above the sea-level, and the bank to be operated upon was 100ft. high. The plan of operation consisted in driving one heading, 53ft. long, about 15ft. above the level of the bank; another heading, 23ft. long, to the left from this, and with a chamber at the end; and a third, 29ft. long, to the right, but nearer the mouth of the first heading, also with a chamber at the end. The chambers were charged with 6¼ tons of gunpowder, two high-tension fuses being placed in each chamber, together with duplicate fuses in case of a missfire, and connected with the cable for firing, which was done by means of a small Siemens dynamo of 400 volts. Eight hundred thousand tons of rock were displaced, and another 20,000 tons loosened by the explosion. The report adds that it is proposed to carry out a larger blasting operation at the same quarries this summer.

Turkish Concessions.—In the course of a letter praising German methods as compared with English, the *Pall Mall Gazette* correspondent mentions that it is "expected by Turks in high positions" that a firman will be granted shortly to Sir Ellis Ashmead-Bartlett for the introduction of electric traction into Smyrna and lighting and traction into Salonika. Much has been reported from time to time about Turkish concessions, though nothing tangible is yet forthcoming. However, things are wont to move slowly in the East, so we need not despair of one fine morning hearing of something definite. As the correspondent says, in other words, the thin end of the wedge, so far as the future of electricity in Turkey is concerned, was driven in by the introduction of electric lighting into the Palace. Oriental prejudice constituted the greatest hindrance to the progress of things electrical in Turkey, and now that has been partially broken through, concessions are only a matter of time, though our manufacturers and others should contend for their fair share of the favours, since other very keen competitors are in the field. When concessions are once given, the next thing will be to make the most of them and seek more.

German-American Cable.—A Reuter's telegram from Berlin on Sunday, referring to the laying of the new cable from Germany to America, concerning which some surprise has been expressed that the concession should have been granted to an English company, says it is declared in authoritative quarters that the cable for technical reasons has to be landed at the Azores, where the Telegraph Construction and Maintenance Company of London possessed the exclusive right of landing a cable. In order that the plan for the German cable might not be frustrated, the consent of the London company became necessary. The company agreed only on condition that it should be entrusted with the construction and laying of the cable, and it was thus that the concession came into the hands of an English company. It is added, however, says Reuter, that German interests have not been overlooked, inasmuch as the English company utilises to a considerable extent German material and German labour in laying the cable.

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It is further added that no German manufactory able to undertake the construction and laying of such a cable exists at present, but that one is in course of formation, and should further submarine cables be decided upon, the order for them will be given to a German firm.

Soiree.—The Royal Society gave a successful conversazione at Burlington House on Wednesday evening, the 21st inst. This was the "ladies' night," and, as usual, a varied array of attractions had been provided, though the ladies present gave most of their attention to some objects of antiquarian interest exhibited by Dr. Gladstone dating from the period B C. 200. Another exhibit was Mr. Mackenzie Davidson's apparatus for throwing Röntgen ray effects into stereoscopic relief, which likewise engendered much interest. In this apparatus a rapidly rotating disc, with two apertures cut in it, is so arranged and so rotated that each eye receives the rays only from the source of light opposite to itself, and never receives them at exactly the same moment that the other eye is receiving its rays. In the same way a Röntgen ray shadow of an object, cast on a fluorescent screen by one of the sources of light, is only seen by one eye, and the shadow cast by the other source of light is only visible to the other eye. If these succeed one another fast enough, faster than 10 times a second, the impressions on the eye become continuous, and the shadow of the object is seen in stereoscopic relief. Chain lighting effects were shown by Messrs. Joseph Swan and A. C. C. Swinton, the former gentleman using a new form of interrupter called the Wehnelt-Caldwell, and the latter a new valvular contact breaker. Mrs. Ayrton, the only lady exhibitor present, showed images of the crater of a hissing arc on a screen.

Sydney and Electric Traction.—In our issue of April 28 last we referred to the fact that the Railway Commissioners in Sydney were laying down a plant at Ultimo for supplying sufficient power to operate the whole system of the proposed electric tramways in that city, and at the same time to provide for the electric lighting requirements of the Municipality. We also alluded to the fact that an offer had been made by the Commissioners to allot to the Municipality sufficient generating power at a cost far lower than would be the case if the Municipality itself were to provide and maintain plant for this purpose. We now understand from a report which appeared in a recent issue of the *New South Wales Railway Budget* that the committee who had considered the question of public and private lighting (and to whose report we refer elsewhere in this issue), after duly considering the matter were unable to recommend its adoption by the Council, and the offer was accordingly declined. In further reference to this power-house, our contemporary remarks that, although the work in connection with this is progressing more favourably now than has been the case for some months past, the date when the line will be open for traffic is still doubtful. A considerable amount of delay has been occasioned by the difficulty experienced in obtaining steel and iron work for the roof of the power and boiler houses, consequent upon the strike of engineers in England. This, however, has now been overcome, and a start has been made of the roofing of the building. The power-house will contain 14 boilers, capable of generating 20,000 h.p. Not more than seven of these boilers will be needed for the George-street portions of the line.

Phosphorescence. — Our French contemporary, *L'Electricien*, in a recent issue refers to a phenomenon observed by M. Ernest Gerard with respect to the development under certain conditions of phosphorescence in incandescent lamps. He found that by rubbing the glass bulb of an incandescent lamp with his hand or with his sleeve an evanescent light, having the appearance of phosphorescence, manifested itself inside the tube or bulb. In seeking information on the point, it was explained by our contemporary that it was the custom, in order to ascertain the degree of vacuum possessed by the bulbs, to rub these with a cat-skin in the dark, and that phosphorescence more or less intense was the measure of the degree of emptiness. The phenomenon observed by M. Ernest Gerard was brought under the notice of the Belgian Society of Electricians, of which he is the vice-president, and it was then pointed out that in 1660 the physicist Picard had noticed a luminous appearance in the vacuum of a barometer, and that Haukesbee, in agitating the mercury in the same tube, observed a purple light, and it was upon these evidences that M. Gerard, in rubbing with a cat-skin, found a Gessler tube to be illuminated. At the same meeting M. Mennessier, without knowing the nature of the opinion which was held by our contemporary on the point, explained that the phenomenon observed was not produced in lamps with a perfect vacuum, adding that it was the degree of emptiness which served to classify them. A subsequent speaker remarked that the presence of a filament was necessary for the production of the phenomena. The filament and its attributes would constitute the interior of a Leyden jar, the other portion being represented by the base of the lamp and the lamp itself. *L'Electricien* thinks that the phenomenon referred to by M. Gerard ought to attract attention.

London and its Electrical Supply.—Last Friday, says the *Times*, the Select Committee of the House of Lords presided over by Lord Brougham further considered the Bill promoted by the Central Electric Supply Company, by which powers are sought to acquire a site on the Regent's Canal for the purpose of constructing a generating station for electricity, and to lay mains through Marylebone to supply the St. James's and Pall Mall Electric Supply Company and the Westminster Electric Supply Company with electricity in bulk. It is also proposed to supply electricity in bulk to four other districts should it be desired. Mr. Fitzgerald, Q.C., addressed the committee on behalf of the Metropolitan Electric Supply Company; and Mr. Freeman, Q.C., then opened the case for the Vestry of Marylebone against the scheme, saying the Vestry simply desired to protect the public interests and to prevent undue inconvenience by the breaking up of the streets, which, although paid for by the companies concerned, always entailed a certain amount of expense to the ratepayers also. Evidence having been given in regard to the objections entertained by the majority of the inhabitants of Marylebone to the proposals of the Bill, and Mr. Waddington having given similar evidence, the case for the opponents was closed. Mr. Balfour Browne, Q.C., then replied for the promoters. After the committee had deliberated, the Chairman said they had decided to pass the preamble of the Bill on certain conditions. The committee desired that the Electric Lighting Acts of 1882 and 1888 should be incorporated in the Bill; that there should be only a single line of route and one trench for the conveyance of the energy to the parishes of St. James's and Westminster, the size and route of the trench to be agreed upon by the company and the local authority of Marylebone, and that any case of difference should be decided by the Board of Trade. The committee also restricted the supply to the St. James's and the Westminster Companies, and wished to state that they desired that this company should be bound by all the provisions which Parliament had required to be inserted in electrical provisional orders.

The Chinese and Telegraphy.—In an interesting article contributed to our Transatlantic contemporary,

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the *Electrical World*, Prof. F. B. Crocker refers to some aspects of the electric telegraph in China. In that empire this means of signalling is the only electrical application which has been developed to a state of any importance, and even this is still quite primitive in its methods. The telegraph system of the interior is operated by the Imperial Government largely for its own purposes, but it is available also for commercial and private messages. Prof. Crocker shows that even in the case of the Imperial telegraph system great difficulty is experienced on account of the dogged opposition of the people to anything that is new or foreign. They cut down the poles, break the insulators, and remove the wire. In some cases it is not altogether fanaticism on the part of the natives, as we are told that they incidentally do themselves a good turn by using the poles for firewood and the wire for various purposes. It is found that copper wire is especially welcome to them on account of its greater value. Malicious damage to the telegraph lines near Shanghai having become a serious matter, it was discouraged by the Governor, who ordered that the head of someone in the neighbourhood should be chopped off for every pole chopped down. This was one method certainly of making "the penalty fit the crime," but we are told that the plan was found to be effective in spite of the fatalistic indifference to death of the Chinese compared with the Caucasian races. The author goes on to show that the apparatus and methods employed in the Government telegraph system are exceedingly old-fashioned. At Canton, the most important commercial city of the empire, the office was equipped with half a dozen Morse recorders. The method adopted consists in giving a special number to each word, and these are arranged in columns like a table of logarithms. With reference to telephones, these are used in treaty ports, but even in the largest cities their number is limited. Shanghai having the greatest number of telephones, and being one of the most important places, has only one exchange with four operators, 380 subscribers, and 4,000 calls per day.

Testing Dynamo Iron.—Prof. Dr. Epstein recently discoursed upon the above subject before a gathering of electrical engineers at Frankfort-on-the-Maine. He pointed out how little was known of the special properties of iron, and what slow progress was made with the study of this subject. Of special interest to the electrical engineer was the study of the magnetic properties of iron, and these did not claim his attention in their simplest form, but occurred in complication with secondary phenomena. Continuing, he compared magnetism with the mechanical changes which take place in a steel spring upon being stretched, the elastic reaction of the latter and hysteresis phenomena governing in similar manner a loss of energy. This loss of energy was, by the magnetisation of iron sheets for dynamo cores, dependent upon the quantity of material employed, the frequency of the magnetising current, volume of the same, and peculiar properties of the iron. The latter were not alone dependent upon chemical constitution, but also to a high degree upon the thermal treatment. The former distinctions between wrought iron, cast iron, and steel had vanished, and the practical man had now at his disposal a great variety of qualities, whose properties approached similarity. Casting and rolling lent to the iron simply the necessary shape. The manufacturing process proper of dynamo iron commenced with the annealing — the hardening process. It was the thermal treatment of the iron upon which the magnetic quality of the iron depended—a process requiring extreme care, but which was not always certain. A critical stage was also the mechanical shaping of the sheet after its thermal treatment, since each mechanical demand upon the iron might prove detrimental to the result of the annealing process. However, even a thoroughly well manufactured iron showed no constant magnetic properties. Investigation of the hysteresis loss in iron had induced the establishment with which the speaker was connected to construct a new form of testing apparatus for iron, and the results obtained had shown that the different samples of iron taken varied very considerably, and only tests made by the same method were at all comparable. This result pointed to the desirability of consumers, manufacturers, and scientists working together, and employing one common method of testing. The establishment of standards was desirable, whereby the iron would be tested in its finished form.

The Como Exhibition.—The exhibition in connection with the centenary of Volta furnished details for an interesting article in the *Morning Post* of Tuesday last Referring to the historic section, or that portion of the exhibition which deals exclusively with the work of the Como physicist, the writer mentions that this contains a cast of the great inventor's skull, and around it are arranged the various pieces of apparatus which were invented or employed by him in his classical researches. That, as a matter of course, which commands the greatest attention is the famous "pile." Having furnished other details, all closely associated with the physicist's earlier researches, including the electrophorus, the condenser, and the primitive electrometer, the last named of which has become so much associated with Lord Kelvin's name that one is somewhat amazed, says our contemporary, at finding it in the list of Volta's inventions, the writer proceeds to refer to other sections of the exhibition, noting *en passent* that there is a particularly choice display of electrical appliances, chiefly from Milan, where the electrical industry seems to be in great progress. Our contemporary goes on to say that it is in cooking appliances nowadays that search must be made for novelties in matters electrical, and in this direction there is at the exhibition no disappointment. It is added that "the thrifty housewife has only to turn on the current for a very short time in order to bring the water in a pretty little kettle to the boiling point. Similarly this invisible agent brings the metal rods of a grill to a red heat, which soon converts the raw beefsteak into a delicious edible snack. The laundrymaid need have no more trouble in keeping her smoothing irons hot, since by simply joining them when in use to the electric mains they may be kept at the required temperature for any length of time. In like manner the curling-tongs of the hairdresser need only be switched on before he applies them to the locks of his clients." Specimens of these appliances and many others for cookery purposes are on exhibition in abundance, and perhaps attract most notice from visitors. Dynamos and motors of the most recent and approved designs are shown in large numbers, with electrical measuring instruments. Telephones for all conceivable purposes are shown, and the display of telegraph apparatus is one of the best ever made at such an exhibition. Instruments of every kind are on view, including the Hughes and the Baudot, which are chiefly used on the Continent, and the sounder and Wheatstone, which are peculiar to Great Britain and America. A complete relay set, such as is used for fast-speed Wheatstone working in the British postal service, finds a place in one corner, while opposite it stands a large selection of testing appliances, among which are several samples of Siemens's electro-dynamometer, an instrument not often seen outside the test-room or the electrical laboratory. Several portable sets of telegraph apparatus for use on special occasions, neat and compact, are shown.

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MUNICIPAL ELECTRICAL ASSOCIATION.

BRISTOL CONVENTION.

FRIDAY'S PROCEEDINGS.

Mr. J. H. RIDER again presided, and called upon Mr. J. F. C. Snell to read his paper on

Condensers for Electric Light and Power Stations

BY J. F. C. SNELL, A.M.I.C.E., M.I.E.E., M.I.M.E., BOROUGH ELECTRICAL ENGINEER, SUNDERLAND.

MR. J. F. C. SNELL.

A good deal of labour is expended in obtaining an extra 1 per cent. of efficiency of electrical plant, and it is anomalous to find so many electrical stations which are among the most modern in equipment of all generating centres of power exhausting steam into atmosphere, and thereby reducing the efficiency of the steam plant wholesale. When one considers the fundamental equation $\frac{T - T_1}{T - T_2}$, which gives the increase of efficiency obtained by a condensing engine over and above that of the same engine working with an atmospheric exhaust, it seems that in the most difficult of cases—*i.e.*, where circulating water has to be purchased and the station site is limited in extent—it is financially unsound, and also unsound engineering to ignore the claims of the condenser. Take a simple example of an engine working with a chest pressure of 135lb. absolute, and with 6lb. back pressure in the exhaust, and compare the results with those obtained from the same engine having the same initial pressure, but exhausting into a 25in. or 26in. vacuum, or against a vapour pressure of 3lb. absolute, what increase of efficiency results? The temperature of steam at 135lb. absolute = 350deg. F., and that of 21lb. absolute = 231deg. F., and that of 3lb. absolute = 127deg.

The theoretical efficiency of the engine working with a condenser would be $\frac{350 - 127}{350 - 231} = 1{\cdot}87$ times greater than the same engine working to atmosphere. In the classical papers of the late Mr. Willans, published in the *Proceedings* of the Institution of Civil Engineer, vol. xiv., 1893, curves and results were shown of trials of throttle-governed engines in which the condensing curve (which is a straight line in this case) is much below that of the non-condensing curve, and the initial quantity of steam to overcome friction being very much less, and the constant increment per horse-power being the same in both cases, the two lines are parallel, showing that the value of condensation of steam increases with a decrease of load, a very valuable fact in view of the variable load of an electric light station and the present tendency towards large units of power. It is a pity that the valuable tables given weekly in *Lightning* do not give a column showing whether a station is condensing its steam or exhausting to atmosphere, for the former must have the advantage in coal consumption. Of course, this is not all gain, a certain debit having to be made for the auxiliary machinery required to drive air or circulating pumps or both, which auxiliary power amounts to some 2 or 3 per cent. of the whole. There are other considerations which should induce one to adopt condensers, such as the nuisance which is caused sometimes from the exhaust steam blowing about and becoming condensed and falling as a greasy rain; or, again, the atmospheric vibration which is frequently caused by an exhaust pipe. A saving is effected in less cleaning of boilers; the hot-well water can be used for feed, and only a small amount of make-up water is required. Other advantages could also be brought forward. The locality must needs affect the type of condenser adopted. If a natural source of circulating water is not available, can ground space be obtained for artificially cooling the water? This and other considerations must settle the question.

Condensers may be classed broadly into two kinds: (1) those in which the circulating water is always separated from the exhaust steam; (2) those in which the circulating water is mixed with the exhaust steam. The first class contains the surface condenser and the evaporative condenser. The second class contains the old jet condenser and the more modern ejector condenser.

Surface Condensers.—In the author's opinion there can be no inducement to adopt any other class of condenser if plenty of circulating water can be had. If not, artificial cooling arrangements should be adopted. If economy of circulating water is necessary, this system is very good, and though it does not approach the simplicity and excellence of surface condensing plant supplied from liberal and natural sources of cooling water, yet it appears to the author to be the next best system. In the *Railway World* of February, 1899, a case is cited of the Madrid power-house, where, after a 12 hours' full-load run, the temperature of the tank from which the circulating water was drawn had not increased. The water, after passing through the condenser, is in that case made to fall over a series of metal sheets contained within a tower through which a circulation of air is forced by fans. The advantage of surface condensers is that the condensed steam can be returned to a hot-well, and after passing through a carefully arranged oil filter, can be used again as boiler feed. It is true that both air and circulating pumps are required, and in the case of cooling towers fans as well, also that this type requires a larger percentage of auxiliary power than other types. It is also more costly in outlay, but eventually, and especially in hard-water districts, it will probably be found better to instal than a type in which condensed steam and circulating water are mixed together. The principle of using the heat units of the hot-well water, instead of wasting them as well as the latent heat units taken away by the circulating water, is one that must be right. The author has recently been obliged to go into the question of extensions at Sunderland, where every available foot of ground on the existing site will be taken up as soon as the extensions are completed, and the only alternative of exhausting to atmosphere (for which the station was originally designed) is the adoption of artificial means of cooling the circulating water, or the use of condensers of the evaporative type. The author has decided to adopt self-contained surface condensers, one to each pair of 500-h.p. steam dynamos, and a cooling tower with fan draught for top loads or special climatic conditions. Sunderland water is very hard indeed (about 25deg. Clark's scale), and as considerations of space have made it imperative to adopt marine boilers, it is more necessary to use the condensed steam again as feed. The price of the condensing plant, steam driven, including cooling towers and all pipework, will be about £2. 5s. per electrical horse-power installed. In large stations it will certainly be best to have each engine completely equipped with surface condenser, air, and circulating pump, even if the pumps be separately driven. Simplicity of design is most essential, and any system allowing for changing over from one condenser to another, or many, will in the end introduce unnecessary complexity of design. Each engine, condenser, and pumps, and atmospheric by-pass uptake should be separate. By having the condenser close to the low-pressure cylinder a gain in vacuum in the cylinder results. There is less work for the air-pump, and there are less joints on the exhaust to be maintained. Should the condenser be a portion of the engine and the pumps driven from it, or should they be independent of it? The author understands that even in some modern marine practice the condenser is being made independent of the main engine, and the pumps are separately driven. The present tendency of electrical men—writing from a station engineer's standpoint only—is towards high speed. This in itself practically disallows the pumps being driven from the main engine; again it is convenient and economical to have the condenser below the engine-room floor instead of taking up unnecessary space. A good drainage is thus given to the low-pressure cylinder, and though not all-important, a gain in the appearance of the station. The engines can also be worked to atmosphere more readily. In stations of small dimensions, where the price of a separate condenser for each small unit would be prohibitive, it becomes necessary to have a common exhaust pipe, and perhaps several condensers connected thereto. This is not to be desired, as the more valves and complications the more chances of losing the vacuum, and that perhaps at a critical moment, when a drop in pressure over the whole system might result. The question whether the condensers are to be separate or built up with the engines therefore depends much on the type of engine itself. To sum up, the author is of opinion that high-speed or moderately high-speed engines, with separate con-

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densers to each, driven by a motor or auxiliary engine, and with the condensing plant below ground, and a separate atmospheric by-pass, commends itself as the most reasonable and simplest design. The systems of cooling circulating water will be dealt with later in the paper. Surface condensers, including air and circulating pumps, cost approximately £1·6 per electrical horse-power if steam driven, or £3·73 per electrical horse-power if motor driven. They take up approximately 0·03 square feet per horse-power. The cooling surface in the best practice is two square feet per horse-power, and the weight of circulating water should not be less than 25 times the weight of steam condensed, and more if the surrounding temperature and temperature of circulating water be high. The importance of having brass tube plates, with the tubes ferruled into the plate, plenty of air-pump volume (usually taken at 1-24th the low-pressure volume), brass liners, brass buckets, and phosphor-bronze air-pump rods, scarcely needs pointing out. A type of air-pump now much in favour is that known as Edwards's, which does away with foot and bucket valves, and therefore reduces to a minimum a chief source of trouble in air-pumps. The head or delivery valves of course remain, but another advantage is that these can be renewed from a side door without stopping the pump. India-rubber valves are of no use with oily water, as they waste and rot so quickly. Muntz metal sheets, or vulcanised fibre valves, are found best in practice. It is best to let the air-pump have an easy discharge to the hot-well, as if much head of water be allowed on the delivery side trouble results in getting rid of the air, and the vacuum is consequently impaired. The barrels, buckets, and valves of the feed pump should also be of brass, as the hot-well temperature will be some 130deg. or 140deg. F. In a recent description of a surface condenser with motor-driven air and circulating pumps for Glasgow, the curves show a modulus of 66 per cent.—that is, $\frac{\text{Pump horse-power}}{\text{Electrical horse-power}}$. These sets are each to care for 15,000lb. of steam, or at 22lb. per electrical horse-power, say about 700 e.h.p., and have each a surface of 1,250 square feet—that is, 1·78 square feet per electrical horse-power. The air-pump took 13 h.p. at full load, and I have calculated out the circulating pump at 7 h.p., or a total of 20 h.p. of auxiliary plant for a 700-h.p. engine—*i.e.*, slightly under 3 per cent., a usual figure. The air-pump motor runs at 800 revolutions per minute and the pump at 150 revolutions, a rather high rate for an air-pump; the 7in. centrifugal pumps deal with 1,000 gallons per minute against a 10ft. head, and run at 530 revolutions per minute.

Evaporative Condensers.—The next type of condenser which keeps condensed steam separate from the circulating water is one which has sprung up only recently, and is still in rather an experimental stage. At least, little has been written on the matter, excepting, as far as I know, a paper before the Institution of Civil Engineers by Mr. Henry Davey in 1896, one before the Institution of Junior Engineers by Mr. Fraser, and an admirable paper recently read before the Institution of Mechanical Engineers by Mr. Oldham. The author has had experience with three types of evaporative condensers. The principle is, of course, the passage of a film of water over tubes arranged either horizontally or vertically, which by evaporation carries off the latent heat of the steam contained within the pipes. In some cases the pipes are enclosed within a casing and the cooling is aided by forced draught obtained by means of a separately driven fan. It is claimed that the amount of circulating water evaporated is less than the amount of feed water, but of course this is obtained only by means of a considerable amount of air cooling. The condensers can be, and usually are, fixed on the roof of the engine-house. The average vacuum obtained is from 18in. to 22in., and air-pump and circulating pump are both required, but the work done by the circulating pump is small, being that due to the height of the condenser itself. The objection to this type in the author's opinion is the fact that the condenser is some distance from the engine, and, on account of the benefit of wind draught and ground space occupied, it is placed on the roof, and natural drainage of the exhaust is impossible, and the vacuum in those with which the author had to deal, at any rate, has not been nearly so good as that obtained with a surface condenser. So far as his experience with this class of condenser goes, the vertical arrangement of tubes is better than a horizontal construction. Various means have been devised to keep the water spread over the tubes so as to use every inch of cooling surface: tapes, spiral guides, troughs at intervals, and other devices. The amount of cooling surface per electrical horse-power is found to be about 2·75 square feet as against 1·75 to 2 square feet for a surface condenser. The air pump should be larger on account of the large amount of exhaust pipe usual in such cases, and so arranged as to drain the exhaust pipe at its lowest level. The circulating pump is very much smaller than in the case of a surface condenser, being only required to circulate something like one-twelfth of the amount of water. There is a well-known type of evaporative condenser at Kensington Court which is frequently used as an air condenser only, being in its present situation impossible to circulate water owing to the proximity of important residential buildings, and the fear of creating a nuisance. This type of condenser for congested districts must of necessity be a valuable one, and next to surface condensers in the author's opinion will prove to be the best when more developed. A case is cited in Mr. Oldham's recent paper read before the Institution of Mechanical Engineers of an evaporative condenser connected to two Willans engines of 350 h.p. This condenser was 140ft. away from the engines, and the distance from the engines to the condenser and thence to the air-pumps was 350ft. These engines could run at 100 h.p. without any cooling water, the condenser simply acting as an air condenser. It therefore seems that only sufficient tube area is necessary to enable this type of condenser to be used without employing any circulating water at all. The auxiliary horse-power required for driving the pumps is about 2 per cent., and the circulating water necessary may be taken at 1½ times the steam condensed. Another case is cited of a Theisen plant dealing with 3,000 h.p. These condensers are supplied with a 12in. fan, and the auxiliary plant requires only 16 h.p. for the centrifugal pump and fans and 15 h.p. for the air-pump, or 1·03 per cent. only of the total power. The cost of an average evaporative condenser may be taken at £1·8, with motor-driven auxiliaries, including air-pump, circulating pump, and fans, and the area taken up about 0·15 square foot per electrical horse-power. The make-up water of either of the above-mentioned types of condenser can be, if necessary, in hard-water districts treated by a softener or by an evaporator since so small a quantity is required.

Ejector Condensers.—The next type to consider is the ejector, which the author thinks ranks third on the list. He does not, however, like it so much as the other types because of the intermixture of circulating water and steam and consequent loss of a hot feed. Thus one of the two great advantages of condensation is lost. This is, however, a very neat and a very cheap condenser, occupying very little room. The principle of course is the supplying to a specially-shaped vessel a stream of water under good head or pressure passing through the inner sides of a series of cones, around the outside of which the exhaust steam circulates. The *vis viva* of the falling water, with the added energy due to the differences between atmospheric pressure and vacuum in condenser, carries away the combined steam, air, and water. No air-pump is therefore necessary, but a circulating pump similar in size to that used with a surface condenser is required—*i.e.*, circulating water about 25 times the weight of steam condensed. At two stations with which the author was connected the engines exhausted into a common pipe, to which several ejectors were fixed, varying in size. The author does not like this, but considers that a separate ejector to each engine, as arranged by Mr. Wordingham, at Manchester, is by far the best. There is one important point in connection with this type; it is necessary to seal the delivery from the condensers with water. In cases of failure of the head of circulating water, the vacuum might cause the water seal to rise in the pipes, and so to the engine, causing some little trouble (if a new cylinder or a blown-off low-pressure cover may be classed as such). To prevent this, non-return valves or siphon bends are always fitted. An automatic atmospheric exhaust valve is also, of course, always added. For neatness and cheapness this type is to be strongly recommended. Unfortunately, it has that, to him, great objection: the inability to return the condensed steam as feed water to the boilers. The cost of this condenser is as low as £0·9 per electrical horse-power, including the circulating pumps to raise the water to sufficient head, usually not less than 25ft., for the purpose of supplying the condensers. The author suggests an interlocking arrangement, so that the water may not be shut off before the engine has been shut down, as non-return valves do not always act.

Jet Condensers.—The last type here mentioned was the first to be adopted—viz., the old jet condenser. In this case the air-pump has to be large enough not only to clear away the condensed steam and air, but also the whole of the injection water, no circulating pump being necessary except it be for recooling. The amount of power required to drive the air-pump is 2 per cent. of the total engine output, and the cost is £0·88 per electrical horse-power. This may be dismissed at once by saying that this type is effete so far as electric power stations are concerned.

Circulating Water.—As to those cases in which no natural source, such as river, sea, or canal, is at hand from which water for circulation is obtainable, there are many ways for dealing with the cooling of water; amongst them being the cooling ponds, cooling sheets, as at St. Pancras, and by spraying over a pond, such as is extant at Croydon and Newcastle, and is being adopted at Cheltenham and elsewhere; also towers, as at Brighton, the Central London, and as the author intends adopting at Sunderland. There is usually no warrant for adopting cooling ponds, the cooling area required to equate the increase from the steam being so great, and ground being as a rule far too valuable. A simple method was adopted at St. Pancras, con-

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sisting of a series of corrugated iron sheets over which the water was allowed to trickle. This system, however, requires such a very large cooling area, and the wind pressure on the exposed area is sometimes so great as to make an adequate system too bulky to be practicable. Of course, a large reservoir was in connection with this, the cooling going on throughout the 24 hours, and the temperature of the water rising considerably at times of full load, which was reduced to normal temperature during the hours of light load. The system of spraying through specially constructed hydraulic nozzles over a large reservoir is very successful, but unfortunately this too requires a large ground space, though in inland provincial stations it would be a most excellent method. The ground space is about 24 square feet, and the price about £0·9 per horse-power. The author's opinion is that towers with an artificial air draught offer the most ready method of dealing with this important matter. Towers do not take up much room, the vapour is taken away from a good height, and the amount of auxiliary power required for driving the fan is only 0·8 per cent. The ground space is about 0·15 square feet, and the cost £1·05 per horse-power.

Allusion has been made to the necessity of brass-ended pumps for condensing plant. There is one other point—viz., the elimination of oil from the hot-well water—which must be effected before the water is fed into the boilers. In most engines nowadays—such as Belliss, Allen, or other high-speed marine types—very little oil need be used—in fact, the engines at Sunderland of the former type are run almost without any oil in the cylinders, and at the last inspection the cylinders were in splendid condition, and showed no signs of wear. Almost all enclosed engines are now constructed with outside glands on the cylinders, and with lantern glands with drains returning to the crank chamber. By this means oil is not now sucked up from the crank chamber into the low-pressure cylinder, and the amount of oil present is therefore very small. There are several filters on the market now which profess to deal with the oil in water, and no doubt do so to a great degree, but it is a difficult matter to eliminate oil which becomes saponified and so intimately mixed with the water. A careful selection of the oil, or the replacement of cylinder oil by graphite, for example, will minimise this trouble. The author disclaims any novelty in this paper, and has merely laid the same before the association as a nucleus for discussion, which, it is hoped, will be beneficial to us all. The weight of steam per electrical horse-power is taken at 20lb. throughout.

Mr. W. A. CHAMEN, of Glasgow, in opening the discussion, claimed how needful it was that large stations should be running condensing. Otherwise, the steam issuing from the exhaust pipe was very apt to fall as rain in the adjacent streets. He had had that trouble at Glasgow, and, in answer to the committee's question as to what should be done, could only advise that the public should choose another street to walk in. He believed that some air and circulating pumps were being installed at Poplar direct-driven from high-speed engines, and he asked whether further information about this could be obtained. The maximum engine speed to which they direct coupled their pumps at Glasgow was 120 revolutions, and he thought this was quite high enough. He had found great trouble with evaporative condensers, and the difficulties were increased owing to the distance of the condenser from the engine, which necessitated a large number of joints and leakages. He wished that Mr. Lowe, of Messrs. Willans and Robinson's, had been present to give them his experience in the design of exhaust pipes. He had found that where small pipes entered large ones, eddies causing considerable back pressure were set up. He rather objected to the ejector condenser on account of the difficulty of obtaining the efficiency of a set exhaust into them. As regards the use of graphite instead of oil, Mr. Lowe had found that the internal parts were exceedingly apt to rust badly when left after having been lubricated with graphite only. Where water was scarce he advocated the use of cooling towers in connection with surface condensers. At Glasgow they had a canal near their works and arranged the intake some 600ft. away from the discharge pipe. He was afraid, however, they would have trouble before long, as the tramway people proposed to do the same thing a little higher up the canal. He was very much adverse to the usual practice of placing the condensing plant below the floor, where it was very apt to be neglected.

Mr. C. H. WORDINGHAM complimented the author on his paper, and agreed with him that surface condensers were the best to use as a rule. He also found from his personal experience that the author's figures as to the cost of condensers were practically in agreement with some which he had obtained for his own station in Manchester. Personally, he believed in the use of separate condensing plant for each engine. In the large 3,500-h.p. machines he was now considering they were arranging the condenser in halves, so that the risk of breaking down might be reduced. This machine would be running at 75 revolutions per minute, and the pumps would be direct coupled. He quite agreed with Mr. Chamen in his objection to the ejector condenser in that it was impossible to test steam consumption. The separation of oil from the condensed water was a very difficult matter, and personally he believed it was more possible to divide the oil from the steam before condensation.

Mr. A. ELLIS, of Bolton, remarked that in their works they were just taking up the question of condensation. There was a stream near them, but as it was only 5ft. wide and 9in. deep they had decided to put in cooling towers and to discharge into a lodge at light load.

Mr. A. S. BARNARD, of Hull, said his practical experience showed that it was better to work without a water seal with the ejector condenser. Since arranging his plant in this way he had never had the vacuum fail. There was in this case no need to rely on an air cock in the exhaust. In starting up he ran the engines until there was a slight back pressure in the exhaust pipe, and then turned on the water and got the vacuum at once. There was no need of an automatic valve to give relief in case the water failed, as the steam had a straight blow through. They worked the by-pass to the atmosphere at Hull by hand, and did not rely on an automatic apparatus.

Mr. J. KLEIN said that it might be of interest to state that a surface-condensing plant, combined with a Klein cooler of the "tower" type, was working at the Bristol Wagon Works. In this type of cooler the water was only raised to a height of about 20ft., the tower surrounding the cooling stack being 60ft. high. The difference in temperature between the interior of the tower and the atmosphere outside caused a draught up the tower, which supplied the necessary air for evaporating a portion of the water and for carrying away the vapour. Several towers of this type were working successfully in this country, and a large plant to deal with the condensing water for some 3,000 h.p. was being erected for the City and South London Electric Railway. These tower coolers occupied more space than the fan coolers, but their advantage was that there were no moving parts and the draught was obtained without expenditure of power. Of course, where sufficient space was not available, fans must be used. As to the oil question, it was extremely difficult to separate the oil from the water after condensation. He had found that the best way of removing the oil was by a separator in the exhaust pipe between the engine and the condenser. No trouble was then caused by the oil in the condenser, and the separator was much simpler and more efficient than the filter used for removing oil from the water. The oil was separated from the exhaust steam by changing the direction and reducing the velocity of the steam, the action being similar to that of an ordinary steam separator.

Mr. E. T. RUTHVEN MURRAY, of Willesden, had inspected the drawings of the arrangement Mr. Blackman was proposing to use at Poplar. The pumps were worked by means of a worm and wheel gear at the back of the engine. He personally thought that a much better vacuum could be obtained with separate condensers than with one main condenser on a main source pipe. He also believed that the steam and oil could be separated much better; then the oil could be got out of the mixture after condensation.

Mr. R. C. QUIN, of Blackpool, said that at his town they used a number of oil-filters in series, being filled respectively with sand, coke, and sawdust, but even then it was not possible to filter out the oil that had been changed by a saponification process by filters.

Mr. L. ANDREWS, of Hastings, remarked that the high price of coal supplied to his station rendered condensing most necessary, and that comparatively recently they had tried evaporative condensers of a vertical type. The first trial with these was made some two years ago, and he quite supported the author's statement that that they gave more frequently an 18in. vacuum than a 22in. He had found

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that there was great difficulty in breaking up the steam when passing through the pipes so as to prevent a core of uncondensed steam running down the centre. At Hastings they had obtained much better results by running the nests of tubes in series than in parallel. As they had the condenser on the roof they were able to drain it by gravity, but there was a 2in. drop in the vacuum between the condenser and the engines.

Mr. MORLEY took up the question of lubrication, and said that a large number of marine engines were run without any oil at all, except when just going into port. Oil was used then to prevent the parts rusting when they were standing. The use of graphite was not to be recommended, as it caused greater wear in the engine. In the same way a mixture of oil and graphite had no advantage.

Mr. A. B. MOUNTAIN, of Huddersfield, did not agree with the author's condemnation of jet condensers. Every case should be examined on its own merits. He had tried running without oil as recommended for some two years, and then had to renew all the piston rings and the piston itself. But he quite agreed that graphite was not suitable.

Mr. C. D. TAITE, of Southport, said that quite recently he had to design a large reservoir to hold some 1,000,000 gallons of water to be used in connection with a 5,000-h.p. plant. The cost came out at about £3,000, and he was proposing to use jet condensers and to let the water flow back by gravity.

Mr. T. H. MINSHALL, of Croydon, had recently had a talk with Mr. Thornycroft on the question of the use of oil with engines. It was made clear to him that oil was not used because the boilers could not stand it, and as the makers were paid for all repairs, they did not mind the renewing of parts. On trial trips, however, oil was always used in order to get record speeds.

Mr. C. J. SUTHERLAND, of Worcester, said that when using economisers there was not so much need for the saving of heat by means of surface condensers. The ejector type was a very simple one, which it was easy to maintain.

Mr. J. S. HIGHFIELD, of St. Helens, questioned if the cooling gear really prevented the rain trouble with very large plants. The large amount of vapour issuing from such towers was likely to give trouble by condensation.

Mr. H. B. SPENCER said that he would like to sound a note of warning as regarded air and circulating pumps worked by the main engine. Some years ago, when he was with an engine insurance company in Manchester, he had occasion to analyse the various breakdowns of engines that had occurred over a considerable period. He found that about 20 per cent. of these were due to failures of air pumps or condensers. He thought that electrical engineers were much more free from accidents with their separate condensing plants than if they had had pumps worked even by slow-speed main engines. The advantages of having the condensing plant independent of the main engine were now being recognised, and he might add that his father, Mr. John Fred Spencer, who had had a good deal to do with the introduction of the surface condenser, had designed some 30 years ago for Woolwich Arsenal some independent surface condensers, two of which were still working satisfactorily, and he had advocated the use of such arrangements for large engines. He questioned whether it was worth while endeavouring to work engines without oil. Although now possible with saturated steam, there could be no question that in a few years' time most of the gentlemen present would be using superheated steam, and oil would then be a necessity. Some years ago he had had to do with an engine at Bristol which was finally worked without oil after several vain attempts had been made to remove this from the condensed steam by filters. The boiler was of the West India type, externally fired, and the entrance of oil into the boiler was immediately followed by softening of the plate over the furnace. Thus it was absolutely necessary to exclude it. To enable the engine to work without oil a saddle was fitted over the slide valve on Messrs. Thornycroft's system. This arrangement was successful, but involved a good deal of attention. He believed that the oil difficulty was best solved by the means Mr. Klein had referred to—namely, by a separator in the exhaust pipe—which had recently been found successful in several instances.

Mr. J. F. C. SNELL, in reply, said he was very glad to hear so much spoken of cooling towers, which he thought would come into general use. He also believed in having all the machinery in view. There was no reason why the condensing plant, when slightly below the floor level, should be covered in. He thanked Mr. Barnard for his remarks, and for the experience he had given them in working ejector condensers without a water seal. He (Mr. Snell) did not, however, believe in working these condensers in parallel. He had spoken of from 18in. to 22in. as the vacuum to be obtained with evaporative condensers, but a 12in. vacuum with this apparatus was no uncommon figure. He had also tried working without oil for some 18 months, and had found it most destructive to the working plant.

The Arrangement of Steam and Other Pipes, and their Fittings.

BY J. E. EDGCOME, M.I.M.E., M.I.E.E., BOROUGH ELECTRICAL ENGINEER, KINGSTON-UPON-THAMES.

MR. J. E EDGCOME.

The subject of steam and other piping is one of the greatest importance to engineers of central stations, and, indeed, to all who have to deal with steam plant. It is a subject upon which volumes might be written and still leave much unsaid. The author does not pretend to advance any especially new or original information, but rather a series of notes based on some little experience, in the hope of eliciting what should prove to be a most interesting discussion, and a discussion from which every member may be able to carry away some useful suggestion, to be put into practice when laying down a new generating station, or when carrying out the inevitable extension of his present works. The arrangement of piping referred to in this paper is proposed for small or for moderate sized stations, which form the majority, rather than for those very large stations to be found in a few of the big cities, and where, possibly, special arrangements are necessary.

Steam-Pipes.—The author is of opinion that in the majority of cases, the best and most favourable arrangement of steam-piping is in the form of a steam-ring, running from the boiler-house through the engine-house and returning to the boiler-house, as shown in Fig. 1. It is advisable that the ring should be cross-connected at two or more places, as shown at A B and C D, so that in the event of repairs being necessary to any pipe, say at E, the closing of the valves, F G, does not necessitate, in case boiler H is under steam, that the steam should pass to the engines, say P or R, by the long route, K A L M, but by the shorter route, K A B M. This arrangement will also allow of considerable lengths of steam-pipe being cut out when the engines and boilers upon them are not in use, and will be found to give greater flexibility to the ring system. In most cases, particularly when the engine-house and boiler-house are approximately on the same level, it is usually more convenient to carry the steam-piping overhead, and where a single line of boilers is installed backing towards the dividing wall, and similarly a single line of engines is laid down with the engines abutting towards the same wall, it is extremely simple to carry out a steam-ring system. Where a double row of engines is installed the system becomes a little more complicated, and it is usually advisable to form a second loop of steam-piping in parallel with the main ring within the engine-house, feeding the engines on either side, the engines in that case facing one another with the machines outward. Serviceable and reliable steam-pipes may be made up of lap-welded mild steel with heavy wrought-iron flanges, the flanges being screwed on hot and the ends brazed. The flanges must, of course, be faced up to enable good joints to be made. In larger sized steam-pipes it will be found that joints can be kept tighter by having the flanges made with a

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slight boss, which is faced up for the joint, instead of the whole of the flange being faced up for that purpose, as shown at A in Fig. 2; from 1-16in. to ⅛in. is sufficient for the thickness of the boss. Steam-pipes, where supported on brackets or columns, should be carried on rollers to allow of free contraction and expansion.

Joints.—With the higher steam pressures now in use care and discrimination are required in making and keeping good sound joints. There are innumerable makes of jointing material on the market. Rubber prepared with plumbago makes a good sound joint, which requires taking up when steam is admitted to the pipe, as the material softens with the heat, although it sets into a hard permanent joint when tightened up. An admirable and reliable joint is one made with corrugated brass rings, painted with thin red lead.

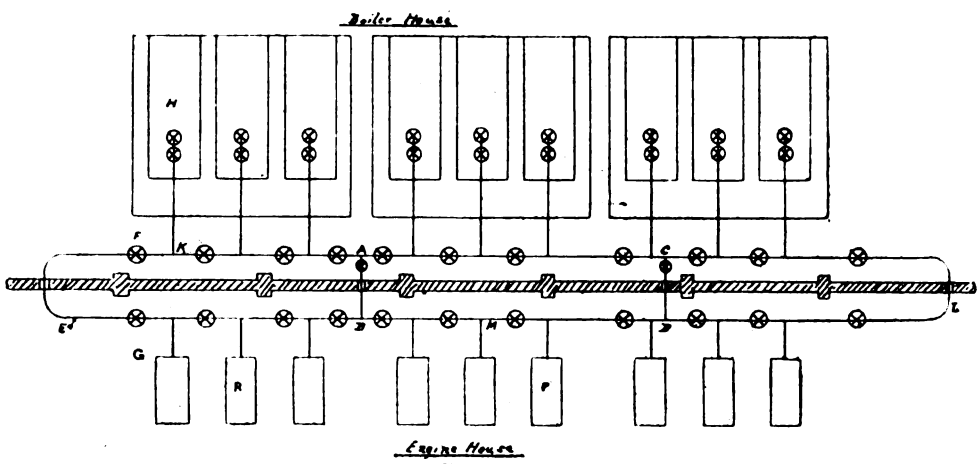

FIG. 1.

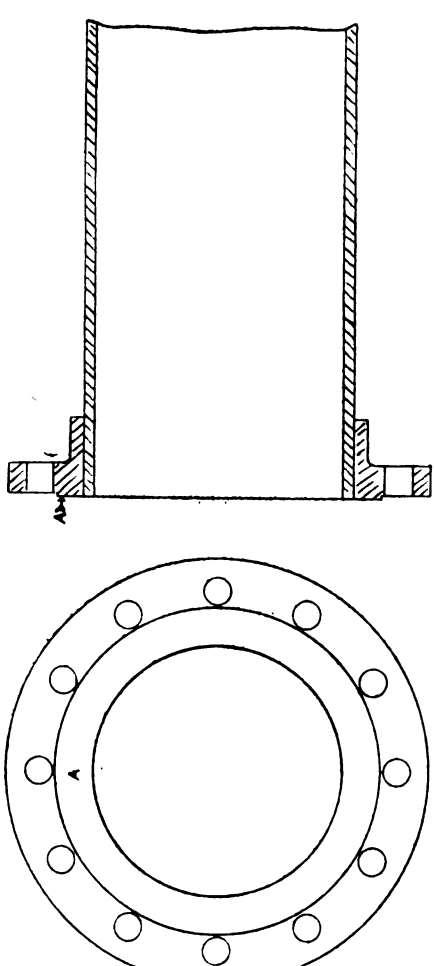

FIG. 2.

Drainage.—One of the most prolific causes of trouble with steam-piping is that from accumulation of water, and too much care cannot be taken in the thorough draining of the pipes. For this purpose a number of separators should be fitted in the ring on the boiler side to collect the water from the steam where it leaves the boilers, and in the author's opinion it is certainly advisable that every engine should be fitted with its own separator to deal with any water which may be carried over from the main steam-pipe. To deal, however, with the water which will notwithstanding collect in the main steam-ring in the engine-house, it is advisable to connect the ring in several places to steam-traps, similar traps being connected to the separators of the engines. The author has found from experience that to permanently connect the engine separators to steam-traps deals more effectually with the water trouble than to constantly blow out the water from the separators as it collects there, especially in view of the difficulty experienced in ascertaining the quantity of water in the separators, except by the use of gauge-glasses, which are a source of constant trouble owing to the difficulty of getting glasses to withstand the pressure when there is any variation of temperature or when they are subjected to sudden cold draughts. The connecting pipes from the boilers to the main steam-pipe and from the main steam-pipe to the engines should be preferably of copper, with full swan neck bends to keep the water back as much as possible and to allow of expansion.

Steam-Traps.—These are most necessary adjuncts to the steam-pipes; but although there are some very good steam-traps on the market, probably most engineers will agree that an ideal trap has yet to be discovered. All steam-traps require a certain amount of attention, and should be fitted with a reliable class of stop-valve to enable them to be shut off from the live steam main for inspection and for the renewal of the valves and seatings when necessary. Most of the modern traps will discharge at a considerable height, depending, of course, upon the steam pressure, and it will be found that a quantity of excellent feed water may be collected by this means. When discharging to a height each trap should be fitted with a non-return valve to prevent the column of condensed water in the pipe returning to the trap. It will be found convenient to group the discharge pipes from a number of steam-traps into a small tank, having an overflow pipe to the hot-well. This will enable the discharge of every trap to be inspected, which is a necessary precaution to ensure that each is in proper working order.

Valves.—Valves are a very important part of a steam system, and care should be taken to select a class of valve suitable for the work which it has to perform. Full-way valves possess so many advantages over other types that in the most modern plants these are almost wholly used for high-pressure steam work, and can be obtained from the smallest to the largest size. The large valves on the main steam-ring should each be provided with a small by-pass valve to enable a length of cold steam-pipe to be warmed up and the pressure balanced before the main valve is opened. This will prevent the straining of the joints caused by sudden expansion, and likewise accidents due to water hammer. When erecting new steam-pipes attention should be given to the thorough cleaning of the pipes, as otherwise fine particles of grit, driven by the steam into the faces of the valves, cut into the seats, causing considerable trouble and expense. The author was informed by one large firm of valve makers that, owing to the trouble they had experienced from this cause, and the expense to which they had been put, due to the necessity of taking down and refacing valves fitted in this manner on new pipes, they intended in future to include in their estimates a certain sum to cover such cost. Where, as is almost universally the case, boilers are run in parallel, it is advisable to fit a self-acting valve between the steam-ring and the main stop valve on each boiler, the self-acting valve being placed immediately after the stop valve. There are various types of this valve, the usual form being a ball working on an inclined plane. The object in all cases is to provide a valve which shall close automatically when the pressure on the boiler it controls falls below that in the steam-ring, as this enables that particular boiler, when thus isolated, to recover itself and to get up a full head of steam, upon which the automatic valve reopens and again connects the boiler to the steam-main.

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Blow-off Valves.—Where the boiler blow-off valves discharge into one common pipe, as is usually the case, it is very necessary that the blow-off valve should be of some type in which the handle shall be practically locked when open. This will prevent the blow-off from a live boiler being forced into a boiler which is standing off for the purpose of being cleaned. Want of attention to this precaution has been the cause of many accidents, frequently involving the death of the men working in the boilers. This locking arrangement is usually carried out by the use of some special form of key, in which the key is held locked in the valve as long as the valve is open, and can only be withdrawn when the valve is shut; and as long as one key only is available, it is, of course, impossible for two valves to be open simultaneously. As, however, a key is supplied with every valve, the spare keys, which it is advisable to keep in case of breakage, should be locked up in charge of one of the engineers, and should not be available in the works. The author remembers seeing on a battery of boilers, which had been carefully fitted with this class of valve, two of the blow-off valves open at one time with, of course, a key to each valve, entirely doing away with the element of safety, and further causing this false feeling of security to become an added danger. Where the blow-off from the flooding valves of superheaters are led into the same blow-off pipe, and when, as is usual, a type of two-way valve is used which cannot be fitted with a locked key, possibilities of accident are averted by making a stringent rule that the flooding valves must not be opened unless the key of the boiler blow-off valves is hanging within sight.

Pipe Covering.—A few words must be said with reference to the various coverings in use for preventing radiation of heat from steam-pipes. It is most necessary that all pipes carrying steam should be enclosed in a covering of some non-conducting material. Endless varieties of pipe coverings exist, which may be divided into two classes—permanent coverings and removable coverings. The former, which are generally wrapped with some description of linen or canvas, have a good finished appearance when coloured and varnished, but suffer from the disadvantage that the covering is destroyed when it is necessary to remove it from the pipe at any point, and the appearance of the whole length of pipe is spoilt in consequence. Removable coverings are, on the other hand, as their name implies, specially made for the purpose of allowing free inspection of the pipe, but in appearance they are usually clumsy, and do not lend themselves to the neat finish of permanent coverings. It is also questionable whether, as a rule, they are such efficient non-conductors of heat as are permanent coverings.

It would take up too much time to attempt to describe the many varieties of coverings on the market. They are all manufactured from some good non-conducting material, such as asbestos, magnesia, slag wool, or felt, and are put on either wet or dry. There are also numbers of coverings which depend principally for their non-conducting properties upon an air space being left around the pipe. Probably every engineer has been induced at some time to try various coverings, and, like the author, has possibly found a few good, many indifferent, and some distinctly bad. There is no doubt that to obtain an efficient steam supply, with a minimum of condensation, every portion of steam-carrying metal must be covered with a thoroughly good non-conductor, and where practicable all valves and flanges should be treated in the same manner. This applies equally to the drain pipes, or, at any rate, to that portion connecting to the steam-traps. For the sake of keeping down the temperature in the engine-house, it is generally advisable also to cover the exhaust pipes with some non-conducting material. Much more might be said on the subject of pipe work, but the author trusts that what he has advanced will fulfil his expectations—namely, to produce a useful and exhaustive discussion on what he ventures to think is a most important portion of central-station equipment.

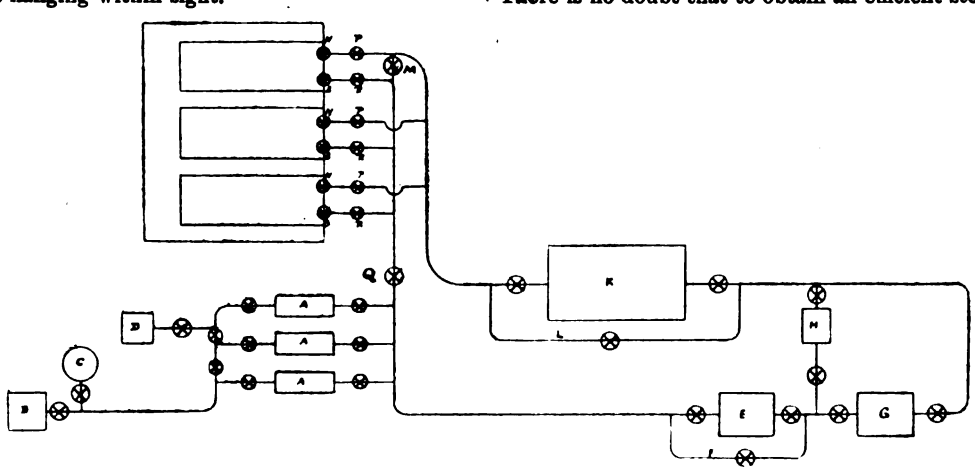

FIG. 3.

Check Valves.—The check valves of boiler feed pipes are more convenient for the purpose of inspection when fitted with an arrangement which allows the valve and seating to be inspected while the boiler is under steam, and the author would also suggest the convenience of fitting every feed branch with a plug-cock, having a removable handle, to enable each check valve to be shut off for inspection both from its own boiler and from the feed main. A plug-cock with removable handle is recommended in place of an ordinary wheel valve, as the latter may be accidentally closed, whereas the handle would be fitted to the former only for the specific purpose of examining the check valve or for completely cutting off the water supply from a boiler when standing off. The feed supply would, of course, in all cases be regulated by means of the check valves themselves. Perhaps the author may be permitted to say a few words on the subject of feed-water supply. A convenient arrangement is to connect the pump suctions through suitable pipes and valves to the hot-well, the cold-well, and also to a third supply in case of emergency, and to connect the discharge pipes from the pumps to a double line of piping supplying the feed water either through the filters and one or more economisers, or if required direct to the boilers. In the accompanying diagram, Fig. 3, A A A are the feed pumps, B the hot-well, C the cold-well, D the tank connected to a third supply, E is a cloth filter with by-pass, F; G a sawdust filter fitted in series with E, with a by-pass sawdust filter, H, the by-passes being used when the main filters are being cleaned. This arrangement has given excellent results, leaving the boilers clear of all traces of oil, which formerly proved a source of considerable trouble and anxiety. The condition of the sawdust in G and H is a good indication of the condition of filter E, and proves whether or not it is doing its work properly. K is the economiser with by-pass L, to enable it to be inspected and cleaned without passing the feed direct to the boilers *vid* Q, which would entail cutting the filters out of circuit. The arrangement of the branches from the hot and cold feed enables the boilers to be fed either with hot or cold water through the stopcocks and check valves, P N or R S, and by opening valve M cold water can be fed through the hot-feed check valves, or the reverse, should any of the branch pipes or check valves be out of order.

Mr. S. Z. DE FERRANTI, in opening the discussion, thought steam-pipe work ought to be treated in the same way as switchboard work had been and simplified to its lowest limit. He would reduce everything to a minimum. The steam-rings which existed in so many central stations cost a great deal to instal, and they cost even more to maintain. The valves gave endless trouble, and were never tight. He personally would very much prefer running the plant in independent sections with one engine and the boilers necessary to drive it in each section. For emergency's sake there might be some small steam-pipes between the boiler sections. In this way the radiation losses were reduced to a minimum, and he thought the stand-by losses were also very considerably reduced.

Mr. A. H. GIBBINGS, of Bradford, asked the author whether in the drawing of the steam-pipe he gave in his paper one flange was recessed. Personally, he had found that two rings with a complete ring of packing gave very good results.

Mr. J. J. STEINITZ, of West Ham, much preferred to have a large factor of safety in his steam-pipes, and to do without the steam-ring. He believed that a great amount of the trouble found with valves was due to their not being inspected and tried. He made it a point at his station to have every valve opened and closed at least twice a week.

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Mr. H. L. P. BOOT, of Tunbridge Wells, found that the Willans steam-joint gave no trouble whatever. He had had considerable trouble in getting dry steam in his station, and had found it advisable to lag all the valves. For this purpose he would use a blue asbestos lagging. He had disconnected the individual steam-traps, and had run all the drain pipes into one common inspection trap.

Mr. W. A. CHAMEN, of Glasgow, believed the origin of the steam-ring now so generally found in central stations, was due to an accident which occurred in the old days in the Kensington Court electric lighting station. At that station, one night a joint in a temporary pipe blew out and caused the total extinction of the lights. He did not believe this could happen with the class of packing they used now. In those days ½in. thickness of asbestos was very often employed with this. As soon as the joint started to blow, the packing was rapidly disintegrated and blown out. He agreed with Mr. Ferranti as to the simplification of steam-pipe arrangements, and at Glasgow he was dividing up the station into sections. To prevent sudden rushes of water under the engines, he had run a common 15in. main rather high up in the boiler-room. From it the pipe to the engine had a gradual descent, as had also the pipe to the boiler. In this way there was no pocket for the water to collect in. A steam separator was absolutely no use against a rush of water. He was using no copper bends, but had had trouble with his steam-pipes in one case, due to the temporary manner in which it was supported. He described the explosion valve made by the firm of Schaffer and Budenburg, in which the valve acted in such a way as to cut off steam if either a steam-pipe burst or a boiler tube went. In fact, the valve prevented sudden rushes of steam through it in either direction.

Mr. A. B. MOUNTAIN, of Huddersfield, said they must have duplicate steam-pipes in electric lighting stations. He was doing away with drain-pipes and steam-traps in his station, and was running the drains back into a common receiver, which could be inspected, and which returned the water automatically to the boilers.

Mr. J. HOPKINSON said that a lot of the trouble which had been found with valves was due to the treatment they received in erection and working. Valves should be opened and closed at least two or three times per week to keep the surface in good order. The grit and dirt often allowed to remain in steam-pipes when first erected was the cause of an enormous number of faulty valves, and engineers should take great care that the pipes were clean before they were erected.

Mr. E. T. RUTHVEN MURRAY, of Willesden, referred to the trouble in steam-rings from expansion. With a difference of temperature of 500deg., a 100ft. pipe altered in length by 3in. He believed that the proper solution of this difficulty was to provide elasticity in the pipes, and not to try expansion joints. Copper expansion bends were required when making connections to engines and boilers. He thought he had found instances in which copper pipes carrying superheated steam became defective owing to the copper becoming granulated. He strongly advocated the use of back-pressure valves in the blow-off to prevent accidents when boilers were being cleaned.

Mr. FLETCHER remarked that valve-makers were not given a free hand in their own work. Several engineers required stuffing boxes much too deep, so that they could not really be properly packed. This resulted in leaks. He thought attempts should be made to standardise such matters. As regards the trouble found in valves, when engineers allowed so much of their buildings to get inside the steam-pipe range before erection, it was not to be wondered that such trouble ensued with the valves. The explosion valve described by Mr. Chamen throttled the steam at all but full load. It was absurd to use foul port valves everywhere else, and then to allow one throttling valve such as he had described. The use of by-passes to relieve the pressure on the valves was very important in reducing the friction and wear on the valve surfaces.

Mr. C. H. WORDINGHAM, of Manchester, said that in the discussion some distinction should be made between large and small stations. It would not do in a small station to be dependent upon one joint for the steam supply. Where duplicate pipes were provided to connections with each boiler and engine, it was exceedingly difficult to localise the faulty valve. In large stations such he had been thinking of recently, there would be only 11 units in the engine-room as against 120 units in the boiler-room. In this case seven or eight boilers would go to the unit to be connected with one engine, and the inter-connecting pipes between the groups would be made rather small, as they would only be used in case of emergency. He agreed with Mr. Ferranti in that each boiler unit should carry its own reserve. He had found that expansion joints were not reliable, and had adopted a long vertical U-pipe to take this up. He thought that the high-steam low-water valves made by a certain firm were a great nuisance. At Manchester last winter they dared not feed the boilers at time of heavy load, and just when every ounce of steam was needed in the station, these valves started blowing off owing to the water being rather low in the boiler. When they paid firemen to watch the water-gauges, he thought the matter should be left in their hands. As regards lagging of pipes, he thought it was also advisable to cover the cold-water pipes in the station to prevent them condensing on the surface the moist atmosphere in the station.

Mr. J. F. C. SNELL, of Sunderland, complimented the author on his excellent paper. That there was need for such a paper was shown by the fact that recently an engineer had erected an electric lighting station and used cast-iron bends. He did not believe in having the valves upside down, owing to troubles with the glands. He knew of one case in which with a boiler pressure of 130lb. he could not get more than 120lb. at the engines until all the pipes and valves had been properly covered. Now the drop had come down to 3lb. He advocated the mounting of the feed choke valves on an expansion piece of steel, which should be bolted to the boiler, so that the corrosion due to the electrolytic action set up between the two dissimilar metals should take place on the expansion valve and not on the boiler itself.

Mr. L. ANDREWS, of Hastings, said they had the ring system of steam-pipes at his station, and had no trouble, but when owing to expansions the ring was dismantled a fault had occurred which interrupted the lighting. It was very important that in such circumstances there should be a duplication of steam connections.

Mr. J. H. RIDER, of Plymouth, did not believe in the ring system, but thought that the arrangement of pipes devised by Mr. Albert Gay, of Islington, was a very good one. The extra advantage of the ring system was opposed by condensation in those parts not in actual use. He agreed in the need there was for doubling the flanges of the pipes.

Mr. J. E. EDGCOME, in reply, said that after the discussion he felt he would have to go back to Kingston, throw out his ring main, and introduce in its stead the Gay-Rider system. Having illustrated how with a boss on either side it was very easy to break a joint, he concluded by thanking the members for the great interest they had taken in the points he had raised.

LEEDS CITY TRAMWAYS.

A return showing interesting details regarding the cost of electric traction has been issued by the Tramways Department of the Leeds Corporation. The return covers a period of one year ending March 25 last. The electric tramway track is about seven miles. For the period mentioned the car receipts amounted to £48,032. 15s., the mileage to 934,368 miles, the receipts per mile 12·33d., and the working expenses to 4·83d. This does not include interest on capital and sinking fund, or depreciation on electrical plant other than cars. The cost of generating current per Board of Trade unit was ·60d. Of the total number of miles ran by electric and trailer cars, motors ran 816,749 and trailers 117,619. The consumption of current per motorcar mile was ·960 units, and per trailer car mile ·480 units. The total units generated for the year was 809,101, less supplied to arc lamps, 32,660.

Indian Telegraph Rates.—A dispatch on the subject of the telegraph rates between India and Europe is understood to have come home by the last mail, in which proposals for securing a reduction of not less than 50 per cent. in the present tariff, at as early a date as may be practicable, have been submitted for the consideration of the Secretary of State.—*Financial News.*

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CITY LIGHTING.

History of a kind is made quickly in these days, but it may be it is very much of the character of the proverbial marriage made in haste to be repented of at leisure. Unfortunately, the makers of such history are unable from the nature of things to see the criticisms of future historians. Nor for the matter of that would they much care, for their epidermis is neither thin nor tender. There is an old tale that the remark was made to a scientific man that he could not blow both hot and cold. He at once proceeded to show that it depends, not upon how he blows, but what he blows upon. In one case it would be pronounced hot, and in the other case cold, though really temperature in both cases would be the same. It really seems, however, that in electrical matters men are capable at the same time of acting two diametrically opposite parts; and, unless we are mistaken, this is exactly what the City Fathers are doing with regard to lighting matters. There seems to be some mistake even now as to our views in this matter. It is said, why support high prices and ineffective service? We do not; and we contend the important point is not of price or of service, but of adhering to agreements honourably entered into by two parties. If the agreements press too heavily on one party, surely that is not a question of repudiation at all risks, but of further arrangements. The circular issued a few days ago from the manager's office of the City Lighting Company ought once and for all to clear the way and define the position. It states the company's case clearly and temperately. It shows that for years prior to 1890 the subject had been before the authorities, and they "decided that the prospects of electric lighting in the City were not sufficiently demonstrated to justify their undertaking it at the risk of the ratepayers' capital." That was the position in 1890 in a nutshell, and accordingly agreements were then made which the authorities thought fair, the company thought hard, but agreed to, and so the City got its lighting. But now let the circular speak for itself. It states:

"The conditions imposed by the contracts include: (*a*) the lighting of the streets at a price which from the commencement has entailed a loss; (*b*) the setting aside of 7½ per cent. on certain items of capital expenditure to form a depreciation fund; and (*c*) the creation of a reserve fund equal to 5 per cent. of the net revenue in each year before the payment of any dividend. These provisions (for the year 1898) were equal to an addition of nearly 1½d. per unit sold to the cost of the private lighting. The contracts were not to become valid unless the contractors obtained provisional orders from the Board of Trade, and such orders were to embody as far as possible all the conditions of the contracts. These orders were obtained, and your directors would particularly call attention to the fact that the terms of the contracts, including the exclusive right for twenty-one years, were fully brought to the notice of the Board of Trade. A special clause was inserted in the provisional orders providing for the transfer of the orders to a company to be formed. The contracts and provisional orders

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were transferred to this company with the consent of the Commissioners of Sewers and of the Board of Trade. Your directors assert that the capital of the company, which amounts to £1,622,000, including premiums, has been subscribed on the faith of the contracts with the Commissioners and of the grant therein of the exclusive right for twenty-one years, and that the company has done nothing whatever to justify the contracts being set aside either by the Corporation, as successors of the Commissioners of Sewers, or by the Board of Trade. The price of electricity was fixed by the Commissioners at 8d. per unit, subject to a provision for reduction after a cumulative dividend of 10 per cent. had been paid on all the capital employed in the business. Your directors, as you are aware, have from time to time voluntarily reduced the price, notwithstanding that the dividends paid on the ordinary shares have been as follows: 1891, nil; 1892, nil; 1893, nil; 1894, 2½ per cent.; 1895, 5 per cent.; 1896, 7 per cent.; 1897, 10 per cent.; 1898, 6 per cent.; showing an average of about 3·8 per cent. only. Your directors have offered to reduce the maximum price to 6d. per unit as from Jan. 1 next. They could not possibly reduce the price to 5d. at present, without jeopardising the payment of a dividend. . . ."

"Your directors maintain that the Corporation were in honour bound under their contract, not only to abstain from giving their consent to other companies, but also to actively oppose the grant of powers to any other company. The Corporation have obtained counsel's opinion that the contracts held by this company are null and void by virtue of a clause in the Sewers Act of 1848. Your directors having obtained from eminent counsel an opinion which does not accord with that given to the Corporation, have instituted legal proceedings with a view to having the validity of the contracts established. If the contention of the Corporation be correct, it would follow that almost every contract between the Corporation and any company would become null and void by a single member of the Corporation purchasing, on the Stock Exchange or otherwise, a single share in the contracting company, a position which your directors cannot believe to be tenable."

The company thus states, in effect, the contracts are valid, and that the Corporation ought to have actively opposed competition. Once more we must emphatically assert that we are not touching upon the question of competition. It may be good, or it may be bad, but with it at present we are not concerned. We are concerned with the good faith of the first city in the world, and history will either record its justification in breaking its contracts, or that with its boasted honesty, knowledge, and high-mindedness at the close of the nineteenth century it is not justified morally in its action. The legal justification is to be fought out, and is of little concern except to the immediate parties. We do not hesitate to say that in our opinion the Corporation is morally wrong in its action.

Bradford Electric Tramways.—The total receipts from April 1 to June 25 amount to £3,134. 19s. 3d., equal to 13·68d. per car mile.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. Questions may be sent at any time. Answers must be written on one side of the paper only, and should be kept as concise as possible.

QUESTIONS.

179. In an experimental laboratory they have 2,000-volt mains and 100-volt mains. What device could be used to protect the 100-volt mains if by accident the larger voltage was to be sent through them?—A. H.

180. Under what circumstances may an electric lighting provisional order be dispensed with? From the undertaker's point of view, what advantages and disadvantages are attached to it?—J. A. S.

ANSWERS.

Question No. 173.—Describe some practical method of measuring the efficiency of a transformer. Suppose that on connecting the terminals of the secondary to a wattmeter you obtain no reading, while at the same time an ampere-meter in circuit indicates a considerable value for the current, to what would you attribute this, and how would you remedy it?

[The three answers to Question No. 173 have been bracketed equal.—ED. *E. E.*]

Answer to No. 173 *(awarded 7s. 6d.).*—To thoroughly measure the efficiency of a transformer we only need to measure the core loss (hysteresis and eddies), which is practically constant at all loads, and the copper losses at full load. From these data we can rapidly write down the efficiency at all loads by the formula given below, which is due to Dr. Bedell.* To measure the core loss we read by means of a wattmeter the watts taken in the primary on open circuit, and subtract from this the resistance of the primary multiplied by the square of the magnetising current. The copper loss at full load is the primary resistance multiplied by the square of the primary current at full load, plus the secondary resistance multiplied by the square of the secondary current at full load.

Let W = rated output in watts;
H = watts core loss „
C = watts copper loss at full load;
h = core loss as a per cent. of rated output = $100\,\frac{H}{W}$;
c = copper loss at full load as a per cent. of rated output = $100\,\frac{C}{W}$;
f be the fraction of full load at which we wish to measure the efficiency;

then the percentage copper loss at this load is fc, and the percentage core loss is $\frac{h}{f}$, the percentage core loss being greater the less the load.

The total percentage loss at f load is therefore

$$fc+\frac{h}{f}.$$

Let $$t=fc+\frac{h}{f},$$

Then the efficiency of the transformer

$$=100\,\frac{100}{100+t}$$

$$=100-t+\frac{t^2}{100}\text{ nearly }\ldots\ldots(1)$$

as t is small. This is Dr. Bedell's formula.

* S. E. Johannesen, *Electrical World* (New York), p. 588, May 14, 1898.

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Suppose the transformer is on for x hours at full load every day and is idle for the rest of the time, then the all-day efficiency

$$= \frac{100}{100 + c + \frac{24}{x} h} \quad \ldots \ldots \quad (2)$$

The ease with which (1) can be applied to calculate the efficiency at all loads is shown by the following numerical calculations of the efficiency of a small 2-kw. transformer from the two experimental data.

Copper loss at full load = 48 watts. Core loss = 30 watts.

Fraction of load.	Loss as per cent. of output (100 t).	$\frac{t^2}{100}$	Efficiency by formula (1).
$\frac{1}{4}$	4·2	0·18	95·98
1	3·9	0·15	96·25
$\frac{3}{4}$	3·8	0·14	96·34
$\frac{1}{2}$	4·2	0·18	95·98
$\frac{1}{4}$	6·6	0·44	93·84
$\frac{1}{10}$	15·24	2·32	87·08

Suppose this transformer was on full load for five hours and 19 hours on no load, then its all-day efficiency by (2) comes out 91·24.

In answer to the second part of the question, since there is no reading on the wattmeter, then either the volts on the volt-coil are zero or the currents in the volt and ampere-coil differ in phase by 90deg. If the secondary load is non-inductive, then the second alternative is impossible, and therefore the volts must be practically zero. This must be due to an enormous magnetic leakage between the primary and secondary coils of the transformer, so that nearly all the secondary volts generated are required to neutralise the volts due to self-induction in the secondary windings. The remedy therefore is to rewind the secondary so as to avoid magnetic leakage.—J. C. R.

Answer to No. 173 (*awarded* 7*s.* 6*d.*). — Transformer efficiencies are usually taken as the ratio

$$\frac{\text{Secondary output watts}}{\text{Secondary output watts} + \text{Ohmic loss in both primary and secondary} + \text{Hysteresis and eddy-current losses in the iron core at no load.}}$$

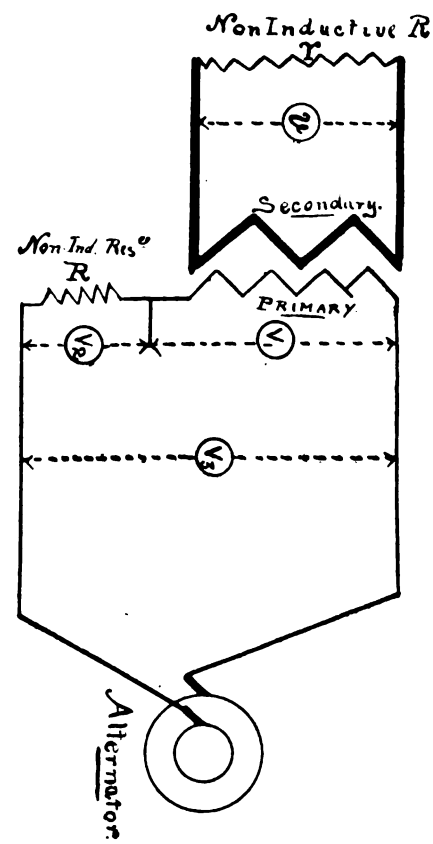
the ohmic $C^2 R$ loss being obtained from the measured values of the resistances of the two windings and the known input and output currents, and the total iron loss being measured by means of a wattmeter with the transformer on open secondary circuit and the normal voltage and periodicity applied to the primary. This method is perfectly satisfactory and accurate for ordinary modern closed-circuit transformers with the primary and secondary windings either superposed or well interleaved so as to reduce magnetic leakage to a minimum.

In the case, however, of open-circuit transformers and transformers having considerable magnetic leakage, either through faulty design or intentionally, for the purpose of giving constant current or a drooping characteristic, the method may lead to considerable error. For in such transformers the iron loss measured at no load is no longer the same as when loaded, due to the leakage magnetism increasing more or less in proportion to the load, and so increasing the eddy currents in the copper wires and in the iron core plates, and in the walls of the metal containing case (if any).

For such cases the primary input and secondary output watts should both be measured simultaneously by means of wattmeters; or at least a wattmeter should be used for the input measurement, whilst the output (taken upon a non-inductive resistance) can be determined by multiplying the secondary voltage by the current, measured on volt and ammeters. If a wattmeter capable of measuring the full load of the transformer is not available, the "three voltmeter" method of measuring the input watts can be used. The connections for this are shown in the figure. Practically simultaneous readings must be taken on all the instruments, from which the efficiency is calculated as:

$$\frac{r}{2R} \frac{(V_3^2 - V_2^2 - V_1^2)}{v^2},$$

The non-inductive resistances should be of wire, with a low temperature coefficient, or banks of incandescent lamps can be used if ammeters are placed in the primary and secondary circuits and read at the same time as the voltmeters. This three-voltmeter method requires great care and many check readings if reliable results are to be obtained. For a full consideration of the sources of error in it reference may be made to Prof. Fleming's paper before the Institute of Electrical Engineers in November, 1892.



There is also a method of measuring transformer efficiencies, devised by Prof. Hopkinson, exactly equivalent to the Hopkinson method of obtaining dynamo and motor efficiencies. It is theoretically far superior to any of the above, as it measures the losses at any particular load directly, and not simply as the difference between the input and the output; but in practice the test is difficult to carry out successfully, besides being only applicable in cases where a second transformer exactly similar to the one under test and also a small auxiliary transformer are available. A description of this test will be found in Prof. Fleming's book on "Alternate-Current Transformers" and also in Geipel and Kilgour's "Electrical Pocket-Book."—Q.

Answer to No. 173 (*awarded* 7*s.* 6*d.*).—There are five different methods of measuring the efficiency of transformers, and these may be altered in detail to suit special requirements. These are: calorimetric methods, dynamometric methods, voltmeter and electrometer methods, ammeter methods, and wattmeter methods. The need of special methods for measuring power in an inductive circuit arises from the fact that the product of the $\sqrt{\text{mean}^2}$ value of the current, and the $\sqrt{\text{mean}^2}$ of the difference of potential at the ends of the circuit, does not give us any measure of the true power being expended on that circuit. The wattmeter method is by far the best and simplest method, and is therefore most used now for testing the efficiency of transformers. The efficiency varies with the load, so that a number of tests should be made at various loads. The wattmeter should also be tested to see that the time constant is zero, and if not, this must be allowed for by first measuring the error. Fig. 1 shows the method when the current is supplied at the high pressure. The thick coil, F, in series with the mains carries the whole of the primary current, and forms the fixed coil of the wattmeter. The movable coil, M, of fine wire is sometimes joined direct across the mains, with a non-inductive resistance in series with it; but in this sketch it is not. The

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primary of a small transformer, T_1, is attached to the mains, while the secondary is connected to the movable coil of wattmeter, so that the pressure is less; V_1 is an electrostatic voltmeter to measure the pressure at the mains; R is a non-inductive resistance, which may be incandescent lamps in series, and a known non-inductive resistance in series with these, to the ends of which a Cardew voltmeter is connected to measure the potential difference. Let this be v, when switch K_1 is closed and K_2 open. Then current in this circuit $= \frac{v}{R}$, and pressure of mains $= V_1$, so that the watts $= V_1 \frac{v}{R}$.

The reading of wattmeter is taken at the same time; let this be w, and we have $\frac{V_1 v}{w R}$ = one division of wattmeter scale. This calibrates the wattmeter. K_1 is now opened and K_2 closed, so that the current passes through the

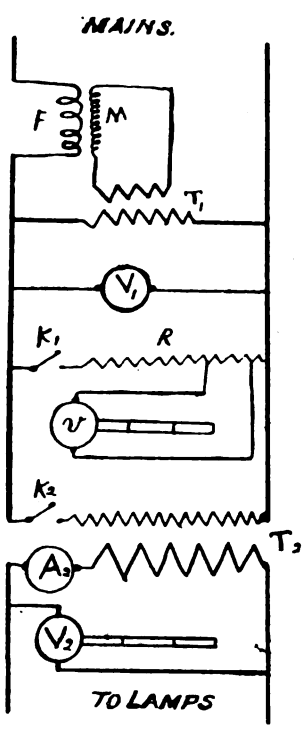


FIG. 1.

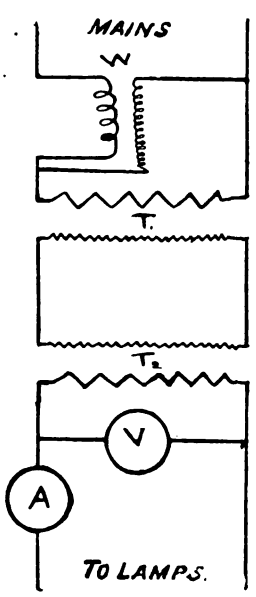


FIG. 2.

primary of transformer under test T_2, and a load of incandescent lamps put on the secondary. Let W = reading of wattmeter, when one division $= \frac{V_1 v}{w R}$; then the power in the primary circuit $= W \frac{V_1 v}{w R}$. A Cardew voltmeter, V_2, measures the pressure in the secondary circuit, and a Siemens electrodynamometer, A_2, measures the current in the secondary circuit. As the load is non-inductive, the product, $V_2 A_2$, gives the power in secondary circuit. Both these instruments read $\sqrt{\text{mean}^2}$ values. Then the efficiency is given by

$$\eta = \frac{V_2 A_2}{W \frac{V_1 v}{w R}}.$$

If the power is supplied at low pressure where the test is to be made, it is good practice to test two transformers at the same time if they are of similar size and make. Fig. 2 shows the connections for this, the current is transformed up in T_1 and down again in T_2, and a load of incandescent lamps put on T_2. The wattmeter, W, measures the power supplied, and the Cardew voltmeter, V, and Siemens electrodynamometer, A, the power received after the double transformation. Both transformers are practically equally load, and the loss may be assumed the same in each. The total loss will be $W - V A = Q$, say. Then the efficiency of one transformer will be

$$\frac{V A + \frac{Q}{2}}{W} = \frac{W - \frac{Q}{2}}{W}.$$

With regard to the second part of the query, probably the wattmeter does not read low enough to measure the small power in the circuit on which it was used; if this is not the case, there is either an open circuit in the fine-wire coils and its connections or a short-circuit in the thick-wire coils, which should be sought for and corrected.—J. GILHAM.

Question No. 174.—What devices do you consider the best on traction switchboards in order to (1) protect the machines from short-circuit; (2) to protect the board from lightning?

Best Answer to No. 174 (*awarded* 10*s.*).—In modern traction switchboards the one method of protecting the

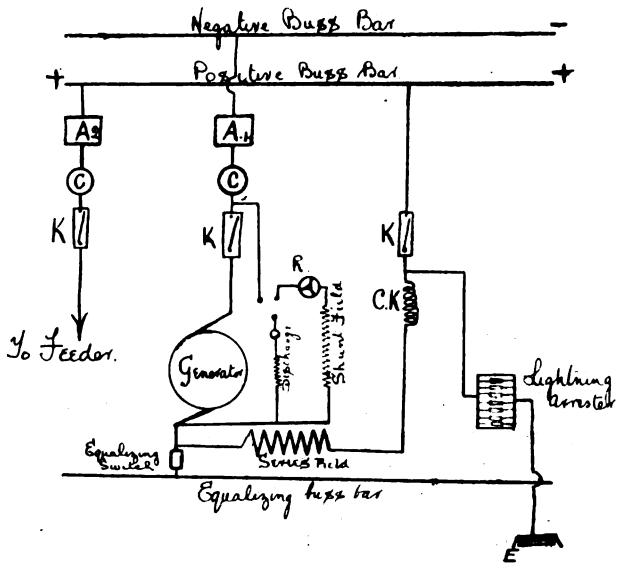
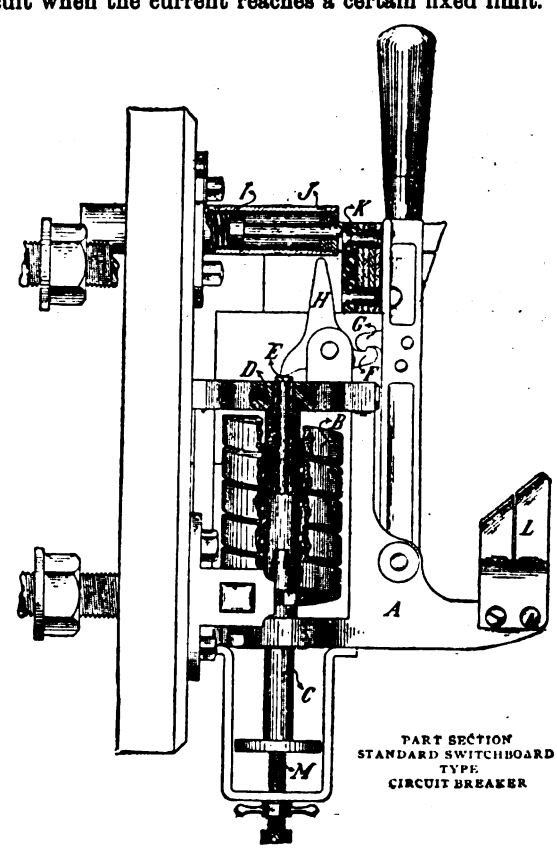


FIG. 1.

dynamos from short-circuit (or excessive overloading) is to use some form of an electromagnetic device to break the circuit when the current reaches a certain fixed limit. The



A—Iron Jacket
B—Solenoidal Coil
C—Movable Plunger
D—Fixed Plug
E—Striker Pin
F—Catch of Striker Plate
G—Catch of Switch Arm
H—Striker Plate to throw Switch out
J—Spring Piston
K—Spring Tube, head removable
K—Steel Striker Plate on Arm
L—Buffer Springs
M—Adjusting Screw

FIG. 2.

use of fusible cut-outs for this purpose has been entirely abandoned on account of their uncertain action. This circuit-breaker is usually placed in the negative lead (refer to Fig. 1, A_1) of the dynamo near the 'bus bar for protec-

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tion of the dynamo, and in the main feeder (Fig. 1, A_2) for protection of the cable.

The requirements of a good circuit-breaker are: (1) it must be of simple construction and not liable to get out of order; (2) it must break circuit at once on a certain predetermined current being reached; (3) the break shall be sufficient and quick, and take place without sparking at the main contact surfaces; (4) it must be of ample capacity to carry the full load continuously without heating.

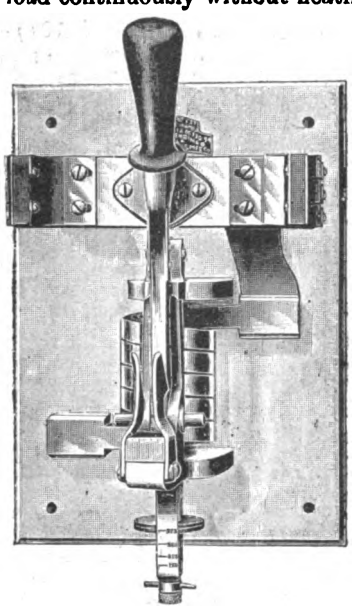

FIG. 3.

The I.T.E. circuit-breaker (Figs. 2 and 3) meets all these requirements. Its action depends on the pull exerted by the solenoid, B, on the plunger, C. When the current reaches a certain fixed amount, the plunger, C, is sucked sharply into the solenoid, strikes the pin, E, which releases the catch, F G, the compressed spring, I, throwing out the switch. The final break takes place between carbon contacts (which are easily renewable), these taking all the spark which occurs at the break.

The great advantages of this particular type of instrument are (1) its certainty of action; (2) the nearer the approach to short-circuit the quicker the switch is opened; (3) the range of operation is adjustable between wide limits.

Protection from Lightning.—The method used to protect the dynamos, etc., from lightning, is to put into the path of the lightning discharge a choking coil (Fig. 1, C.K.),

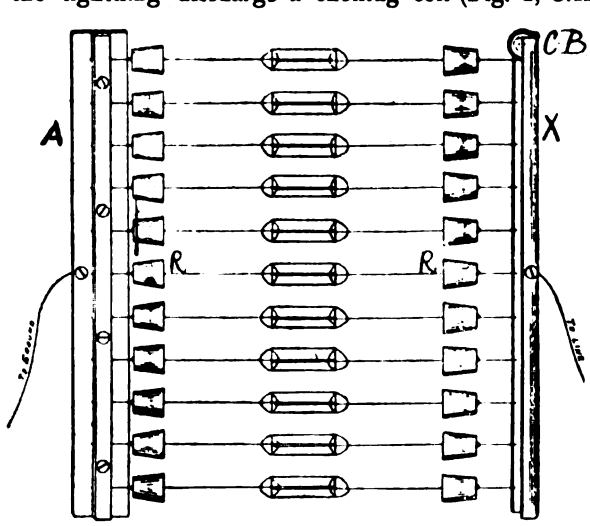

FIG. 4.

thus from the oscillatory nature of the discharge providing an opposing force, and then to provide an alternative path through a lightning arrester to earth. This arrester must be capable of taking repeated discharges without requiring any attention, and of such a design that the arc formed when a discharge takes place shall not be maintained or continued by the working pressure (voltage). The "Ajax" arrester (shown in Figs. 4 and 5) has found favour with many traction engineers on account of its certain action. It consists of a frame holding a number of fusible discharge paths, each of which consists of two fine brass wires insulated with a layer of very fine silk, laid side by side for about 1in., and enclosed in a glass tube (Fig. 4). The ends of the wires are brought through the rubber plugs, R R: one to the brass strip, A (Fig. 4), the other projects into the tube, X, which is connected to the line and the choking coils, as in Fig. 5. When a discharge takes place along the line it meets with the coil and passes into the arrester to the tube X (Fig. 4), then by the carbon ball, C B, to the discharge fuse and to earth, thus melting this wire. The circuit to earth is for the

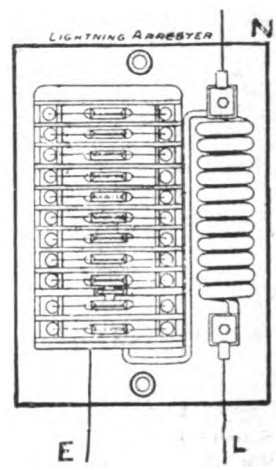

FIG. 5.

extremely short period entirely broken, thus effectually preventing the working voltage from continuing the arc; the carbon ball now drops to No. 2 wire, and is ready to take the next discharge. The great advantage of this type of arrester is that each fuse is called upon to act but once, and, being in a sealed tube, is effectually prevented from any deterioration. The overlap of 1in. in the brass wires form a very large discharge surface, which is always in good condition. The fuses are easily renewable at a very small cost.—R. GRIGG.

Answer to No. 174 (*awarded* 5*s.*).—The best device for preventing injury to machines by short-circuit is the British Thomson-Houston automatic circuit-breaker, and is universally used in traction work. A sketch is given below of one of these appliances with the electrical connections. When the circuit-breaker is closed, the current flows up

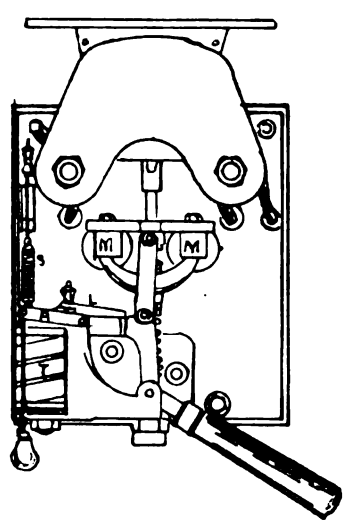

FIG. 1.

through the tripping coil, T, to the stud M, crossing over the yoke, Y, to the stud M^1, and thence to the ground or return circuit. When the current has reached a predetermined volume, which is limited by the tension spring, S (Fig. 1), the armature, A, is depressed. Lifting the latch, L, yoke, Y, is drawn away from the studs, M and M^1, by a spring, and the whole of the current is thrown through the coils, B and B^1 (Fig. 2) and upper

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contacts, C and C^1. As the yoke, Y, is drawn down, the plug, P, which is attached to it follows, and is withdrawn from between the contacts, C and C^1, when the whole current is broken between these contacts, which are directly under the influence of the magnetic field created by the coils, B and B^1. From the foregoing it will be seen that in the design of this apparatus the important question of wear and tear has been carefully studied, and ample protection has been provided against what at one time looked like an insurmountable difficulty—viz, that of reducing the

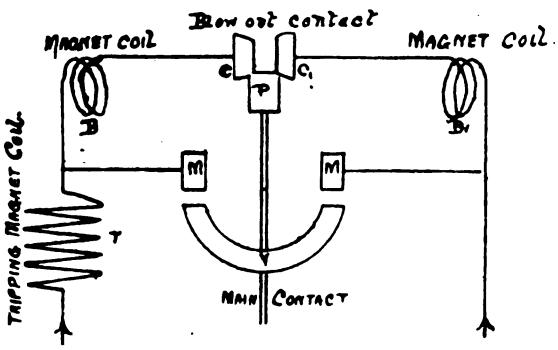

FIG. 2.

burning effect of the electric arc necessarily prevalent in a short-circuit.

In answer to the second part of this question, the next important piece of apparatus we might say is a lightning arrester. Fig. 3 shows the form of lightning arrester largely used on traction circuits for the protection of circuit and machines from discharges of atmospheric electricity. The rule is to provide an arrester for each pole, and in long lines each pole should be connected to arresters at each end of the line. The screw shown on the right of sketch is adjustable, and is set so that a slight air-space separates it

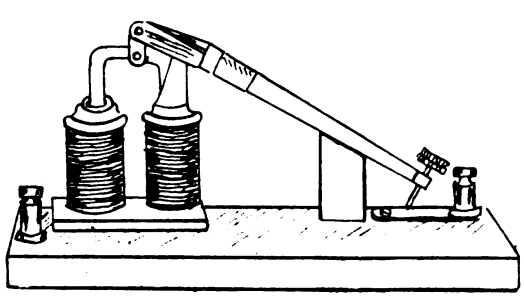

FIG. 3.

from the plate—the latter is connected to earth. In the event of lightning striking the circuit, a discharge will take place to earth through this small air-space. Should the dynamo current be inclined to follow the arc of the discharge—as not infrequently occurs—the electromagnets become at once excited and lift the arm breaking the arc. The arrester sets itself again by gravity. The connection should be made with wire if not less than 16 S.W.G., and great care should be taken to ensure a good earth connection.—A. B.

THE SUPPLY OF ELECTRICITY TO LONDON.

A Select Committee of the House of Lords sat on Monday to consider the scheme of the Central Electric Supply Company, Limited, for powers to construct large works for the generation and supply of electrical energy in bulk. Lord Brougham presided, and the other members of the committee were Lord Boston, the Earl of Dartmouth, Lord Windsor, and Lord Bolton. The counsel for the Bill were Mr. Pember, Q.C., Mr. Balfour Browne, Q.C., Mr. R. Wallace, Q.C., and Lord Robert Cecil, Q.C., for the promoters; Mr. Worsley-Taylor, Q.C., and Mr. Du Cane for the London County Council; Mr. Fitzgerald, Q.C., and Mr. Moore for the Metropolitan Electric Supply Company; and Mr. Freeman, Q.C., and Mr. Talbot for the St. Marylebone Vestry.

Mr. Pember, Q.C., in opening the case for the promoters, said the main object of the measure was to effect the construction of a generating station for the supply of electricity in bulk in the parish of Marylebone, and the land it was proposed to take for the purpose was on the Regent's Canal in the neighbourhood of Grove-road, Lodge-place, Lodge-road, and North-bank. The subsidiary works proposed were a tunnel or waterway in connection with the proposed station for the purpose of getting water from the Regent's Canal for condensing; a dock or basin situated at the termination of the tunnel to get barges from the canal; a conduit or line of pipes from the north side of the Regent's Canal; and a piece of railway connecting with the Great Central Railway Company for the purpose of obtaining coal. The intention of the promoters was to supply electricity in bulk to persons who might require to obtain it and redistribute it to the public. The Bill was promoted in one sense by the St. James's and Pall Mall Company and the Westminster Company, who had combined to form the Central Electric Supply Company, which, technically, was the promoter of the Bill.

Mr. Eustace Balfour, chairman of the St. James's and Pall Mall Company, architect to the Grosvenor Estate, and chairman of the new Central Electric Supply Company, gave evidence in support of the Bill.

Mr. Boulnois, M.P., Prof. Kennedy, F.R.S., Mr. Dobson, chief engineer to the St. James's Company, **Sir Frederick Bramwell**, and **Mr. Vigers**, surveyor, also gave evidence, and the case of the promoters was closed.

Mr. Worsley-Taylor, Q.C., addressed the committee for the London County Council, and contended that the two companies concerned ought to have come to Parliament in their own names, and not by means of a third company, for these powers. The new company would not be bound by any of the provisions which Parliament had required to be inserted in the provisional orders of these companies, and revision of prices would be rendered impossible.

The committee adjourned.—*The Times.*

THE GOVERNMENT TELEPHONE BILL.

The adjourned debate on the motion for the committal of the above Bill to the Grand Committee on Trade, reported in our last issue, was resumed in the House of Commons on Monday, 26th inst., when **Mr. Hanbury** said that perhaps he might take that opportunity of stating to the House what were the arrangements which had been made with regard to the National Telephone Company since the subject was last before the House. There were three points which he had discussed with the company. The first was the difficulty which had arisen with regard to certain large boroughs where the National Telephone Company had practically done away with the overhead system, and had spent considerable sums of money in establishing an underground system. That was done before there was any probability of any Bill of this kind being introduced into the House, and that money was expended although the ratings granted were granted under leases founded on very short notice. There was a strong fear expressed on behalf of the National Telephone Company that the corporation of a borough which under the Bill had new powers given it to establish a telephone system of its own might see its way to establish a monopoly of the telephone within its borough, give notice to the Telephone Company to terminate its wayleaves in six months, thus confiscating a large sum of money. That, of course, was an event not at all likely to happen, though, of course if such a corporation did take such a step it would be sheer confiscation, and therefore he agreed that it should be a condition of any license to any corporation or company, where such money had been expended, that those wayleaves should be practically secured to them during the remainder of their license. That was only a fair step to take. In the first place, it was no great concession, for he believed no corporation would have behaved in the way the company thought possible; but as a condition of so securing their wayleaves he required that the company should come under control. One of the great complaints made against the company was that it was unregulated, that there was no control over their rates, either maximum or minimum, and that they were not obliged to treat with the public at all on equal terms. In the future the company would be prohibited from granting any preferential terms whatever.

Sir James Fergusson: They never did.

Mr. Hanbury: At any rate, that would be impossible in the future. The second point was that he realised that if they were going to induce either new companies or special corporations to embark on that work, a license extending only to 1911 was hardly sufficient temptation to them. He thought they ought to give to those new companies and corporations a substantial term of either 20 or 25 years; and if they were to do that it would be grossly unfair, he thought, not to extend the National Telephone Company's license also, subject, however, to the same restrictions and prohibition of preferential rates. Everywhere the company would cease to be a monopoly. In those limited areas where the company had already exchanges, competition would be encouraged by the Bill, and the company had undertaken to enter no new areas—that was to say, that, whereas under existing conditions they had a perfect right to compete throughout the whole of the country, in future the license would be so limited that they would not be able to set up exchanges in any area whatever. That, of course, would be a greater protection to the smaller municipalities, where there was no exchange at present, and where the National Telephone Company would be prevented under the present Bill from setting up competition. He hoped the House would acknowledge that the company had treated the Government most fairly, and he trusted that, now they had come to terms, the result would be a more efficient service throughout the length and breadth of the land. The House would he hoped, deal with perfect fairness by the company

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now that terms had been arranged and allow the Bill to be sent to the Standing Committee.

Mr. Cohen (Islington, E.) moved to omit the words "Standing Committee on Trade," and to substitute "Select Committee of this House." He recommended that course because new considerations were now involved in the Bill

Mr. Kimber (Wandsworth) supported the motion for a Select Committee, and was speaking at midnight when, by the rules of the House, the debate stood adjourned.

The debate on the above amendment was resumed in the House on Wednesday, when the following views were exchanged:

Mr. Labouchere thought it perfectly clear that either the Leader of the House or the Secretary to the Treasury had been in communication with directors of the National Telephone Company between the second reading and the decision of the Government to send the Bill to a Grand Committee. After these conversations the House was told that certain concessions had been made. To whom?

Mr. Hanbury: To the Government.

Mr. Labouchere: The National Telephone directors think the concessions were to them. Everybody knew there had been a great deal of lobbying, and the banker of the company had sent out circulars in the hope of influencing members against the measure.

Sir J. Lubbock (intervening): What authority has the hon. member had for making that statement? Let him read the circular.

Mr. Labouchere: The right hon. baronet did not honour me with a circular, because he knew my public virtue could not be shaken. So strong was the feeling against this lobbying that it was desirable the whole matter should be threshed out on the floor of the House. Indeed, the honour of the House demanded that this should be done.

Sir J. Jolicy complained that the Government were rushing this question, for what reason he did not know.

Sir J. Lubbock desired to say a word about the canvassing of members which had been so much condemned. He denied that any circular he had issued deserved the fierce denunciations of Mr. Labouchere. The circular asked that those who were in favour of this Bill going to a Select Committee should support that view by their votes. There was nothing unusual in that; it was done every day. Referring the measure to a Select Committee would not be favouring the Telephone Company in any way; in fact, he believed the members of the House who were directors of the company would be found voting against that proposal. It was because the London Chamber of Commerce complained of the extension of municipal trading that he thought this question should be further considered. If the Bill went to the Grand Committee on Trade, the London Chamber of Commerce and other interested bodies would be debarred from giving effect to their views. He admitted that if the measure went to a Select Committee it would scarcely become law this session, but that was of less consequence than that a good and wise Bill should be passed.

Mr. Balfour wished to assure the right hon. baronet that nobody on either side of the House seriously supposed any stain attached to his character. If any man stood absolutely above such suspicion it was the right hon. baronet. He could not agree, however, with his views, as it was only by a reference to the Grand Committee that the measure could pass during the present session, and an end be put to what everybody regarded as a most unsatisfactory state of affairs. The company had given up their position as monopolists, and made arrangements which would greatly facilitate that competition which was so desirable. Sir John Lubbock professed to represent the London Chamber of Commerce, but he could not see how the right hon. baronet could make himself the spokesman of a body from whom he differed fundamentally. The London Chamber of Commerce wished the telephones to become a Government monopoly, while the right hon. baronet desired to hand them over to private companies.

Mr. Hanbury asked to be allowed to explain what had been done. The National Telephone Company had agreed that they would not work outside the areas where they at present had exchanges. That was to say, their general license to run all over the country ceased and they were confined to their existing areas. But in all the other areas there was a perfect right reserved either to the local authority or to a new company.

Mr. Lawrence insisted that a new issue had been put before the House by the concessions made to the National Telephone Company, and that they should have further information on these points before they came to a decision. The Government had placed on the paper a proposal that the whole question of municipal trading should be enquired into by a joint committee, and yet they now asked the House to sanction this wide extension of the principle without any examination whatever into the subject. A year's delay would make little or no difference either to the National Telephone Company or to the convenience of the public, and he should therefore support the reference of the Bill to a Select Committee.

Mr. Lough (Islington, W.), thought they ought to have fuller details of the revolutionary change that had taken place in the attitude of the Government before they came to a decision on the question before them. He asked the Secretary to the Treasury whether he would lay before the House a paper embodying fully and clearly the arrangements that had been made within the last few days.

Mr. Hanbury said that all the suggestions of the Government would actually be embodied in the Bill which he would present to the Grand Committee.

After further discussion the amendment was negatived without a division, and the B 'l was referred to the Grand Committee on Trade.

PHYSICAL SOCIETY.

At the ordinary meeting of this society held June 23, 1899, with Mr. T. H. Blakesley, vice-president, in the chair, a paper "**On the Magnetic Hysteresis of Cobalt**," by **Prof. Fleming**, **Mr. A. W. Ashton**, and **Mr. H J. Tomlinson**, was read by **Mr. Ashton**. A rectangular-sectioned circular ring of cobalt was insulated with silk tape and wound over with four secondary coils put on at quadrantal positions. Over these secondary coils six primary coils were placed, and the ring was submitted to a complete set of magnetic tests with a ballistic galvanometer. From these observations various curves have been plotted, and the results have been compared with a similar set of readings taken on a cast-iron ring. A chemical analysis of the cobalt showed that it contained about 1 per cent. of iron and 1 per cent. of nickel. The authors conclude that although in general form the magnetisation curve for cobalt resembles that of cast iron, its hysteresis exponent is similar to that of annealed soft iron. The absolute hysteresis values corresponding to various maximum flux densities are, however, not very different from those of a typical variety of cast iron.

Prof. Everett referred to the fact that the sample of cobalt contained about 1 per cent. of iron, and said that it would be interesting to know how cobalt free from iron would behave.

The **Chairman** said that the hysteresis curves obtained from the step-by-step method could not be applied to dynamos, because the time taken to perform the cycle altered the shape of the curve. He would like to see the curves for cobalt determined in cases where the cycles were quickly executed.

A discussion on "**Physical Tables**" was commenced by **Mr. J. Lupton**, who briefly reviewed some of the difficulties met with in compiling physical tables and in keeping them up to date. He divided them into four classes according to their objects, and criticised several well-known books of constants. He pointed out the danger of leaving out apparently obvious figures, and referred to the necessity for accurate proof reading.

Prof. Everett said that in his work he had aimed at giving an idea of the meanings of various numbers rather than stating them with great accuracy. He drew attention to the difficulty of condensing large series of numbers into a clear and concise table.

Mr. Watson said that it was important that the units in which numbers were expressed should be stated at the head of each table.

The **Chairman** having pointed out one or two small points to be attended to in the compilation of tables, the society adjourned until next October.

COMPANIES' MEETINGS AND REPORTS.

ELECTRIC AND GENERAL INVESTMENT COMPANY, LIMITED.

On Tuesday the tenth ordinary general meeting of this Company was held at Winchester House, Mr. George Herring presiding. In moving the adoption of the report, the **Chairman** stated that a net profit of over £25,000 had been made during the past year on a called-up capital of £20 000. He particularly wished to draw attention to the fact that it was the smallness of the called-up capital which enabled the directors to pay what they were proposing to pay in dividends. With reference to the balance-sheet, the directors had acted quite correctly in adding this year £11,450 to the provision for contingencies, raising this fund on May 31 last to £13,724. The money was still in the business, and he expressed a hope that it would cause a proportionate increase in the dividends to be paid in the future. The investments at cost, he assured them, were absolutely safe. In regard to the profit and loss account, the general charges amounted to £4,294. The interim dividend absorbed £2,000, and the gross profit for the year amounted to £31,744, while the balance of net profit was £25,450. They had sold enough of the securities for the founders to pay to the holders of the founders' shares £20 per share, and they had sold enough of the securities for the ordinary shareholders to pay equivalent to the same amount. The motion having been unanimously carried, a dividend of 3s. a share was afterwards declared on the ordinary shares, making, with the interim dividend, 5s. a share for the year ended May 31 last, as well as a bonus of 4s. a share. On the founders' shares a dividend was declared of £30 per share, with a bonus of £40 a share for the year ended on the date already mentioned.

CALLENDER'S CABLE AND CONSTRUCTION COMPANY, LIMITED.

The third annual general meeting of this Company was held yesterday (Thursday), at 90, Cannon-street, Mr. H. Drake presiding.

In moving the adoption of the report, the **Chairman** said that he felt that the results shown would be regarded by the shareholders as satisfactory. The business had largely increased during the past year, and continued to progress in the current year. The Chairman said that after paying the interest on debentures, dividend on preference shares, and the sum for depreciation of machinery, plant, etc., they had a balance in hand of £36,212. With this it was proposed to pay a dividend on the ordinary

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shares at the rate of 10 per cent. per annum, being 10s. per share, of which 5s. was paid in November. This would amount to £10,000. Also by payment of a bonus of 5s. per share, amounting to £5,000, by placing £15,000 to reserve, and by carrying forward £6 212, the total payments to the holders of ordinary shares for dividend and bonus for the year 1898 would therefore be at the rate of 15 per cent. per annum The plant and premises had been maintained in a thorough state of efficiency, and the cost of renewals and repairs debited against the year's profits. A new additional factory had been erected on the land purchased in 1898, and a considerable sum expended on the plant and machinery therein. No advantage was, however, reaped in 1898 from that expenditure, as the first section of the new factory was only occupied early this year, and the most important part was only available for work a few weeks ago. The business transacted in 1898 was much in excess of that in previous years, and continued to increase in a most satisfactory way. If full advantage was to be taken of their prosperity, the means of production at Erith would have still further to be enlarged, and it might be necessary to take up other branches and new applications of cable work. The contracts necessitated the use of considerable floating capital, and the directors were of opinion that the capital should be further increased. They recommended that power should be taken for the creation of 20,000 new preference shares and 20 000 new ordinary shares, both of £5 each, to be issued from time to time as the directors might find necessary. It was also proposed to make certain alterations in the articles of association with a view to the better keeping of the accounts of the Company.

Lieut.-Colonel G. A. Elliot seconded the adoption of the report.

Mr. T. O Callender remarked that the Company now had contracts in 102 different towns.

The report was adopted.

An extraordinary general meeting was held afterwards to consider the proposed increase of capital, etc. In the course of the discussion, the **Chairman** said that more capital (about £100,000) was certainly needed. The existing shareholders would have the first offer of the new shares, but he could not say at what price the issue would be made, as the point had not yet been considered by the directors. The resolutions were agreed to.

THOS. PARKER, LIMITED.

The directors' report for the year ending April 30 states that after writing off various depreciations the balance standing to the credit of profit and loss account is £17,689. 6s. 6d. ; out of this the directors propose to pay a dividend at the rate of 10 per cent. per annum, less income tax, amounting to £7,250, to place £8,000 to the reserve fund, and to carry the balance forward to next year's account. Debentures to the amount of £20,500 have been issued to shareholders and their friends. The directors will be pleased to receive further applications, which would enable them to carry out extensions in the works and business, and at the same time reduce the balance due to the bankers. The director who retires by rotation is Mr. R. Armistead, who is eligible for and offers himself for re-election. The auditors, Messrs. Allen, Edwards, and Smith, also retire, but are eligible for and offer themselves for re-election.

METROPOLITAN DISTRICT RAILWAY.

On Monday an extraordinary general meeting of the Metropolitan District Railway Company was held at the Westminster Palace Hotel. Mr. J. S. Forbes presided. The object of the meeting was to consider and approve the following Bills before Parliament: the Brompton and Piccadilly-circus Railway and the Harrow and Uxbridge Railway.

The **Chairman** said that the extension to Bow would be opened in two years, the extension from Ealing to Harrow in less than two years, and the extension to Uxbridge in two years. Those interested in the District Railway would meanwhile have to possess their hearts in patience, but the position of the Company would then be materially improved. He moved the approval of the Bill.

The motion having been carried unanimously, the **Chairman** dealt with the Brompton and Piccadily-circus Railway, explaining that this was a Bill to enable the Brompton and Piccadilly circus Railway to extend their proposed line to Charing Cross, where an exchange station for the District would be constructed. A resolution conferring upon the directors power to come to an agreement was then carried.

MEXICO ELECTRIC TRAMWAYS, LIMITED.

The second ordinary general meeting of shareholders was held on Wednesday at Winchester House, Old Broad-street, E.C. Colonel Sir Charles Euan Smith, K.C.B., C.S.I., chairman of the Company, presided.

The annual report was adopted, and the auditors, Messrs. Deloitte, Dever, Griffiths, and Co., reappointed. A vote of thanks to the chairman terminated the proceedings.

The report stated that after payment of interest a profit was earned of £14,146 in 1898. The directors in the Mexican Company have resolved to transfer 5 per cent. of this profit to reserve account, and to carry forward the balance to 1899. The tramway system as taken over by the Company comprised about 150 miles tramway track of single line, operated partly by steam and partly by animal traction, permeating the city of Mexico and the various suburbs, with an annual traffic of about 22,000,000 passengers. The construction of the electric lines is being proceeded with with the greatest energy, and already about 10 miles of track have been completed, and it is anticipated that by the first of next year electric traction will be employed on the two main suburbs and through the principal section of the town to the length of about 25 miles. Further extensions (about another 26 miles) have been authorised. Later on, the conversion to electric traction will be proceeded with in fresh sections of the system.

LEGAL INTELLIGENCE.

EXTENSIVE ENGINEERING FRAUDS.

The adjourned Quarter Sessions for Cheshire were opened at Knutsford Session House on Wednesday. Sir Horatio Lloyd presided in the first court, and heard the case of Henry Cleaver, 44, described as an electrical engineer, who pleaded not guilty to two charges of obtaining the sum of £1. 1s. with intent to defraud Messrs. Stanley Davies and Pollard, at Hyde, on Feb. 9, and attempting to obtain the sum of £25 from the same firm, with intent to defraud. The preliminary proceedings in this case appeared on p. 608. We are indebted to the *Manchester Guardian* for the following report:

Mr. Yates, who prosecuted, said the system adopted by the prisoner was an ingenious one. He had inserted an advertisement in an electrical journal that an electric installation was to be put down at Reading, and that specifications would be sent on receipt of a guinea, to be returned in case of a *bonâ fide* tender. Messrs. Davies and Pollard forwarded a cheque for a guinea, and afterwards submitted a tender for the work amounting to £4,880. The prisoner replied that he would place the order with them on receipt of £25, and a second £25 was to be paid afterwards. It was found that there was no installation to be put down at Reading.

Several witnesses were called in support of this statement.

Cleaver, in his address to the jury, denied that there was any intent to defraud. The matter related to an electrical process on which he had spent hundreds of pounds and also money of people associated with him. He was about to take out a third patent, and he demanded the guinea with a view to eliciting *bonâ fide* tenders, and, seeing the figures varied from £7,500 to £3,000, it justified him in having £25 as a guarantee.

Sir Horatio Lloyd, in summing up, said the jury could come to no other conclusion than that there had been fraud. Letters had been sent broadcast, and hundreds of guineas obtained.

The prisoner was found guilty.

The **Chairman** said that anyone who had heard the case must have been convinced. Manufacturers must be protected against such people.

Sentence of 12 months' hard labour was passed.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Salford.—The Tramways Committee invite tenders for a sample tramcar by July 18.

Hammersmith.—The Vestry invite tenders for the supply of transformers, etc., by July 5.

Glasgow.—The Corporation are prepared to receive tenders for the supply of 80 electric tramcar bodies by July 22.

Edinburgh.—The Corporation invite tenders for installing the electric light at the central fire station, Lauriston. Tenders by July 18.

Glasgow.—The Corporation are prepared to receive tenders for the supply and erection of boilers, steam-engines, three-phase generators, etc., by July 22.

South Shields.—The Corporation invite tenders for a 1,000-i.h.p. vertical triple-expansion engine with condenser and 500-kw. alternator. Tenders by July 10.

Wallasey.—The Urban District Council are prepared to receive tenders for the supply and delivery of alternating-current transformers. Tenders by July 20.

Wallasey.—The Urban District Council are prepared to receive tenders for the supply and erection of a 300-kw. alternator with engine combined. Tenders by July 20.

Rathmines and Rathgar.—The Electric Lighting Committee invite tenders for the supply and erection of various plant for the municipal electricity works. Tenders by July 14.

Pembroke (co. Dublin).—The Electric Lighting Committee invite tenders for the supply and erection of various plant for the municipal electricity works. Tenders by July 14.

Cardiff.—The Corporation invite tenders for the purchase of a 40-kw. Paxman-Siemens steam alternator, 2,500 volts, 16 amperes, 40 periods, at 200 revolutions. Tenders by July 6.

Warrington.—The Corporation are prepared to receive tenders for the supply, delivery, and erection of the various work in connection with the electric lighting of the borough by July 18.

Wimbledon.—The Library Committee invite tenders for wiring the library for the electric light. Plan and specification may be seen at the Library, Hill-road, Wimbledon. Tenders by noon on July 7.

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Morecambe.—The Urban District Council invite tenders for the supply of an economiser. For specifications and drawings apply to Mr. C. F. Parkinson, M.I.E.E., engineer, Electricity Works, Wood Hill-lane.

Grimsby.—The Corporation invite tenders for the supply, delivery, and erection, and the carrying out of various work in connection with the electric lighting of the borough. Tenders by noon on July 10.

Whitehaven.—The Town Council invite tenders for the supply of electric fittings and electric incandescent lamps, as may from time to time be ordered during the year ending July 31, 1900. Tenders by 10 a.m. on July 3.

Lowestoft.—The Corporation invite tenders for erection of an electric light station. Specifications, etc., may be obtained from Mr. Albert E. Pridmore, 2, Broad-street-buildings, London, E.C. Tenders by 12 noon on July 18.

Southampton.—The Corporation invite tenders for the supply and erection of—(Section A) continuous-current motor-boosters; (B) tramway switchboard; (C) battery of accumulators and accessories. Tenders by July 11.

Nelson.—The Gas and Electricity Committee invite tenders for the supply of an engine and dynamo (output from 25 kw. to 50 kw.), either new or second-hand. Further particulars can be obtained from Mr. W. Foster, gas manager, Nelson. Tenders by July 5.

Manchester.—The Electricity Committee invite tenders for the supply of the following stores during the 12 months ending June 30, 1900—viz.: carbons, incandescent lamps, and meters. Particulars, etc., may be obtained from Mr. F. E. Hughes, secretary, Electricity Department, Town Hall, Manchester. Tenders by July 10.

RESULTS OF TENDERS.

Belfast.—The tender of Mr. William H. Drennan has been accepted for the electric lighting of the Belfast Free Library and the Belfast Town Hall.

Leicester.—The Sanitary Committee have accepted the tender of Messrs. Ashwell and Nesbitt, at the sum of £2,791. 4s. 1d., for the electric lighting of the isolation hospital.

Ipswich.—The Guardians have accepted the tender of Messrs. Crompton and Co. for keeping the electric plant in good condition for a period of five years, at a cost of £7. 10s. per quarter.

Hampstead.—The Vestry have accepted tenders for a feed-water heater, steam and exhaust pipes, and an economiser for the extension of the central electric lighting station, the total cost being £4,354.

Grimsby.—The Public Lighting Committee have decided to recommend that the tender of Messrs. Hawins and Goodhand, of Grimsby, for the erection of buildings for the electric lighting station, for £11,525. 2s., be accepted.

Buxton.—The Urban District Council have accepted the following tenders for works in connection with the electric light station in Buxton: Contract No. 7, arc lamps—Crompton and Co., Mansion House-buildings, E.C.; Contract No. 8, arc lamp-posts—McDowall, Steven, and Co., Milton Ironworks Glasgow. Contract No. 7 includes the supply, delivery, and erection of the lamps, with all fittings, switches, etc. Contract No. 8 includes the supply and delivery of the lamp-posts at Buxton.

BUSINESS NOTES.

Aluminium Company.—Mr. Justice Cozens Hardy has sanctioned (on a petition by the Company) a recent reduction of capital.

Bridgwater.—The notice to rescind the resolution referred to in our last issue was discussed before the Council last week and lost.

Aldershot.—The proposed tramways scheme (Power and Traction, Limited) is being discussed by the District Council in committee.

Huddersfield.—The Local Government Board have sanctioned the borrowing by the Corporation of £50,000 for purposes of electric lighting.

Newport (Fife).—Steps are being taken with the view of forming a company for the purpose of installing a system of electrical lighting in Newport.

Llandudno and Colwyn Bay Light Railway.—It is stated that the engineers and contractors for the construction of the above will commence work in October next.

Leicester.—The Town Council are applying to the Local Government Board for sanction to the additional amount required for the electric lighting of the isolation hospital.

Chitty Dynamo and Motor Company.—On Monday Mr. Justice Cozens-Hardy made a compulsory order for the winding-up by shareholders and creditors of the Company.

Bangor.—Colonel Slack has held an enquiry into the Council's application to borrow £4,500 for the erection of a dust destructor in connection with the electric supply work.

Paignton.—The District Council have agreed to appoint a Lighting Committee to deal with the gas lighting, and also to consider the introduction of the electric light.

Portrush.—At a special meeting of the Urban Council it was resolved that a committee of the whole Council be called to discuss the question of the overhead system of electric traction.

Keynsham.—The Rural District Council, whose roads will be traversed by the scheme at Newton St. Lo, have resolved to dissent from the proposed electric tramways for Bath and district.

Llandilo.—At a public meeting held on Friday last at the request of the Urban District Council, it was unanimously resolved to have the town lit by electric light, the cost being estimated at £1 500.

Helios Electrical Construction Company, Limited.—This Company has been registered with a capital of £10,000 in £10 shares, and the object is to carry on the business of electrical engineers, etc.

Newhaven.—The Urban District Council have decided to grant a syndicate permission to obtain a provisional order for the lighting of Newhaven by electricity provided the Council can purchase after 20 years.

Sales of Plant.—In another column will be found particulars referring to sales of plant by Messrs. Binks, Ridsdale, and Co., Limited (in liquidation), and by the committee of the Conservative Club, Glasgow.

Western Telegraph Company, Limited.—This Company has been registered with a capital of £1,000 in £1 shares, and the object is to acquire and construct telegraph and telephone wires and cables, etc.

Greenock.—We learn that another offer for the tramways is to be made by Mr W. M. Murphy, Dublin and London, which will include a new section running through Roxburgh-street, in the higher portion of the town.

Abram.—The District Council have appointed a committee to confer with the Wigan and District Tramways Company on the subject of extending the system to certain portions of the townships of Abram and Ashton.

Whitby.—There is considerable opposition to the suggestion to locate the electric lighting station in close proximity to the town station. It is reported that probably a refuse destructor will be added to the proposed works.

Totnes Electricity Supply Company, Limited.—This Company has been registered with a capital of £10,000 in £1 shares, and the object is to carry on in Totnes and the surrounding districts the business of electricians, electrical engineers, etc.

Tewkesbury.—The Council have decided to take steps to ascertain the cost of obtaining a provisional order and the probable cost of establishing an electric light installation. A committee of the whole Council is to make the necessary enquiries.

Cape Electric Tramways, Limited.—The directors have declared an interim dividend of 3½ per cent., free of income tax, payable on receipt of the transfer returns from South Africa. The transfer books will be closed from 6th to 11th prox. inclusive.

Londonderry.—The British Thomson-Houston Company have made an offer to the Town Council for the extension of electric light and power in the city. The price of current quoted varies from 2¾d. to 4d. per unit for light, and from 1⅞d. to 2½d. for power.

Cheltenham.—The Light Railway Commissioners have held an enquiry into the application of Mr. Thomas Nevins to the Board of Trade for powers to construct a light railway from Lansdown railway station to Cleeve Hill. The Commissioners reserved their decision.

Snelgrove Electric Cash Register and Till Syndicate, Limited. This Company has been registered with a capital of £10,000 in £1 shares, and the object is to acquire and deal with provisional specification No 23,842 of 1898, for electric cash register tills, granted to W. Snelgrove.

Norwich Mutual Telephone Company, Limited.—This Company has been registered with a capital of £20 000 in £1 shares, and the object is to establish and maintain a telephonic exchange, or exchanges, and to acquire and carry on the business of the Norwich Telephone Company.

Cardiff.—The Corporation Tramways Committee on the 25th inst. had before them several letters from the tramways company protesting against the withdrawal by the Council of the permission to double the lines in certain parts of the borough. It was decided not to reopen the matter.

Ealing.—The Electric Lighting Committee's report states that 24,091 private lamps have now been applied for, and of this number 24,086 have been connected. The mains to Clovelly road will be extended on condition that one of the builders agrees to wire eight of the new houses

Electrical Corporation, Limited.—This Company has been registered with a capital of £30,000 in £1 shares, and the object is to adopt an agreement with J. E. Harding, and to carry on at Valparaiso or elsewhere the business of electricians, mechanical engineers, tramway proprietors, etc.

Shildon.—The Lighting Committee have instructed the surveyor to give the particulars asked for by a number of firms willing to undertake the electric lighting of the district, and also to ask the Electric Construction Company at what terms they would comply with the requirements of the district.

Accident.—A little girl was running across the tramway line at Dover on Wednesday when she was knocked down by a Corporation electric tram and died soon afterwards. This is the first fatal accident which has happened since the installation of the electric trams on the overhead system in Dover.

Edinburgh.—The Electric Lighting Committee on the 27th inst. recommended the acceptance of estimates for the extension of the boiler-house at Dewar-place station amounting to a little over

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£2,000, and estimates for the formation of a siding at M'Donald-road station amounting to somewhat over £1,000.

Pacific Cable.—The Chancellor of the Exchequer and the Secretary of State for the Colonies received a deputation from the Eastern and Eastern Extension Telegraph Companies at the Treasury yesterday for the purpose of stating the companies' views in regard to the all-British Pacific cable project.

Dewsbury.—The Dewsbury Corporation and the Heckmondwike and Cleckheaton District Councils having agreed to promote a scheme of their own, notice has been given to the Light Railway Commissioners by the local authorities of their intention to oppose the British Electric Traction Company's scheme.

Heckmondwike.—The District Council on Monday resolved to apply to the Local Government Board for sanction to the Council's proposed system for supplying electrical energy, and instructed the electrical engineer to prepare a detailed estimate to enable the Council to apply for the necessary borrowing powers.

Tverton (Bath).—At a meeting of the Council last week a resolution was carried assenting to the proposed electric tramways provided that the company do not charge in excess of the present omnibus fares. It was also suggested that a loopline be constructed to take in the thickly-populated part of Oldfield Park.

Plymouth.—Major Cardew, R.E., has held an unopposed enquiry into the Corporation's application for a loan of £18,000 for applying electrical power to the Compton tram section. The equipment will be similar to that of the Prince Rock section. The cost is estimated at 5d. per car per mile, against 10d. for horse power.

City of Carlisle Electric Tramways Company, Limited.—This Company has been registered with a capital of £60,000 in £1 shares, and the object is to acquire the powers and rights conferred by the Carlisle Tramways Order, 1898, and to carry on the business of carriers of passengers and goods, electrical engineers, etc.

India Office.—Messrs. Foote and Milne, successors to J. G. Statter and Co., Limited, have been entrusted by the Secretary of State for India with the electric lighting of the whole of the India Office, which is probably the largest Government installation now being carried out, the number of lights [being equivalent to over 3,000 8-c.p. lamps.

Bournemouth.—The surveyor has been instructed to obtain information as to what is being done in generating electricity in connection with refuse destructors in other towns and report. The Town Council have consented to the construction of a tramway by the Winton Urban District Council from Winton to the top of Richmond Hill.

British Electric Railway Company—At a recent meeting of shareholders of the British Electric Railway Company Mr. R. M. Horne-Payne, the chairman, said that the installation of the plant for utilising the water power from the fal's of the Gold Stream at Victoria (B.C.) had been completed, and the plant had been running satisfactorily since April

Kingston.—An enquiry will be held to-day into the Town Council's application to the Local Government Board for sanction to borrow £15 000 for electric lighting purposes. A plan and particulars of the proposed electric light railway scheme are to be submitted to the Light Railway Commissioners, in accordance with a plan prepared by the borough surveyor.

Sheffield.—The electric light was used for the first time at St. Marie's Church on Sunday last. The current is supplied from the Corporation mains, at a pressure of 200 volts, from a special transformer in Norfolk-row. The electroliers were designed by Mr. C. Hadfield, in conjunction with Mr. J. G. Burchell, and the installation was carried out by Messrs. John Dewhurst and Son, Limited.

Rawmarsh.—At the last meeting of the Urban District Council the General Purposes Committee reported that they had considered the question of electric tramways, and a resolution was moved that the Rotherham Corporation be asked to receive a deputation from the Council on the subject of a joint scheme. It was agreed to ask the Gas Sub-Committee to take the matter into consideration.

Shipley.—At Tuesday's meeting of the District Council the Electricity Committee reported that the provisional order for electric lighting in the Shipley district had passed through the House of Lords, and had reached the first stage in the House of Commons. It was resolved to again inform the Electrical Power Distribution Company, in answer to their communication, that the District Council would not transfer any of their powers.

Drumcondra.—The Urban District Council, after having considered the terms on which the Dublin District Electricity Corporation, Limited, are prepared to supply electric light—viz., 4d. per unit for public and 5d. per unit for private lighting—have resolved to ask the Local Government Board for powers to enter into such arrangements as they may deem most advantageous with the Dublin Electricity Corporation, Limited, or others, as they may be advised.

St. Helens Cable Company, Limited.—This Company has been registered with a capital of £50,000 in 4,200 £10 shares and 4,000 £2 shares, and the object is to adopt and carry into effect certain agreements expressed to be made by the Company with Messrs. B. G. and W. J. Glover, G. E. Heyl-Dia and Hanchett and Co., Limited, W. Hanchett, and others, and generally to carry on in all or any of their respective branches the businesses of wire rope and cable manufacturers, etc.

Rawdon.—At a recent meeting of the joint committee appointed by the District Councils of Horsforth, Rawdon, and Yeadon to consider the best method of bringing about a system of trams from the Leeds city boundary to Leadon or Guiseley, it was decided that, before discussing the offers made by various parties to construct and work the tramway, the respective Councils should separately decide whether or not they themselves would undertake to carry out the scheme or allow a private firm to do so.

Accrington.—With regard to the meeting of the shareholders of the Accrington Corporation Steam Tramways Company, previously referred to, we learn that an agreement for the sale of the company's undertaking to the British Electric Traction Company for £55,000 was approved of subject to certain conditions. One condition of the purchase is the extension of the present lease of the lines, but representatives of the Corporations of Accrington, Haslingden, and Rawtenstall, the three boroughs concerned, are opposed to the renewal.

Hull.—An unofficial trial of the tramways took place on the 27th inst. on the Hessle-road section. At present there are 30 motor-cars on hand and 25 to 30 trailers. Next week there will be from four to five miles of line opened, extending two miles westward from the starting point. The fare for the whole distance has been fixed at 1d. per passenger. Electricity is now being generated by one engine of 260 h.p., and two more engines of the same power are being set up. The Hessle-road system will be opened on Wednesday next, and the Anlaby-road section about a week later.

Hammersmith.—At the last meeting of the Vestry the Finance Committee reported "that with reference to the Vestry's resolution of Jan. 4 last directing an application to be made to the London County Council for a loan of £56,000 for further extensions of electric lighting station and plant, we now find that in consequence of the increase of the amount of the contracts over the estimates it is necessary to increase the loan to £69,122; we have, therefore, directed a further application to be made for the latter amount, and we recommend that our action be approved." The report was adopted.

Dorking.—At last week's meeting of the Urban District Council a letter was read from an electric power distribution company in reference to the lighting of the town by electricity. It was stated that the Electric Lighting Committee hoped in the course of the next four or five years, when the present agreement with the gas company expires, to be able to recommend the Council to instal the electric light at a rate which would enable it to pay its own way. Consequently the clerk was instructed to reply to the company that the Council could not enter into a contract with them at the present time.

Smith, Simpson, and Co, Limited.—This firm is manufacturing a patent aluminium coating, which has been tested by Mr. R. C. Quin, Corporation electrical and tramway engineer, Blackpool, and as a result it will be applied to all the new combined trolley and arc lamp pillars now being erected on the Blackpool promenade. The use of the coating is not confined to trolley or lamp pillars; it is equally applicable to any exterior ironwork, such as bridges, girders, etc., and is specially suitable for railway bridges, and it is claimed that if properly applied it gives absolute protection from rust and corrosion.

Islington.—At the last meeting of the Guardians a report was received from the Highgate-hill Infirmary Building Committee recommending the acceptance of the tender of Messrs. Frank Suter and Co., Limited, for electric lighting, at the sum of £7,794. In connection with this matter letters were read from Messrs. Kirk and Randall and Messrs. Foote and Mill, the latter firm complaining that their tender, which was lower than Messrs. Suter and Co.'s, had not been accepted. The report was agreed to. The Vestry have taken steps for preventing the Vestry of St. Pancras from interfering with the roads in the parish.

Bath.—At the last meeting of the City Council it was resolved to oppose the application made by London financiers for an order to institute a system of electric tramway for the city and district. The Council resolved to apply for an order in November. It was explained that it did not necessarily follow they would lay down the tramways themselves. A resolution was passed sanctioning the application for another loan for electric lighting purposes to the amount of £26,000. This sum is in addition to £55,275 already advanced, and covers mainly the cost of extending mains to different parts of the city at present unserved.

Removals.—Mr. Carl Quitmann is removing from 17, Jewin-crescent, E.C., where he has been carrying on the business of importer and agent for electrical, gas, and paraffin goods for the last 22 years, to 3, Cloth-street (just behind Manchester Hotel), Aldersgate-street, E.C.—Messrs. Sanders and Co., general agents for the Baldwin Locomotive Works, Philadelphia, U.S.A., have removed their London office from 36, Lime-street, E.C., to 110, Cannon-street, E.C.—Messrs. Gent and Co., of Faraday Works, Leicester, have removed their London warehouse and office to 25, Laurence Pountney lane, Cannon-street, E.C.

Spen Valley Tramway Scheme.—At a meeting of the Dewsbury Town Council last week, it was resolved to oppose the British Electric Traction Company, who are seeking power to construct a line to serve Dewsbury, Liversedge, Heckmondwike, and Cleckheaton. The draft scheme of the three public authorities for providing a line at their joint cost was approved. It is intended to include Ravensthorpe in the joint scheme. The agreement between the Cleckheaton and Heckmondwike District Councils and the Dewsbury Town Council with reference to the proposed joint electric tramway has been ratified by the Cleckheaton General Purposes Committee.

Metropolitan Electric Supply Company, Limited.—This Company have given notice that on July 22 they intend to apply to

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the London County Council for their approval to the Company's standard pressure at which electrical energy is supplied being altered as follows: (1) where there is no transformation of energy on the consumer's premises the standard pressure to be altered from 100 volts to 200 volts; (2) where there is a transformation of energy on the consumer's premises the standard pressure to be altered from 100 volts, with choice to the consumer of a pressure of 50 volts, to a pressure of 200 volts, with choice to the consumer of a pressure of 100 volts.

London County Council.—At the usual weekly meeting of the Council held at the County Hall, Spring-gardens, on Tuesday, it was agreed to lend the Newington Vestry £10,000 for electric lighting purposes. A notice to lay mains, etc., from the County of London and Brush Provincial Electric Lighting Company, under the Camberwell order, and one from the same company under the Wandsworth order, was approved of. The report of the Parliamentary Committee stated that clauses and an agreement had been settled with the promoters of the London United Tramways Bill, and recommended that the seal of the Council be affixed to the agreement arrived at with the promoters.

Shoreditch.—At the last meeting of the Vestry a report of the Lighting Committee was submitted, stating that they had been advised by the chief engineer of the necessity of erecting additional sub-stations, and they recommended that permission be granted them to build two new underground sub-stations, one at Batey's-corner and one at the corner of Great Cambridge-street and Hackney-road and that the Works Department be instructed to prepare the necessary specifications and plans for the two buildings in question to the approval of the Lighting Committee. An amendment to refer the plans to the Vestry for their approval, and not the Lighting Committee, was lost and the report agreed to.

Personal.—We are informed that Mr. C. H. Gadsby, Wh.Sc., M.I.E.E., has resigned his post as contract engineer to the British Electric Traction Company for the purpose of devoting himself to private practice as a consulting electrical engineer, and has opened offices at 20, Victoria-street, Westminster, S.W., where he will make electric traction work his speciality. The British Electric Traction Company has retained Mr. Gadsby as engineer for the Devonport tramways.—Mr. R. F. Ferguson, superintending engineer to Messrs. Manlove, Alliott, and Co., has been appointed clerk of works and electrical engineer at the station now being built at Townmead road. Mr. Ferguson will take over his duties within a month.

Norwich.—The Town Council have passed a resolution to the effect that £15,000, being the second instalment payable to the Norwich Electric Tramways Company in respect of new streets and street widenings under Section 30 of the Norwich Electric Tramways Act, 1897, be paid to the company; and that such sum be borrowed on the security of the borough fund and borough rate. A motion has been passed requesting the Norwich Tramways Company to put on double shifts of men when the tramways are being constructed in the Market-place, Guildhall hill, St. Stephen's-street, and St. Andrew-street. Wayleaves have been granted to the National Telephone Company for underground wires at an annual rental of £5. 5s.

Blackpool.—The various departments of the Corporation have prepared their estimates for this year, and the rate has been reduced by 6d. The reduction is partly due to an increased assessment, and partly to the fact that the gas, electricity, and tram profits are estimated at no less than £20,000, which is considered as a very low estimate. The cost of replacing the electric light cables was £13 239, and towards this £2,300 was paid out of rates each year of 1898 and 1899, thus leaving a balance of £8,639 to be met out of rates or other revenue. As separate trading departments, the electric lighting department spent £8 107, and the tramway department spent £11,547. The Alhambra Company is to be supplied by the Corporation.

Southend.—Sir Courtenay Boyle has held an enquiry into the objection of the Leigh Urban District Council to the confirmation of the order for the making of about six miles of light railway in Southend and the Leigh urban district. The Corporation of Southend are the promoters, and the Urban District Council desired the Board of Trade to insert a clause binding the promoters to widen a road to a minimum of 23ft., and to complete the whole of the light railway within three years. Sir C. Boyle said it was a strong thing to go into another local authority's district without their consent, but the Corporation were justified in resisting the claim of the Urban Council to pay for the widening of the road. He adjourned the case for the parties to come to some agreement.

Dudley.—A trip of two of the one-storeyed electric cars took place on the 22nd inst. Each car has a length of 27ft. 3in., capable of accommodating 28 passengers, and is fitted with cushioned seats, and with enclosed cabs at each end for smokers. Each car is fitted with two motors of 30 h.p., a powerful hand-brake, and an electrical emergency brake. The facilities afforded the driver of instantly stopping the tram were demonstrated. The cars were illuminated by five 16-c.p. lamps. The current was supplied from the Corporation's generating station at Springsmire, the plant of which was put to a practical test for the first time. The station contains two engines of the Westinghouse type of 200 h.p. and 100 h.p. respectively. It is anticipated that the line will be opened for the public in about a fortnight.

Bankruptcy.—Yesterday afternoon the examination in bankruptcy of Thomas Stothert M'Laren, electrical engineer, carrying on business at 80, Haymarket-terrace, Edinburgh, took place in the Sheriff Court before Sheriff Substitute Maconnochie. Bankrupt deponed he began business in 1897 as an electrician. He borrowed £200 from a relative and a friend, and likewise about £70 from his father. He only kept a ledger which also showed all his cash transactions. He had executed several small contracts for the Corporation, and had lost money on some of these owing to having charged too small prices for the class of work he put into the various jobs. He should have made about £250 on his contracts, but instead he had lost more than his profits should have been. The state of affairs was: assets, £553; liabilities, £1,358, showing a deficiency of £805. The oath was administered.—*Glasgow Herald.*

St. George's (Hanover-square).—At last week's meeting of the Works Committee of the Vestry, Prof. Kennedy, engineer-in-chief to the Westminster Electric Supply Corporation, Limited, wrote, with regard to the steam from the corporation's works emanating from Vestry's sewers, that he had given instructions to cease the use of condensation entirely at present; further, that the new pipes had been completely laid to the canal, but the contractors had not yet delivered the pumps for use with them, so that they could not at present get any benefit from them. In another letter Prof. Kennedy stated, in regard to the complaint about smoke and grit proceeding from the company's premises, that it did not come from their chimney. It was resolved to instruct the surveyor to employ someone to watch the company's chimney. It was mentioned that complaints from residents of Ebury-street and Chester-square were numerous.

Leeds Tramways.—Another trial run of an electric car was made on the Headingley route of the Leeds tramways on Friday last. Sir Francis Marinden, on behalf of the Board of Trade, was conveyed on an electric car over the route on the 27th inst.—Of the 60 applicants for the position of traffic manager, Mr. W. R. Spaven, chief inspector Leeds Corporation tramways, has been appointed. The salary has been fixed at £300 a year. Mr. Spaven has been connected with the working of the tramways in Leeds for close upon 21 years, during 10 of which he has been chief inspector. His duties will consist of the supervision of the trams on the lines, of drivers and conductors, and others engaged on the various routes. Mr. Wharam will have under his management the depôts, the offices, and all work arising out of these departments—the control of the system being thus divided between the two managers under the committee.

Chelmsford.—The Town Council have now adopted a report of the Electric Lighting Committee recommending that an offer be made to the Chelmsford Electric Lighting Company to purchase the undertaking upon the following terms: (1) the contract of September, 1898, between the lighting company of Messrs. Crompton to be distinctly set out, and completed to the satisfaction of the consulting engineer to the company before completion of service; (2) the generating works to be increased so as to comply with Mr. Hammond's suggestions to provide sufficient land to permit reasonable expansion of the works on the most efficient lines; (3) that the price be £24,000; (4) the company to provide for the legal transfer of the two provisional orders for 1894 and 1898 to the Town Council, so as to empower the Corporation to carry on the undertaking as specified therein; and (5) the offer to be subject to the Local Government Board sanctioning the borrowing of the money required.

Manchester.—The annual report of the Electricity Committee of the Manchester Corporation states that in the year ended March 31 last there has been an increase of 44 per cent. in the output of electricity from the works, amounting to 1,722 255 units. The consumers numbered 2,570, being an increase of 515 during the year. Mains laid measure 74 miles 217 yards, an increase of 28 miles in the year. The gross revenue amounted to £71,941, and the expenditure to £34 350, showing a gross profit of £37,590, out of which £20,402 went to meet interest on mortgage debt, and as contribution to sinking fund, leaving a surplus or net profit of £17,188. This has been appropriated by payment to the city fund in aid of rates of £12,000, and to the reserve fund £3,188, carrying forward £2,000 to next year's account. The total capital expenditure on the undertaking is £493 716, and application has been made to the Local Government Board for sanction to raise an additional sum of £500,000 for extensions.—*Leeds Mercury.*

Smoke Nuisance.—The representatives of the Charing Cross and Strand Electricity Supply Corporation appeared last week before Sir James Vaughan to two adjourned summonses charging them with sending forth black smoke from their chimney in Maiden-lane, Strand, in such quantity as to be a nuisance, contrary to the provisions of the Public Health (London) Act, 1891. Sir James Vaughan said it was a case in which he was bound to convict. He had no doubt that if the defendants did their work in Maiden-lane, Strand, in the same way as they did at Lambeth, there would be no nuisance. The defendants must pay £5 and £5. 5s. costs. He hoped they would take steps for reducing the nuisance as much as possible. If they did that, and did not succeed, it would be an extremely good answer to any summons that might be applied for. Another case against the same defendants, which had been adjourned for the production of expert evidence, was withdrawn on the payment of £5. 5s. costs.

South Staffordshire Tramways.—The position of affairs with regard to the tramways in South Staffordshire has (says the *Birmingham Gazette*) undergone a great change during the last few days. The present position of the local authorities appears to be this: Walsall, Wednesbury, and Darlaston have agreed upon a united policy for purchasing and working the tramways in their respective districts jointly. West Bromwich will purchase the whole of the tramways running through the borough, about 12 miles of single track, and is quite prepared to work them alone or jointly with other authorities. Handsworth appears not to have decided to purchase or to have joined with any other authority,

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and they with Tipton will be in the hands of the South Staffordshire Tramways Company, which might lease to another company. Parliament would scarcely allow Handsworth, with only half a mile of tramways, to cause a break in 20 miles of tramways between towns in South Staffordshire and Birmingham.

Lewisham.—At the last meeting of the District Board the Works and General Purposes Committee reported that they had considered the notice by the Blackheath and Greenwich District Electric Light Company, Limited, of their intention to lay a main from the north corner of Grote's-place, Blackheath, to its southern end, crossing the road at this point, thence along Grote's-buildings and Lloyd's-place to the north corner of Lloyd's place in Tranquil-vale, and recommended that the Board approve the works as shown on the plans submitted, subject to the proposed main being laid in the carriageway just outside the channelling and certain other amendments and conditions. The Blackheath and Greenwich District Electric Light Company gave notice of their intention to lay mains in Tranquil-vale and Royal-parade, Blackheath, and requested permission to lay cables under the footpaths in Montpelier-vale and Montpelier-row, Blackheath. The last matter was referred to the Local Committee. On the recommendation of the Blackheath and Lewisham Local Committee the tender of Messrs. Mowlem, at £194, for widening the roadway in High-street, Lewisham, from the London and Provincial Bank buildings to the Albion public-house, near Albion-road, was accepted.

Parliament.—During the last week the following Bills were read a third time and passed: St. James's and Pall Mall Electric Light, Glasgow and South-Western Railway, Wolverhampton Tramways, North Staffordshire Railway, Great Eastern Railway (General Powers), Edinburgh Corporation, Kensington and Notting Hill Electric Lighting, South-Eastern Railway, and the Brynmawr and Western Valleys Railway. The following Bills were read a second time: Bradford Tramways and Improvement, Walker and Wallsend Union Gas (Electric Lighting), Brompton and Piccadilly-circus Railway, City and Brixton Railway, and the Lincoln and East Coast Railway and Dock. The following Bills were read a third time: Derby Corporation Tramways, etc., Bexhill and Rotherfield Railway, Bradford Tramways and Improvement, London, Walthamstow, and Epping Forest Railway, Harrow and Uxbridge Railway, and London United Tramways. The Oystermouth Tramway Bill was read a second time. The Dundee Tramways and Improvement Bill was amended and ordered for third reading. The Ilkeston Corporation Tramways Bill passed Earl Spencer's Committee in the House of Lords, and was ordered to be reported for third reading.

Appointments Vacant.—The Electrical Committee of Bristol are prepared to receive applications for the vacancies for two improvers; a resident engineer and electrician is required at the Middlesex Hospital Convalescent Home, Clacton-on-Sea. Particulars of these and other vacancies appear elsewhere.—An assistant engineer is required in connection with the working of the electric lighting plant in Lagos. Salary £300 a year with free quarters. Terms, one year from arrival in the colony, subject to renewal for a further period of two years. Half salary during voyage out and home on expiration of engagement. Free passages out and home provided. Leave of absence. If the engagement is extended, and if the exigencies of the service permit, six months on full salary with free passage home and out again for every period of 12 months' continuous residential service. The engineer will be required to leave for the colony before Aug. 15. Applicants must have had a thorough mechanical and electrical training and have had experience of locomotive boilers, engines, and alternating-current plant. Married men are ineligible. Applications will be received by the Crown Agents for the Colonies, Downing-street, Westminster, S.W., up to July 4.

Swansea.—The report of the Tramways and Electric Lighting Committee adopted at the last meeting of the Council mentions that the Local Government Board have sanctioned the loan of £52,046 for the purposes of electric lighting; that the further amended plans for the generating station have been approved, and the engineers have been instructed to forthwith proceed with the preparation of the detail drawings and specification of the works, and to engage a surveyor to take out the quantities of the proposed building; that the Board of Trade have approved of the proposed system for the supply of electrical energy; that the design of the combined lighting and traction poles and also the positions of the same have been approved. The difference in the cost of the combined poles is £8 each, which amount the Corporation have agreed to pay. Various alterations and additions to tramways were recommended. With regard to a letter from the tramways company desiring to meet a committee of the Corporation with further reference to the light railways orders, it was stated that as the Town Council have already decided that they are opposed to the promotion of the order under the Light Railways Act, the committee thought that no advantage would accrue from such proposed meeting.

Beckenham.—The Local Government Board have sanctioned the loan for the electric light with the exception of £800 asked for for a siding, with regard to which further particulars were asked for. The railway company had asked £600, with £140 as was understood for a signalman, and £300 as a guarantee. The Clerk said at last week's meeting of the Urban District Council that three years ago they asked a lump sum of £600, and he was instructed to write and ask them to explain the difference. Probably the Council would find it not to their interest to go on with the siding at all. The scheme was for supplying electric light to the whole of Beckenham. The Council had not yet had the tenders in for putting up a chimney, and they could not put up one in less than six or eight months, so that it would be impossible for them to supply the district themselves by Jan. 1, 1900, as was contemplated. In view of that fact they had asked the British Insulated Wire Company whether it would be possible to extend the supply from Bromley to Shortlands as far as Beckenham, and now Bromley had entered into a contract to give such a supply from Christmas until March 25, 1900, by which time the supply would be ready. As to free wiring, the surveyor and himself were to bring up a full report. The land for the electric lighting works was taken on a lease for 999 years, and would come into the possession of the Council at once. The report was adopted.

PROVISIONAL PATENTS, 1899.

JUNE 19.

12730. Improved galvanic cell. Peter Offenbroich and Heinr Rockel, 18, Southampton-buildings, Chancery-lane, London.

12731. Improvements in electrical switches, particularly suitable for high voltage connections. George Whittaker Holt and Arthur Atherley, 18, Southampton-buildings, Chancery-lane, London.

12732. Improvements in electrical switches. George Whittaker Holt and Arthur Atherley, 18, Southampton-buildings, Chancery-lane, London.

12750. Improvements in or relating to electric traction systems. Emanuel Cervenka and Simon Mahler, 111, Hatton-garden, London. (Complete specification.)

12757. An improved current-collecting brush for electro-motors, dynamo-electric machines, and the like. Isidor Landauer, 11, Southampton-buildings, Chancery-lane, London.

12767. Improvements in and connected with coin-freed electricity meters. Frederick John Beaumont, 166, Fleet-street, London.

12772. Improvements in electrical resistance baths. William Cross Sellar, 53, Chancery-lane, London.

12787. Improvements in devices for breaking electric circuits and protecting the same from excessive currents. William Phillips Thompson, 322 High Holborn, London. (The Rolfe Electric Company, United States.)

12788. Improvements in and relating to carbon conductors for electric cells and dynamos. Carl Wilhelm Hertel, 322, High Holborn, London.

12789. Improvements in telephone systems. Richard Wienmar, 6, Lord-street, Liverpool.

JUNE 20.

12800. Improvements in or appertaining to certain multiple safety fuse blocks for electric light wires and other similar electric conductors. Matthew Henry Barber, 2, Market-street, Bradford.

12829. Improvements in obtaining metals from their fused ores, oxides, and salts by electrical action. José Baxeres de Alzugaray, 24, Suffolk House, Laurence Pountney-hill, London.

12833. Improvements in filaments for electric glow lamps. Godfrey Bamberg, 22, King William-street, Strand, London.

12842. Improvements in electrostatic measuring instruments. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Elihu Thomson, United States.) (Complete specification.)

12869. Improvements in driving mechanism for dynamos. William Lord Bliss, 6, Bream's-buildings, Chancery-lane, London. (Complete specification.)

12874. Improvements in glass globes, screens, covers, or the like for electrical incandescence and other lamps, and in means for manufacturing the same. Edward Applegarth, 115, Cannon-street, London.

12883. A method of repairing incandescence electric lamps. Marcel Dumont, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, April 12, 1899, being date of application in France.)

JUNE 21.

12904. Improvements in working changing colours for advertising signs, electrical effects, and the like. George Frederick Kenyon and William Henry Blackhurst, 4, St. Ann's-square, Manchester.

12949. Improvements in or relating to the connection of house service or branch conductors to electric mains. Leonard Andrews and John Glass, 46, Lincoln's-inn-fields, London.

12951. Improved cut-out apparatus for automatically disconnecting incandescence lamps having filaments of secondary conductivity. William Phillips Thompson, 322, High Holborn, London. (The Vereinigte Electricitäts Actien Gesellschaft, Austria-Hungary.) (Complete specification.)

12956. Improvements in electric furnaces. La Compagnie Electro-Métallurgique des Procédés Gin et Leleux, 47, Lincoln's-inn-fields, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Jan. 27, 1899, being date of application in France.)

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12959. Improvements in or relating to electric motors. Gustave Verberckmoës and Philippe Caire, 111, Hatton-garden, London.

JUNE 22.

12961. Improvements in and relating to methods of controlling electrically-propelled vehicles. Percy Wilbraham Northey and the Electric Motive Power Company, Limited, 74, Caistor-road, Balham, London.

12962. Improvements in electrically-propelled vehicles. Percy Wilbraham Northey and the Electric Motive Power Company, Limited, 74, Caistor-road, Balham, London.

13008. Improved apparatus for converting alternating currents into continuous current. Max Deri, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

13018. Improvements in electric arc lamps. John Brunswick Barton and John Marshall Gorham, 18, Southampton-buildings, Chancery-lane, London.

JUNE 23.

13054. Improvements in holders for globes and shades of gas, electric, and other lamps. George Frederick Sanders, 36, Temple-street, Birmingham.

13062. Improvements in and relating to incandescent electric lamps. Henry Schuster Cowx, 566, Chester-road, Old Trafford, Manchester.

13074. Improvements in apparatus for electrolysis. Paul Schoop, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

13076 Improved troughing for electric cables. George Sutton, 53, Chancery-lane, London.

13088. Improvements in electric tramways or railways. Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Chancery-lane, London. (Edouard Bonnet, Jules Paufique, and Georges Linière, France.)

13105. Improvements in electric arc lamps. The Jandus Arc Lamp and Electric Company, Limited, and Adrian Denman Jones, 18, Southampton-buildings, Chancery-lane, London.

JUNE 24.

13111. Improvements in and connected with electrical switches. Edward John Wade and the Electric Motive Power Company, Limited, 74, Caistor-road, Balham, London.

13117. An improved magnetic motor. Benjamin Draper, William Bayliff, and Thomas Dutton Bayliff, 15, Water-street, Liverpool.

13118. Improvements in mechanism for electrically driving Roots and like blowers. Arthur Devonshire Ellis and William Bateman Crichton, Sunbridge-chambers, Bradford.

13133. Improved means of cooling enclosed electric motors or dynamos. Wilson Hartnell, Volt Works, Kirkstall-road, Leeds.

13136. Appliance for telephone pay stations. John Edward Kingsbury, 24, Southampton-buildings, Chancery-lane, London. (The Western Electric Company, United States.)

13138. Improvements in the construction of cores in electrical cables. Carl Christian Sonne and Kay Gulstad, 322, High Holborn, London.

13167. An improved electric condenser and the application of the same in combination with electrical devices or machines. Septimus Frizzoni, 45, Southampton-buildings, Chancery-lane, London.

13174. Improvements in electric signalling apparatus. Felix Benedict Herzog, 51, West 24½-street, New York, U.S.A.

SPECIFICATIONS PUBLISHED.

1898.

13304. Electric arc lamps. Arter.

13318. Coin-operated signal apparatus for pay-station telephone. Thompson. (Mason and Weimer.)

15208. Electric heaters. Gold.

15881. Construction of dynamo-electric machines in combination with flywheels of motors. Levavasseur.

16460. Automatic safety device, specially applicable to three-wire or balanced systems of electrical distribution generally. Veritys, Limited, and Steele.

20531. Electromagnetic mechanism for actuating engine valves. McLaren and McLaren. (Nayler.)

27074. Incandescent arc electric lamps. Irish.

1899.

4276. Automatic potential regulators for dynamos. Browne. (Tirrill Automatic Potential Regulator Company.)

5932. Method and apparatus for rapidly transmitting and recording telegrams. Pollak, Virag, Egger, and Silberstein.

7339. Method of operating typewriting, composing, or similar machines by means of electromagnetism. Trowe.

7527. Thermo-electric batteries or piles. Matthias.

TRAFFIC RETURNS FROM ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Returns for week Ending	1899.	Corresponding week 1898.	Increase or decrease.	Total receipts for half-year. 1899.	1898.
		£	£	£	£	£
Birmingham Tramway Co.	June 24	4,180	4,000	+ 180	99,392	91,182
Blackpool and Fleetwood Tramroad	,, 24	611	—	—	9,321	—
Bradford City Trams	Feb. 5	145	—	—	6,733‡	—
Bristol Tramways and Carriage Co.	June 24	3,023	2,828	+ 195	—	—
City and South London Railway	,, 25	933	986	- 53	26 950	26,518
Dover Tramways	,, 24	202	170	+ 32	4,021	3,156
Dublin U.T., elec. cars	,, 23	1,275	1,079	++ 195	25,326	20,312†
Dublin S.D. Electric Tramways	,, 23	1,085	761	+ 323	19,095	12,390
Halifax Corporation Tramways	Mar. 29	312	—	—	10,712*	—
Liverpool Overhead Railway	June 25	1,439	1,474	- 35	36,021	36,977
South Staffordshire Tramways	,, 23	656	620	+ 36	15,826	15,101

* Since June 30, 1898. † Including horse cars. ‡ Since July, 1898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Blackpool and Fleetwood Tramroad Shares	10	23½-24½
Bournemouth and Poole Electric Supply, Limited, Ord.	10	13½-13¾
—— 4½ per cent. Cum. Pref.	10	10¾-11½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	18-19
—— 6 per cent. Cm. Pf., 30,001-40,000 (all paid)	10	14-14½
—— 6 per cent. Cm. Pf., 40,001 60,000	10	13¾-14½
—— 5 per cent. Perpetual Debenture Stock	100	126-129
Brush Electrical Engineering, Limited, Ordinary	2	1¾-2
—— Non. Cum., 6 per cent. Pref.	2	2½-2¾
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	103-106
Callender's Cable Company, Debentures	100	114-117
—— Ordinary	5	14-15
Central London Railway, Ordinary	10	10½-11
——	8	8¼-9
—— Pref. Half-Shares	3	3-3½
—— ,, ,,	5	5½-6
Charing Cross and Strand	5	10¾-11½
—— 4½ per cent. Cum. Pref.	5	5½-6½
Chelsea Electricity Company	5	8-9
—— 4½ per cent. Debentures	100	112-114
City of London, Ordinary	10	14-16
—— 6 per cent. Cumulative Pref.	10	13-15
—— 5 per cent. Debenture Stock	100	125-130
City and South London Railway, Consolidated Ordinary	100	67 69
—— Ordinary	3	4¾-5½
—— 2 per cent., 501-60,000	2	1-2
—— 4 per cent. Debenture Stock	100	132-134
—— 5 per cent. Pref. Shares	10	14½-15½
—— ,, ,, ,, '96	10	13¾-14½
County of London and Brush Prov. Elec. Light Co., Ord.	10	11-12
—— 6 per cent. Cum. Pref.	10	14-15
—— 4½ per cent. Prov. Certs.	—	54-56
Crompton and Co.	3	3¾ 4
—— 5 per cent. Debentures	—	99-102
Crystal Palace District, Ordinary 5 per cent. Stock	100	135 140
—— Preference 5 per cent. Stock	100	140-145
Edison and Swan United Ordinary	3	2-2½
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	97-99
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	5½-5¾
Electric Construction, Limited	2	2½-2¾
—— 7 per cent. Cumulative Pref.	2	3-3½
—— 4 per cent. Perp. 1st Mort. Deb.	100	103-106
W. T. Henley's Telegraph Works, Ordinary	10	24½-25½
—— 7 per cent. Preference	10	18-20
—— 4½ per cent. Debentures	100	113-115
House-to-House Company, Ordinary	5	7½-8½
—— 7 per cent. Preference	5	9-10
Imperial Tramways, Limited	6	24½-25½
India Rubber, Gutta Percha, and Telegraph Works	10	21-22
—— 4 per cent. Debentures	100	101-105
Kensington and Knightsbridge Ordinary	5	12½-13½
London Electric Supply, Ordinary	3	3¾-4
—— 6 per cent. Pref.	5	6½-7
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	104-106
Metropolitan Electric Supply, Limited, Ord., No. 1-62,500	10	16½-17½
—— ,, ,, No. 62,501-85,000	10	15½-16½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-121
National Telephone, Ordinary	5	4½-5½
—— 6 per cent. Cum. First Pref.	10	11-13
—— 6 per cent. Cum. Second Pref.	10	11-12
—— 5 per cent. Non. Cum. Third Pref.	5	4½-5½
—— 3½ per cent. Deb. Stock, Red.	100	100-103
Notting Hill Electric Lighting Company, Limited	10	16-17
Oriental, Limited, 1879	1	1¼-1½
—— £5 Shares	5	7½-8
—— £4½ Shares, New	4½	6½-7
Oriental Telephone and Electric Company	1	¾-1
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6¾-7¾
Royal Electrical Company of Montreal	1½	160-169
—— 4½ per cent. First Shares Mortgage Debentures	100	105-107
South London Electric Supply, Ordinary	3	4¼-4¾
St. James's and Pall Mall, Limited, Ordinary	5	17-18
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	13	37-41
—— 5 per cent. Bonds	100	105-109
Waterloo and City Railway, Ordinary	100	104-107
Westminster Electric Supply, Ordinary	5	14-15

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